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AN EXAMINATION OF INDICATORS OF SOCIAL EQUITY IN MICHIGAN ENVIRONMENTAL POLICY: THE CASE OF THE MICHIGAN ENVIRONMENTAL RESPONSE PROGRAM

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AN EXAMINATION OF INDICATORS OF SOCIAL EQUITY IN MICHIGAN ENVIRONMENTAL POLICY: THE CASE OF THE MICHIGAN ENVIRONMENTAL RESPONSE PROGRAM

By

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ABSTRACT

AN EXAMINATION OF INDICATORS OF SOCIAL EQUITY IN MICHIGAN ENVIRONMENTAL POLICY: AN ANALYSIS OF THE MICHIGAN ENVIRONMENTAL RESPONSE PROGRAM

By

Christopher Paul Grobbel

According to many researchers, policy makers and community leaders, environmental and human health risks in the United States are disproportionately borne by the poor and people of color. These include risks from the disposal of hazardous materials, the siting of hazardous waste generating facilities and polluting industry, and the implementation and enforcement of environmental regulations. Of the more than 90 empirical studies of environmental equity published by 1998, most have focused on issues relative to the siting of potentially polluting facilities, and few have attempted to reveal or analyze the potential for injustice in the state implementation of environmental programs designed to be blind to social difference. This study analyzes measures of social equity in the implementation of Michigan's Environmental Response Act Program, specifically the Michigan Department of Environmental Quality's (MDEQ) implementation and enforcement of the risk priority-based Part 201 program. By statistically analyzing MDEQ performance measures at Part 201 sites randomly selected within socioeconomic categories, this study found differences in the MDEQ implementation, enforcement and funding of the Part 201 program related to income, race/ethnicity and population density. Most results, however, were not determined to be significant using multiple statistical methods. It is recommended that similar research be

undertaken for other state environmental protection programs, and that larger samples be used in future research.

Dedicated to my loving and patient wife, Rachael.

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This publication, as well as my entire graduate education, would not have been possible without the assistance and guidance of Dr. Frank Fear, Resource Development Department, Michigan State University. I feel blessed to have known an individual of such integrity and character as Dr. Fear, and wish to acknowledge his importance to me as a mentor, role model and friend. I wish to deeply thank Dr. George Axinn who more than any other teacher in my life has shown me the importance of professional ethics, and the confidence to express and explore my strong interest in social and environmental justice. I wish to acknowledge the important contributions of Dr. Craig Harris, who set an academic standard of excellence for me to aspire toward, and assisted me greatly in exploring current theory and praxis on environmental and social justice. Also I want to express my gratitude to Dr. Elaine Hockman of Wayne State University for her technical guidance in the design of this study, and to acknowledge her important ongoing contributions to the area environmental equity study. I also wish to express my deep felt gratitude for Dr. Cynthia Fridgen who more than any other regularly guided me through this graduate program, and provided exceptional opportunities to me for personal and professional growth. Lastly, I wish to sincerely thank my parents, for instilling the importance of education and ethics within their children and grandchildren, and guiding us in the pursuit of both.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AG ..... Michigan Department of Attorney General

ATSDR ..... Federal Agency for Toxic Substances and Disease Registry

CAA ..... Federal Clean Air Act

CERCLA ..... Federal Comprehensive Environmental Response, Compensation and Liability Act

CEQ ..... Federal Council on Environmental Quality

CPA ..... Center for Policy Alternatives

ERD ..... Environmental Response Division, Michigan Department of Environmental Quality

GAO ..... Governmental Accounting Office, U.S. Congress

LULU ..... Locally Unwanted Land Use

LUST ..... Leaking Underground Storage Tank

MDEQ ..... Michigan Department of Environmental Quality

MDPH ..... Michigan Department of Public Health

NAACP ..... National Association for the Advancement of Colored People

NPL ..... National Priority List

PCBs ..... Polychlorinated Biphenyls

PRP(s) ..... Potentially Responsible Party(-ies)

RCRA ..... Resource Conservation and Recovery Act

SMSAs ..... Standard Metropolitan Statistical Areas

TRI ..... Federal Toxic Release Inventory

TSDF ..... Treatment, Storage and Disposal Facility

U.S. EPA. ..... United States Environmental Protection Agency

USTD ..... Underground Storage Tank Division, Michigan Department of Environmental Quality

UCC, CRJ ..... United Church of Christ, Commission for Racial Justice

VOCs ..... Volatile Organic Hydrocarbons

WTEF ..... Waste-To-Energy Facility

Chapter 1

THE PROBLEM IN CONTEXT

> "The essential point .. is not to establish that bureaucrats should be consigned to lunatic asylums, but to prove that they often fail to consider and act upon evidence .. of a kind that has not been a part of traditional decision-making and should now be considered in the regulatory and administrative process. Thus it is the claim that they have failed to do something which ought to be done, rather that they have done their traditional work irrationally, that is sought to be brought into question". Joseph Sax, *Defending the Environment*, 1971, p. 138, as referenced by State Bar of Michigan, October 29, 1994.

According to some, "institutional racism continues to affect policy decisions related to the enforcement of environmental regulations".[1] Institutional racism is used here to mean a "strategy that systematically provides economic, political, psychological, and social advantages for whites at the expense of other people of color and as a dynamic

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[1] Commission for Racial Justice United, *Toxic Waste And Race In The United States: A National Report on the Racial and Socio-Economic Characteristics of Communities with Hazardous Waste Sites,* Public Data Access, Inc., 1987, p. x; Lavelle, Marriane and Marcia Coyle, "Unequal Protection: The Racial Divide in Environmental Law, *The National Law Journal,* Vol. 15, No. 3, September 21, 1993, p. S2 - S4, S6; Mohai, Paul and Bunyan Bryant, "Environmental Racism: Reviewing the Evidence", *Race and the Incidence of Environmental Hazards*, West View Press, 1992, p. 164; Foster, Sheila, "Review Essay: Race(ial) Matters: The Quest for Environmental Justice", *Ecology Law Review*, Vol. 20, 1993, pp.730-734, Cutter Susan L., "Race, Class and Environmental Justice", *Progress in Human Geography*, Vol. 19, No. 1, 1995, p. 114; and Hamilton, James T., "Testing For Environmental Racism: Prejudice, Profits, Political Power?", *Journal of Public Policy Analysis and Management*, Vol. 14, 1995, p. 109 and 111.

relationship...flexible enough to adapt to changing historical conditions"[2], and "creates structures..that continually reinforce (discriminatory) outcomes"[3]. Institutional discrimination at various levels of government has been previously documented affecting the location of public housing, residences with lead-based paint, freeway construction, sewage treatment plants, municipal and hazardous waste incinerators, voter polling places, prisons, municipal landfills and toxic waste dumps.[4] As such, institutionalized discrimination based on race/ethnicity involves internal processes, external structures and forces, ideological and historical contexts and understandings that "institutionalized unconscious biases, exclusionary processes, and normative judgements that influence racially meaningful social structures" and drive environmentally discriminatory outcomes and defend dominant white privilege gained at the expense of racial and ethnic minorities.[5]

Bullard notes that despite environmental reforms, "(a)n abundance of documentation shows blacks, lower-income groups, and working class persons are subjected to a disproportionately large amount of pollution and other environmental stressors in their

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[2] Harding, Sandra, "Sustainability, Experience and Knowledge: An Epistemology from/for Rainbow Coalition Politics", *Development and Change*, Vol. 23, No. 3, 1992, p. 179.

[3] Foster, *op. cit.*, p. 734, and Gerald Torres, "Introduction: Understanding Environmental Racism", *University of Colorado Law Review*, Vol. 63, 1992, pp. 839.

[4] Bullard, Robert D., *Dumping In Dixie: Race, Class, and Environmental Quality*, Westview Press, Boulder, San Francisco and Oxford, 1990, p. 29, citing Joe R. Feagin and Clairece Booher Feagin, *Discrimination American Style: Institutional Racism and Sexism*, Malabar, Fla.: Robert E. Krueger Publishing, 1986, p. 9; Foster, *op. cit.*, p. 731, and Hamilton, *op. cit.*, pp. 125-127.

[5] Bullard, *op. cit.*, p. 29; Foster, *op. cit.*; pp. 734-735; and Michael Gelobter, "Toward a Model of "Environmental Discrimination", in *Race and the Incidence of Environmental Hazards: A Time for Discourse*, Bryant and Mohai, Editors, 1992, p. 10.

neighborhoods".[6] According to Bullard, many questions remain to be researched concerning the distributional equity of environmental hazards. While ecological concerns have emerged and remain high across most segments of the U.S. population, social justice and concerns about the distributive impacts of environmental protection policies and programs have not enjoyed widespread public attention or been the concern of social scientific research.[7] Bullard asks, "How are the benefits and burdens of environmental reform distributed? Who gets what, where, and why? Are observed environmental inequities the result of racism or class barriers, or a combination of both?" Charles Lee, the principal researcher for the United Church of Christ's Commission for Racial Justice, adds that "many existing regulatory and enforcement programs need to be targeted (for research)...so that resources can be funneled where there are disproportionate impacts".[8] Foster (1993) notes that notions of environmental racism, as such, are more descriptive than prescriptive of social forces that manifest themselves in racially disparate outcomes and lead state and federal environmental protection agencies to deny connections between race/ethnicity, poverty and other social demographics of the dispossessed and disparate exposure environmental risk[9]. Others ask "(w)hat is unfair?", as disparities in the siting of locally undesirable or unwanted land uses (LULUs) are likely a function of real property market dynamics rather than race/ethnicity,

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[6] Bullard, *op. cit.*, p. 1, and as quoted by Mushak, Betty, "Focus: Environmental Equity: A New Coalition for Justice", *Environmental Health Perspectives*, Vol. 101, No. 6, November 1993, p. 479.

[7] Bullard, *op. cit.*, p. 4.

[8] Lee, Charles as quoted by Mushak, *op. cit.*, p. 479; and Foster, *op. cit.*, p. 735.

[9] Foster, *op. cit.*, p. 735.

class or any intersection of various social oppressions[10].

For the purpose of this study, environmental equity is defined as "the distribution of amenities and disadvantages across individuals and groups"[11] that may result in "the disparate treatment of a group or community based upon race, class .. or some other distinguishing characteristic"[12] within the framework of the implementation and enforcement of environmental protection regulations and programs. The term "race/ethnicity", as defined by the U.S. Census Bureau, indicates racial and ethnic American groups comprised of White; Black; of Spanish/Hispanic Origin; Asian/Pacific Islanders; Native American, Eskimo and Aleuts; and Other persons. "Minority communities" shall be defined as zip code areas with aggregate racial/ethnic subpopulations above state or national minority population percentages. In this context, "minority percentages" of Michigan and U.S. populations are used as a measure of "race/ethnicity".

A 1992 study of the federal Superfund program undertaken by the *National Law Journal* found that the U.S. Environmental Protection Agency (U.S. EPA) takes 20% longer

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[10] Been, Vicki, "What's Fairness Got to Do With It? Environmental Justice and the Siting of Locally Undesirable Land Uses", *Cornell Law Review*, Vol. 78, 1993, pp. 1001-1085; Hird, John A., "Environmental Policy and Equity: The Case of Superfund", *Journal of Policy Analysis and Management*, Vol. 12, No. 2, 1993; Anderton, Douglas L., Andy B. Anderson, John Michael Oakes, and Michael R. Fraser, "Environmental Equity: Hazardous Waste Facilities: ' Environmental Equity' Issues in Metropolitan Areas", *Evaluation Review*, Vol. 18, 1994; Boerner, Christopher and Thomas Lambett, "Environmental Justice In The City Of St. Louis: The Economics of Siting Industrial and Waste Facilities", Center for Study of American Business, Washington University, St. Louis, Missouri, Working Paper 156, April 1995; Zax, Jeffrey S., "Public Policy, Social Welfare, and the Incidence of Airborne Pollution in Genesee County", unpublished paper, February 3, 1997, and Collin, Robert W. "Review of the Legal Literature on Environmental Racism, Environmental Equity, and Environmental Justice", *Journal of Environmental Law and Litigation*, Vol. 9, 1994, pp. 158.

[11] Zimmerman, Rae, "Issues of Classification in Environmental Equity: How We Manage is How We Measure", *Fordham Urban Law Review*, Vol. 21, 1994, p. 633.

[12] Gelobter, *op. cit.*, p. 9, and Bullard, *op. cit.*

to address environmental problems and accepts less stringent cleanup solutions than recommended by the scientific community at sites of environmental contamination in minority areas than those approved in predominantly white communities.[13] For example, civil cases in federal courts from 1985 to 1991 pursuant to violations of the Resource Conservation and Recovery Act (RCRA) found average penalties imposed at sites in white areas were nearly 500% greater than penalties imposed at sites in minority areas.[14] This study also reported that these imbalances occur without regard for a community's wealth, rather that such inequity is fundamentally a matter of race/ethnicity. The report concluded, "we believe the disproportionate exposure of people of color to environmental hazards is not a historical coincidence. It has often been the result of the way in which environmental policies were set by local, state and federal institutions and agencies".[15] State and federal environmental and human health agencies have been criticized for disassociating themselves from the structural and social contexts in which they exist, approaching environmental protection in a socially-neutral manner, and myopically implementing compliance and enforcement programs without any "appreciation, or acknowledgment, of the social context and structural dynamics that influence choices, mobility, and employment of people of color"[16].

The *National Law Journal* report provided the impetus for a federal Justice

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[13] *National Law Journal*, Vol. 15, No. 3, September 21, 1992.

[14] *Ibid.*

[15] *Ibid.*

[16] Foster, *op. cit.*, pp. 729,736-737.

Department investigation of the U.S. EPA's equity in the implementation and enforcement of an array of federal environmental regulations. President Bill Clinton's September 1993 blueprint for reorganizing the federal government called for the incorporation of environmental justice into U.S. EPA operations.[17] Current U.S. EPA Director Carol Browner has responded, "of importance to me and the (Clinton) Administration is to incorporate equity into our mission and programs. We must make sure that our programs are fair and protective to all..."[18] On February 11, 1994 President Clinton issued Executive Order 12898 requiring all federal agencies to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental affects of its programs, policies and activities on minority populations and low-income populations.."[19] As Bullard concludes, "(t)he time is long overdue for placing the toxics and minority health concerns .. on the agenda of federal and state environmental protection and regulatory agencies."[20]

Mohai and Bryant (1992) state that "systematic studies of the social distribution .. of environmental hazards .. are needed".[21] Moreover, of the nine previous studies that have analyzed the interrelated factors of race/ethnicity and class in the implementation of U.S.

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[17] "Current Developments", *Environmental Reporter*, The Bureau of National Affairs, Inc. Vol. 24, No. 19, September 10, 1993.

[18] Browner, Carol, "Carol Browner on EPA Priorities", *EPA Journal*, April-June 1993, p. 4.

[19] *Federal Register*, E.O. 12898, February 11, 1994, p. 7629.

[20] Bullard, *op. cit.*, p. 19.

[21] Mohai, Paul and Bunyan Bryant, "Race, Poverty, and the Environment: The Disadvantaged Face Great Risks", *EPA Journal*, March/April 1992, p. 8.

environmental policy, two-thirds of these studies have concluded that race/ethnicity was more strongly related than class in the disproportionate distribution of environmental risks within communities.[22] To date three multivariate statistical studies have been completed comparing community racial/ethnic demographics with measures of wealth. Each of these studies has concluded that race/ethnicity not only has an independent relationship with environmental hazard, but that race/ethnicity is more significant and strongly related to environmental hazard than income.[23] Further research needs to be undertaken to expand such studies to: 1) measure the degree of environmental discrimination within federal, state and local environmental and public health programs; 2) to apply such research more widely across political boundaries; and 3) to include additional environmental and public health programs at the various levels and forms of governmental environmental regulation[24].

PURPOSE OF THIS STUDY

Drawing from studies undertaken in the past to determine the association between race/ethnicity, class and environmental discrimination in U.S. environmental policy, this study examines specified measures to determine the presence and degree of race/ethnicity, income and population density discrimination, if any, in the implementation and enforcement

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[22] Bryant and Mohai, *op. cit.*, 1992, p. 166 and "Environmental Injustice: Weighing Race and Class as Factors in the Distribution of Environmental Hazards", *University of Colorado Law Review*, Vol. 63, 1992, pp. 923-924.

[23] Bryant and Mohai, *op. cit.*,1992, pp. 169-70, citing the United Church of Christ (1987); West, Patrick C., J. Mark Fly, Frances Larkin, and Robert W. Marans, "Minority Anglers and Toxic Fish Consumption: Evidence From A Statewide Survey of Michigan", Chapter 8 in *Race and the Incidence of Environmental Hazards*, Mohai and Bryant, Editors, West View Press, 1992, pp. 100-113; and Mohia and Bryant, *Detroit Area Study*, *op. cit.*, 1992.

[24] Foster, *op. cit.*, p. 727.

of a state environmental program guiding the identification and cleanup sites contaminated with hazardous substances. This research has been undertaken to analyze the racial/ethnic, income and population density equity within the Michigan Department of Environmental Quality's (MDEQ) implementation and enforcement of Michigan's preeminent environmental and public health protection program, the Part 201 Environmental Response program. Refer to Figure 1 for a flow chart of the overall Part 201 process.

The Michigan Environmental Response Act program (hereafter referred to as "Part 201 program"), formerly known as the "state superfund" and the "polluter pays" law, was passed in 1982 in part to identify, evaluate and list all known and potential sites of environmental contamination with the State of Michigan.

A risk-based priority for each Michigan site of environmental contamination is established by the Part 201 program, which is intended to guide MDEQ implementation and enforcement actions. This relative-risk or risk-priority approach does not consider socio-economics or other characteristics of communities with contamination sites, and is similar to that used by the United States Environmental Protection Agency (U.S. EPA) in implementing and enforcing the federal Superfund program[25]. This approach has been criticized by some because "cost effective risk-based protection by regulating agencies necessarily sacrifices those most expensive to protect...groups within the range of 'acceptable risk' and those most vulnerable".[26] Swanson (1994) notes, "(m)any members of EPA

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[25] Breslin, Karen, "In Our Backyards: The Continuing Threat of Hazardous Waste", *Environmental Health Perspectives*, Vol.101, No. 6, November 1993, p. 484.

[26] Swanson, Samara F., "Race, Gender, Age, And Disproportionate Impact: What Can We Do About The Failure To Protect the Most Vulnerable?", *Fordham Urban Law Journal*, Vol. 21, 1994, p. 583.

regional staff believe that the agency's activities are equitable because they focus on environment, not on particular (social) groups. The belief that a ('socially-blind') focus on national (cleanup) standards and (natural) resources protects all communities equally is, at least partially, the reason that instances of disproportionate allocation of pollution continues unchecked".[27]

"Environmental contamination" is defined by Part 201 to mean "the release of a hazardous substance, or the potential release of a discarded hazardous substance, in a quantity, which is or may become injurious to the environment, or to the public health, safety, or welfare".[28] The list of Michigan Sites of Environmental Contamination prepared pursuant to Part 201 for fiscal year 1995 lists over 11,000 sites of environmental contamination within Michigan's boundaries. Further, since appropriations have been made by the Michigan Legislature for the Part 201 program beginning in FY 1984, over $521 million dollars have been appropriated to implement and administer this program.

CHARACTERISTICS OF THIS STUDY

This study represents an insider's perspective in the procedural and substantive equity of Michigan environmental policy[29]. Although numerous facility siting studies have been undertaken, no similar study correlating measures of the implementation and enforcement

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[27] *Ibid.*, Note 65 at p. 588.

[28] Section 3(k) of Part 201 of the Michigan Natural Resources and Environmental Protection Act, 1994 P.A. 451, as amended, MCL 299.603.

[29] Recommendation for further research in *Zimmerman, op. cit.*,pp. 677-669, Robert W. Collin, "Review of Legal Literature on Environmental Racism, Environmental Equity, and Environmental Justice", *Journal of Environmental Law and Litigation*, Vol. 9, 1994, p. 157, and Michael K. Heiman, "Race, Waste, And Class: New Perspectives On Environmental Justice", *Antipode*, Vol. 28, No. 2, 1996, pp. 114, 116-117, and 120.

of Michigan environmental protection programs with race/ethnicity, income and population density data is known to the researcher following an extensive literature search, informal discussions with policy-makers, state agency officials, public interest groups, and university researchers; and an examination of relevant data bases. Furthermore, unlike numerous bivariate studies undertaken previously, this study analyzes measures of bureaucratic diligence in environmental compliance and enforcement within Michigan's hazardous substances cleanup program.[30] Demographic variables include population density, income, and race/ethnicity. This research is distinct from studies by Pfaff (1989), Mohai and Bryant (1990), Bryant and Hockman (1992), Hockman (1993), Tomboulian, *et. al.* (1995), Nambalamba (1996), and Wood (1997) which analyzed the siting of hazardous waste generating and disposal facilities only in the three Michigan counties that comprise metropolitan Detroit. Finally, this research is the first in Michigan to evaluate a state environmental protection program in comparison with social demographics, rather than merely locationally associating sites of known or potential environmental risk and demographic measures.

Given the importance, public expense, political controversy and visibility of the Part 201 program, surprisingly little research of the efficacy or efficiency of the program has been done to date by any citizen group, private organization or governmental agency. To date, no research has been undertaken to analyze the Part 201 program's equity in the identification or evaluation of sites of environmental contamination, cleanup alternatives selected, and the

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[30] Recommendation for further research in Hamilton, *op. cit.*, p. 127.

rate of remediation, compliance and enforcement efforts undertaken by the MDEQ, or the expenditure and cost recovery of public funds according to race/ethnicity, income or other demographic and socioeconomic indicators. In summary then, this research seeks to answer the questions of whether racial/ethnic, income and/or population density equity exist within implementation and enforcement of Michigan's Part 201 program, and to measure racial/ethnic, income and/or population density inequity, if found.

In no way is it the purpose of this study to find fault with current or previous Part 201 program administrators, personnel or other staff, or to assign blame for overt or more subtle forms of disparity, if found. The study is intended to provide additional insight into the results, if any, of race/ethnicity, income, and population density-neutral environmental decision-making in general, and to specifically analyze Michigan's important Part 201 Environmental Response Act program.

RESEARCH HYPOTHESIS AND QUESTIONS

Hypothesis: This study hypothesizes that measurable and statistically significant difference exists within racial/ethnic minority, urban and/or low income communities in Michigan in the implementation and enforcement of the Michigan Environmental Response Act (Part 201) program.

For the purpose of this study, the overall equity of Michigan's Part 201 Program will be analyzed in terms of activities undertaken by the MDEQ and the Department of Attorney General (AG) in the compliance, enforcement, and the application of public funds to address known sites of environmental contamination within and outside of proscribed guidelines establishing cleanup and/or enforcement priority.

Compliance Equity:

Part 201 requires owners and operators of sites of known or potential environmental contamination to notify the MDEQ within 24 hours of discovery; undertake interim response activities to mitigate immediate environmental and human health and safety hazards; undertake investigation to fully define the extent and nature of the contamination, undertake feasibility study to assess cleanup alternatives; and to undertake the full remediation of such sites. Refer to Figure 1, pp. 159 and 160 for a flow chart of the Part 201 compliance process. Consequently, the MDEQ faces extraordinary challenges in overseeing potentially responsible party (PRP) compliance at the over 11,000 sites of environmental contamination listed under Part 201, and those sites known to the MDEQ though unlisted. In an attempt to explore the MDEQ and AG's equity in overseeing the cleanup compliance, enforcement, and public funding of Part 201 sites, this study will seek to answer the following questions.

1) What are the comparative MDEQ response times in the investigation of the potential releases of hazardous substances and the identification of potentially responsible parties (PRPs) following the report or discovery of contamination in white and racial/ethnic minority areas of varying population density and income levels?

2) What is the annual frequency of MDEQ on-site inspections to monitor and verify the investigation and cleanup of sites of environmental contamination in white and minority areas of varying population density and income levels?

3) What is the comparative speed of bringing hazards under control at sites of contamination in white and minority areas of varying population density and income levels?[31]

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[31] Site hazard control is defined as active measures to prevent the further migration of contaminants (interim response, such as hazardous substance removal, fire and explosion hazard abatement, soil removal from source areas, etc.), the prevention of human exposure (fencing, capping, ground water interdiction, etc.).

4) How long does it take, comparatively, to adequately cleanup a site of environmental contamination under the purview of Part 201 in white and minority communities of varying population density and income levels?

Enforcement Equity:

Enforcement activities are formally undertaken by the MDEQ and AG under Part 201 in a systematic and step-wise fashion when determined by MDEQ staff to be necessary to foster compliance at sites of environmental contamination under the ownership and/or control of "recalcitrant" or "evasive" PRPs. MDEQ officials are empowered by Part 201 to request information from PRPs; as a matter of policy MDEQ officials send "enforcement notification" letters to warn recalcitrant PRPs of impending enforcement actions lacking compliance activities; and possess the authority to unilaterally order the compliance with environmental investigation and cleanup requirements of Part 201. Refer to Figure 1, pp. 159 and 160 for a flow chart of the Part 201 enforcement process. Failure to comply with an administrative order pursuant to Part 201 and its tightly worded time frames, could result in fines up to $25,000 per day, reimbursement of state response costs and/or treble damages for natural resource damages resulting from hazardous substance release and PRP noncompliance. Further, the MDEQ's issuance of an administrative order pursuant to Part 201 carries with it a "pre-enforcement bar", making it illegal for PRPs to file a counterclaim in a court of law refuting all or parts of an administrative order until the PRP actually has completed the environmental protection activities mandated in an unilateral administrative order. Research questions to be answered to examine the MDEQ's social equity in its enforcement of Part 201 include:

1) How many MDEQ information requests are made of PRPs pursuant to Part

201 at sites of environmental contamination in white areas and racial/ethnic minority areas of varying population density and income levels?

2) How many sites of environmental contamination have received formal MDEQ enforcement notification letters threatening state enforcement action in white and minority areas of varying population density and income levels?

3) How many official referrals for enforcement at noncompliant sites of environmental contamination are made by the MDEQ to the AG in white and minority areas of varying population density and income levels?

4) How long has it taken for AG staff to file a lawsuit under Part 201 against, or complete a negotiated settlement, with recalcitrant PRPs at sites of environmental contamination in white and minority areas of varying population density and income levels?

5) How do negotiated penalties, agreed to by MDEQ, AG and PRPs in the process of out-of-court settlement, compare at noncompliant sites of environmental contamination in white and minority areas of varying population density and income levels?

6) How many suits are brought to trial, and what types of judicial relief and/or levels of penalties have been awarded by the Michigan Courts in the enforcement of Part 201 in white and minority areas of varying population density and income levels?

Equity in Public Funding:

The MDEQ possesses the authority under Part 201 to expend public funds at sites of environmental contamination to replace contaminated water supplies, undertake emergency cleanup activities, undertake environmental and PRP liability investigations and initiate or complete cleanup activities at sites of environmental contamination. Part 201 provides for a hazard-risk scoring system to evaluate and prioritize sites of environmental contamination for funding for these purposes. The MDEQ is authorized to expend public funds at sites of environmental contamination outside of this hazard ranking criteria upon the showing that an environmental emergency exists, the continuation of previously funded projects or by

order of the governor of Michigan. Under Part 201, state funds expended by the MDEQ at these locations are to be recovered by the MDEQ in cost recovery actions levied against identified PRPs. Refer to Figure 1, pp. 159 and 160 for a flow chart of the Part 201 public funding process. Questions to be examined in this section of the study are as follows:

1) How do the amount of funds requested by the MDEQ to address sites of environmental contamination compare in white areas and racial/ethnic minority areas of varying population density and income levels?

2) How many public dollars have been spent addressing sites of environmental contamination at sites in white and minority areas of varying population density and income levels?

3) Of those public dollars expended by the MDEQ at sites of environmental contamination in white and minority areas of varying population density and income levels, how much has been recovered and returned to state coffers?

4) How frequently and what amount of public dollars have been spent in MDEQ initiated and executed emergency actions in white and minority areas of varying population density and income levels in the State?

ORGANIZATION OF THE STUDY

A literature review of previous research analyzing the social equity of U.S. environmental policy and environmental protection program implementation and enforcement is presented in Chapter 2. The study design is described in Chapter 3. The research findings are reported in Chapter 4. Limitations, uncontrollable biases, and qualifications associated with the findings are also considered. Study conclusions and recommendations for policy reforms and further research are presented in Chapter 5.

Chapter 2

LITERATURE REVIEW

Numerous empirical studies have been undertaken to analyze and quantify disproportionate environmental and human health impacts within low-income and minority communities in the United States.[32] Of these studies, all but four have shown the existence of disparity within environmental risk when analyzed by race/ethnicity or income, regardless of the selected geographic scope, environment or human health measure, and study methodology.[33] At the time of his study, Goldman (1992) found disparity in environmental risk and impact according to race/ethnicity was found in 87

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[32] Summaries found in Goldman, Benjamin A., *Not Just Prosperity: Achieving Sustainability With Environmental Justice*, National Wildlife Federation and Corporate Conservation Council, February 1992, p. 8, Cutter, Susan L. "Race, Class, and Environmental Justice", *Progress in Human Geography*, Vol. 19, No. 1, 1995, pp. 114-118; and Mohai and Bryant, *op. cit.*, pp. 163-169.

[33] The four of the six studies found that did not find disparity by either race/ethnicity or income were funded by WMX (formerly Waste Management Inc.), the world's largest waste disposal firm . See Hird, John A., "Environmental Policy and Equity: The Case of Superfund", *Journal of Policy Analysis and Management*, Vol. 12, No. 2, 1993: , Anderton, Douglas L., Andy B. Anderson, John Michael Oakes, and Michael R. Fraser, "Environmental Equity: Hazardous Waste Facilities: ' Environmental Equity' Issues in Metropolitan Areas", *Evaluation Review*, Vol. 18, 1994; Susan L. Cutter, "The Burdens of Toxic Risks: Are They Fair?", *Business and Economic Review*, Vol. 41, October - November, 1994, pp. 3-7; Boerner, Christopher and Thomas Lambett, "Environmental Justice In The City Of St. Louis: The Economics of Siting Industrial and Waste Facilities", Center for Study of American Business, Washington University, St. Louis, Missouri, Working Paper 156, April 1995; and Zax, Jeffrey S., "Public Policy, Social Welfare, and the Incidence of Airborne Pollution in Genesee County", unpublished paper, February 3, 1997.

percent of the empirical studies. Seventy-four percent of studies found income disparity in which lower income populations bore disproportionate levels of environment risk and impact.[34] In studies in which race/ethnicity and income were compared to determine if either factor was independently or more significantly related to disparity of environmental risk or impact, race/ethnicity was found to be more significant than measures of income in 22 of 30 empirical studies.[35] As suggested by Goldman (1992), empirical studies can be grouped into four categories as: 1) studies of the geographic distribution or citing of potentially polluting or noxious facilities; 2) distributional measures of ambient environmental pollution; 3) measures of human exposures to toxic and/or hazardous materials from environmental pollution; and 4) analyses of agency diligence in the implementation of environmental regulations in the United States.[36] These four categories will be used to review major empirical studies for the purpose of this research. Particularly, special attention will be paid to the review of empirical studies of each category which examine the distribution of regulatory effort in the implementation of state and federal environmental and human health protection policy and programs.

Siting of Polluting, Potentially Polluting and Noxious Facilities

All but six of the 38 empirical studies referenced herein relative to the geographic siting of polluting, potentially polluting and/or locally unwanted land uses or noxious

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[34] Goldman, *op. cit.*, 1992.

[35] *Ibid.*

[36] *Ibid.*

facilities have found disparity according to race/ethnicity or income.[37] One of the first studies of this type was commissioned by U.S. Congress following widespread civil disobedience in Warren County, North Carolina during the Fall of 1982. Civil rights and church leadership organized and undertook acts of civil disobedience in opposition to the expansion of a polychlorinated biphenyl (PCB) landfill in the predominantly African-American and poor area of Warren County surrounding the PCB landfill. A U.S. General Accounting Office (GAO) study entitled, *Siting of Hazardous Waste Landfills and Their Correlation with Racial and Economic Status of Surrounding Communities* was undertaken and published in 1983. This report analyzed eight southeastern States in the U.S. to determine the relationship between the location of hazardous waste landfills and compared the location of such facilities to demographic measures of race/ethnicity and the economic status of host communities aggregated at the census tract level[38]. Among other conclusions, this report found that in three of the four (or 75 percent) communities surrounding hazardous waste landfills, African-Americans comprised the majority of the population and at least 26 percent of the communities' populations had incomes below the poverty level (defined as $7,412 for a family of four according to the 1980 census).[39] The study also found that the majority of population within areas analyzed was African-

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[37] Goldman, *op. cit.*,1993, p. 8, Zax, *op. cit.*; Tomboulian, Alice, Paul Tomboulian, Kurt Metzger; Doug Towns and Lawrence Hinds, *Tri-County Detroit Area Environmental Equality Study*, United Way Community Services, Detroit, December 1995; Cutter, *op. cit.*, p. 7; and Waste Management funded studies, *op. cit.*

[38] U.S. General Accounting Office, "Siting Of Hazardous Waste Landfills And Their Correlation With Racial And Economic Status Of Surrounding Communities", GAO, RCED-83-168, June 1, 1983, p. 2.

[39] *Ibid.*, p. 3.

American with mean incomes lower than that for all other races/ethnicities in the areas studied.[40] Significantly, the report concluded that the single most important factor governing decisions surrounding the location of hazardous waste landfills was the racial make-up of the receiving community.

The first national study to examine the correlation between the siting of commercial hazardous waste facilities and social demographics was undertaken by the United Church of Christ's Commission for Racial Justice and published in 1987. This study, entitled *Toxic Waste and Race In The United States,* analyzed 500 operating and over 18,000 inactive treatment, storage and disposal facilities (TSDFs) listed nationwide on the 1985 Comprehensive Environmental Response, Compensation and Liability Act Information System (CERCLIS) list, pursuant to the federal Resource Conservation and Recovery Act (RCRA - 40 CFR 260, *et. seq.*) and the Comprehensive Environmental Response, Compensation and Liability Act (40 CFR 260 *et. seq.*) also known as CERCLA or the federal "Superfund".[41]

Among other findings, this study concluded that people of color were twice as likely as whites to live in communities (operationalized as zip code areas) with active commercial TSD facilities, and three times more likely to live in communities with more than one active TSDF or one of the nation's largest commercial hazardous waste

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[40] *Ibid.*

[41] United Church of Christ, Commission for Racial Justice, Charles Lee, Director Special Project On Toxic Injustice, *Toxic Wastes and Race in the United States: A National Report on the Racial and Socio-Economic Characteristics of Communities with Hazardous Waste Sites,* 105 Madison Avenue, New York, New York, 11016, 1987.

landfills.[42] The study also found that per capita income and home values were significantly lower in the 369 communities determined nationwide to host active TSD facilities.[43] Specifically, the study found that 56 percent of U.S. minorities (African-American, Hispanic, Asian/Pacific Islander and American Indian) and 53 percent of the U.S. white population live in communities with CERCLIS sites. Within the 50 largest U.S. cities, 73.5 percent of all U.S. African-Americans live in zip code areas with uncontrolled hazardous waste disposal sites. Communities with the highest correlation of minority communities and uncontrolled hazardous waste sites included Memphis, Tennessee at 99 percent; Flint, Michigan and Seattle, Washington at 95 percent each; Houston, Texas and Chicago, Illinois at 81 percent each (Hispanics only); Albuquerque, New Mexico 75 percent (Hispanics only); and Los Angeles, California at 60 percent (Hispanics only).[44] Of critical importance is this study's finding that race is the single most important predictor of the siting of active commercial hazardous waste facilities, even when compared with and accounting for other socioeconomic factors, such as average household incomes and residential home and land values.[45] Lastly, the UCC study examined the over 18,000 inactive hazardous waste TSD facilities in the U.S. and found that people of color living in communities with inactive hazardous waste sites did

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[42] Goldman, *op. cit.*, 1993, p. 11.

[43] *Ibid.*

[44] Andrews, John, "Minorities & Toxics", *Environmental Action*, September/October 1987, p. 9.

[45] United Church of Christ's Commission of Racial Justice, *op. cit.*, pp. xiii, 17, 23; and as cited by Paul Mohai and Bunyan Bryant in "Environmental Racism: Reviewing the Evidence", Chapter 13 in *Race and the Incidence of Environmental Hazards: A Time for Discourse*, Westview Press, Boulder, 1992, p. 163.

not represent a significantly greater percentage than white populations.

Several other studies have been undertaken replicating the 1987 UCC report using 1990 U.S. census data, including Gould, 1986 (hazardous waste generation); Costner & Thornton, 1991 (existing and proposed waste incinerators); Mohai and Bryant, 1992 (citing of hazardous waste TSD facilities at and surrounding Detroit, Michigan); Greenberg & Anderson, 1984 (state of New Jersey); Ketlar, 1992 (state of New Jersey); Unger, *et. al.*, 1992; *National Law Journal,* 1992; Zimmerman, 1993 (federal Superfund uncontrolled contamination sites), and a follow-up study by the 1987 UCC, National Association for the Advancement of Colored People (NAACP) and the Center for Policy Alternatives (CPA), 1994. Goldman and Fitton, the primary authors of this study, found that the trends evidenced in the UCC 1987 report have become more strongly statistically related since 1987. Specific findings of the CPA study include that, in 1993, people of color were 47 percent more likely than whites to live near a commercial hazardous waste facility, and that between 1980 and 1993 the average concentration of people of color living in zip code areas with commercial hazardous waste facilities increased from 25 percent to almost 31 percent.[46] Finally, the CPA study found that the percentage of people of color is three times higher in areas with the highest concentration of commercial hazardous waste facilities in 1993 than in areas without such facilities - the

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[46] Goldman, Benjamin A. and Laura Fitton, *Toxic Wastes and Race Revisited: An Update of the 1987 Report on Racial and Socioeconomic Characteristics of Communities with Hazardous Waste Sites,* Co-sponsored by the Center for Policy Alternatives, National Association for the Advancement of Colored People and the United Church of Christ, Commission for Racial Justice, Executive Summary, 1994.

same proportion as found in 1980.[47]

Hurley (1988) traced historical land use and demographic changes (*eg.* median income, median house value, percent in white collar occupations, percent African-American) in Gary, Indiana census tracts since 1945.[48] Using regression analysis comparing environmental and census data for 1950 and 1980, he found little correlation between air quality (particulate concentrations) and minority and lower income residents before 1950, but higher correlation between minorities, lower income and air pollution after 1950s. Hurley states, "particulate levels..were (statistically significantly) correlated with race, income, occupation, and property values...Where as in 1950 all classes and races shared the burdens of particulate pollution fairly equally, by 1980 black and low income residents suffered disproportionately".[49] He suggests that these findings are a function of African-American migration into the city in areas of lowest white resident resistance (*i.e.* the central city, areas serviced by well water, and adjacent to toxic waste dump sites). No explanation is provided by Hurley regarding the correlation between migration decisions and locational settlement.

Pfaff (1989) undertook a study of "Pollution and the Poor" in Detroit, Michigan comparing 1980 U.S. census data and found that 41% of Detroit's worst air pollution sources existed in neighborhoods with less than $10,000 a year average per capita

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[47] *Ibid.*

[48] Hurley, Andrew, "The Social Biases of Environmental Change in Gary, Indiana, 1945-1980", *Environmental Review*, Vol. 12, No. 4, Winter, 1988, pp. 1-19.

[49] *Ibid.*, p. 6.

income; 25% of Detroit's 33 most serious contaminated sites were in neighborhoods with average incomes below $10,000; and that four of five or 93% of licensed hazardous waste treatment, storage and disposal facilities were in Detroit neighborhoods with incomes below $10,000 a year.[50] Pfaff also noted that four of four planned hazardous waste treatment, storage and disposal facilities at the time of this report were located in the city's poorest neighborhoods.

Bryant and Mohai undertook the *University of Michigan's 1990 Detroit Area Study* to document previous studies that were undertaken to examine the relative importance of race/ethnicity and other socioeconomic factors in the distribution of polluting industries and siting of hazardous waste disposal facilities. This study also sought to determine the relative importance of race/ethnicity versus socioeconomic factors in the siting and distribution of commercial hazardous waste operating facilities in the Detroit metropolitan area.[51] The primary question examined by these researchers was whether bias in the distribution of environmental hazards is a function of race/ethnicity, an overall function of poverty, or the result of interlocking forces such as political power, awareness of environmental threats, community mobility, and access to decision-makers. These researchers found, among other things, that populations within minority communities were less able to move away from existing environmental hazards, or "buy their way out" of regions proposed to receive hazardous waste facilities. Lower land

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[50] Pfaff, Dennis, *Detroit News*, November 26, 1989, p. 14A.

[51] Mohai, Paul and Bunyan Bryant in "Environmental Racism : Reviewing the Evidence", Chapter 13 in *Race and the Incidence of Environmental Hazards: A Time for Discourse*, Westview Press, Boulder, 1992, and Paul Mohai and Bunyan Bryant, "Race, Poverty, and the Environment", *EPA Journal*, March/April 1992, p. 7.

values in minority areas were expectedly found to be attractive to industry seeking to reduce operation costs. White communities were found to be more politically and financially able to fend-off such proposals, and "minority communities are at a disadvantage not only in terms of resources, but also of under representation on governing bodies."[52]

The researchers concluded that "taken together, these factors suggest that race has an impact on the distribution of environmental hazards that is independent of income or class", and that of the 15 studies done at that time "weigh(ing) the relative importance of race and income, in five out of eight cases race has been found to be more significant and strongly related than has income."[53] The researchers also found that minority residents were four times more likely than white residents to live within one mile of a commercial hazardous waste facility, and that race/ethnicity was also a better predictor of proximity to such facilities than income.[54]

Costner and Thornton (1990) undertook an analysis of the location of operating and proposed waste incinerators in the U.S.[55] This study found that the percentage of minorities living in US communities with existing incinerator(s) at that time was 89

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[52] *Ibid.*

[53] Mohai and Bryant, *op. cit.*, p. 169; Paul Mohai and Bunyan Bryant, "Race, Poverty, and the Environment", *EPA Journal*, March/April 1992, p. 7 , and Paul Mohai and Bunyan Bryant, " Environmental Injustice: Weighing Race and Class as Factors in the Distribution of Environmental Hazards", *University of Colorado Law Review*, Vol. 63, 1992, pp. 921-932.

[54] Mohai and Bryant, *op. cit.*, p. 172, and Mohai Bryant, *EPA Journal*, *op. cit.*, *p.* 7.

[55] Costner, P. and J. Thornton, *Playing With Fire: Hazardous Waste Incineration: A Greenpeace Report*, Greenpeace, Washington, D.C., 1990.

percent above the national average, and 60 percent above the national average for proposed incinerators.

The Agency for Toxic Substances and Disease Registry (ATSDR) (1991) undertook a demographic study of federally funded Superfund or NPL sites[56]. This study represents the only effort that incorporates measures of age, gender and vulnerable populations. This study concluded, in part, that nearly one-half of the 4.1 million people that in 1990 lived within one-mile of 725 NPL sites were members of vulnerable groups defined as women, children, the elderly, and high risk individuals. High risk individuals were defined as people that live, work and conduct activity within one mile of an NPL site; developing fetuses, young children, pregnant women and women of child bearing age, persons with chronic disease, individuals with poor immune systems, and the elderly[57]. Minorities fell into each of these categories as being at highest risk due to occupations, multiple sources of environmental and residential exposure in urban communities, rates of pre-existing disease, age distributions, and higher proportion of pregnancy among minority women at any given time[58].

Importantly, Hird (1993) measured social equity within the implementation of

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[56] National Research Council, *Environmental Epidemiology: Public Health and Hazardous Wastes*, 1991, p. 68.

[57] *Ibid.*

[58] *Ibid.*, and George Friedman-Jimenez, "Occupational Disease Among Minority Workers", *AAOHN Journal*, Vol. 37, 1989, p. 64; Richard Rios, *et. al.*, "Susceptibility to Environmental Pollutants Among Minorities", *Toxicology and Industrial Health*, Vol. 9, 1993, p. 797; Michel Gelobter, "The Meaning of Urban Environmental Justice", *Fordham Urban Law Journal*, Vol. 21, 1994, pp. 841-856; U.S. Department of Health and Human Services, *Health Status of Minorities and Low Income Groups*, U.S. Government Printing Office, Washington, D.C., 3rd edition, 1991; and U.S. Department of Health and Human Services, *Trends in Indian Health*, U.S. Government Printing Office, Washington, D.C., 1991.

federal Superfund[59]. This study analyzed dependent variables including the distribution of federal Superfund sites within U.S. counties and measures of the pace of Superfund site cleanup. Independent variables included the percentage of hazardous waste produced within a county in 1985; the percentage of each county's economy comprised of manufacturing; the potential for local political mobilization (percentage of college educated residents and the percentage of occupant owned homes); and socioeconomic measures (median housing values, percentage of residents below the poverty level, percentage unemployed, and percentage non-white). Control variables included county population density, as an approximation of urban or rural character, and the percentage growth in new housing from 1970 to 1980 (prior to Superfund enactment).

Bivariate and multivariate statistical analyses were undertaken of variables as correlated to the number of sites and measures of Superfund speed in cleanup. Methodologically, this study relies upon comparisons to calculated national averages for counties concerning the above independent variables, and proportionality comparisons are not made in the operationalization of socioeconomic and other independent variables. Regarding the distribution of Superfund sites, this study found that "strong relationships (existed) between more NPL sites and the lack of poverty and unemployment, (the existence of) higher housing values, and (surprisingly) lower percentages of nonwhites"[60].

Specifically, the study found that higher percentages of Superfund sites

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[59] Hird, *op. cit.*, pp. 323-343.

[60] *Ibid.*, p. 335.

statistically significantly correlate with greater presence of manufacturing within a county, higher percentages of college education of residents, greater numbers of owner-occupied homes, and more economically advantaged counties (in terms of both measures of wealth, *i.e.* high median housing values and the lack of poverty). Higher unemployment rates were found to only be weakly associated with greater numbers of Superfund sites within a county. Notably, 80% of all U.S. counties possessed no Superfund sites, requiring the rescaling of several independent variables to allow for model convergence[61]. Corroborating previous studies, Hird found that the number of Superfund sites in counties is strongly and positively correlated with higher percentages of nonwhites. New housing units, as expected, were found to be strongly associated with fewer Superfund sites, and population density (*i.e.* measures of urban vs. rural character) appeared to be unrelated to the number of Superfund sites. Regarding the pace of Superfund cleanups, Hird similarly found that the sites scoring highest on the U.S. EPA list, including federally owned and the oldest listed sites, were associated with greater levels of cleanup. Political representation, as estimated by federal Congressional representation on appropriations committees, has insignificant affect on cleanup pace. Hird found that "virtually no relationship (existed) between a site reaching a particular cleanup stage and the county's socioeconomic characteristics" and that "the pace of federal cleanup efforts bear no relationship to the county's racial and economic

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[61] *Ibid.*, p. 332.

composition."[62] While the findings of this study have been criticized, this study provided useful methodological insight into undertaking an equity evaluation of state and federal governmental hazardous waste cleanup programs.

Greenberg (1993) undertook a national study of waste-to-energy facilities (WTEFs) in association with community demographics, including population density, race/ethnicity, age, income[63]. Greenberg concluded that the strongest association between WTEFs with age, a disproportionate number of facilities being located in communities with higher percentages of elderly residents[64].

Burke (1993) analyzed TRI air emission data for the City of Los Angeles for the period of 1980 through 1990.[65] She found a strong relationship between percent minority residents and the number of TRI facilities within census tracks. Burke reported a positive linear relationship between the number of TRI sites and census tracks within L.A. with higher percent minority, lower per capita income, and lower population density.

Hamilton (1993) undertook a national study of WTEFs and decisions to expand or decrease WTEF capacity between 1987 and 1992.[66] Aggregating data at the county level

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[62] *Ibid.*, p. 337.

[63] Greenberg, Michael R., "Proving Environmental Inequity In Siting Locationally Unwanted Land Uses", *Risk Issues in Health and Safety*, Vol. 4, 1993, pp. 235-252.

[64] *Ibid.*, p. 235.

[65] Burke, Lauretta M., "Race and Environmental Equity: A Geographical Analysis in Los Angeles", *Geo Info Systems*, October 1993, pp. 44-50.

[66] Hamilton, James T., "Politics and Social Costs: Estimating The Impact Of Collective Action On Hazardous Waste Facilities", *RAND Journal of Economics*, Vol. 24, No. 1, Spring 1993, pp. 101-125.

and comparing means difference, he found that facilities in operation by 1986 with surplus capacity and higher levels of documented resident opposition were less likely to be expanded.[67] This finding was reported to be statistically significant at the 95 percent confidence interval.[68] Second, Hamilton found that during the 1970s potential collective action by residents in opposition to WTEF expansion was not statistically significant in facility expansion outcomes.[69] Lastly, Hamilton analyzed WTEF expansion outcomes during the 1980s, at which time battles over similar facility siting had intensified, finding that potential oppositional collective action in host communities was statistically significant at the county level in facility expansion decisions.[70] Hamilton reported that race/ethnicity, however, was not a statistically significant factor in WTEF expansion outcomes.[71] Rather race/ethnicity was statistically significant in WTEF reductions, as communities with higher minority populations were less likely to have a WTEF facility slated for reduction in capacity.[72] Hamilton concludes, "commercial hazardous waste firms did take into account the potential for areas to mobilize and engage in collective action ...during..1987 - 1992. If the effective externality costs estimated by a firm became a function of both the actual compensation demands of an area's residents and the

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[67] *Ibid.*, pp. 103 and 112.

[68] *Ibid.*, p. 112.

[69] *Ibid.*, p. 121.

[70] *Ibid.*

[71] *Ibid.*, pp. 117 -118.

[72] *Ibid.*

probability that these will be successfully voiced through collective action, then a firm could end up locating in an area...due to the failure of residents to oppose the siting".[73]

Hockman (1993) analyzed the location of known sites of contamination and hazardous waste treatment, storage and disposal facilities in Washtenaw County in cooperation with the Ecology Center of Ann Arbor. Hockman concluded that low-income and minority residents, especially in and around Ypsilanti Township, were disproportionately affected and that "race was the single most important predictor of the location of pollution sources".[74]

Bryant and Hockman (1994) examined the distribution of a variety of environmental contamination sources in Michigan, including hazardous waste contamination (Act 307) sites, leaking underground storage tank (LUST) sites, toxic release inventory (TRI) sites, and incinerators, and census data and concluded that the number of African-Americans relative to the number of whites in a given geographic area increases as the number of TRI, LUST, Act 307 sites, and emissions and numbers of chemical released from these sources increased.[75] Other researchers such as Bullard (1983); Berry, et. al. (1977); Holtzman (1992); Roberts (1992); Brueggemann (1993); and Greenberg (1993) have found similar disparities according to race/ethnicity in the siting

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[73] *Ibid.*, pp. 121 - 122.

[74] Hockman, Elaine, untitled and unpublished paper, Ecology Center, Ann Arbor, Michigan, 1993, p. 9.

[75] Bryant, Bunyan and Elaine Hockman, *Hazardous Waste and Spatial Relations According to Race and Income in the State of Michigan,* (unpublished paper), June 1994, p. 17.

of solid waste incinerators, landfills, and human sewage treatment plants.[76]

Greenburg (1994) undertook an analysis of federal Superfund sites within New Jersey.[77] One-hundred and thirteen NPL sites were examined in 90 New Jersey municipalities by comparing site score (HRS score), ranking the relative risk of each site, with 1990 U.S. Census data regarding race/ethnicity. He found that sites with higher HRS scores or of "higher priority" were more strongly associated with white over minority municipalities. Greenburg reported that this finding was not statistically significant, however, and offered the explanation that HRS score is strongly driven by known or potential threats to groundwater serving as a community drinking water supply. Groundwater contamination and residential use was more strongly associated with rural white subpopulations within the study sample.

Anderton, *et. al.* (1994) undertook a nationwide study of the location of commercial hazardous waste (RCRA) facilities in Standard Metropolitan Statistical Areas (SMSAs) and compared these locations with select social demographic variables for race/ethnicity, income, housing value and occupation from the 1980 U.S. Census. This is the first RCRA facility siting study to utilize census tracts as the geographic unit of analysis in comparison to hazardous waste site location. Importantly, this study used multiple methods of analysis, including simple t-tests of difference of means, Wilcoxon rank sum (Z-Statistic) test, and multivariate logistic regression odds analyses. This study

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[76] Goldman, *op. cit.*, 1993, p. 12.

[77] Greenberg, Michael R., "Separate and Not Equal: Health, Environmental Risk and Economic-social Impacts in Remediating Hazardous Waste Sites", in Shyamal K. Majumdar, *et. al.*, Editors, *Environmental Contaminants and Health*, Philadelphia, PA: Pennsylvania Academy of Sciences, 1994.

emphasizes the importance of selecting geographic units of analysis that "are as small as practical and meaningful (and allow for subsequent aggregation)"[78], and are "dependant upon the purpose of the study"[79]. In comparing SMSAs with at least one hazardous waste facility nationally to all other SMSAs without hazardous waste facilities, with surrounding SMSAs, and to areas within a 2.5 mile radius this study found "no evidence of consistent prejudicial result" in the siting of RCRA facilities[80]. Further, the authors concluded that hazardous waste facility locations tended to correlate only with census tracts in metropolitan areas characterized by industrial activities[81]. In summary, the study found that hazardous waste facilities are more likely to be located in industrial areas than in metropolitan with significant minority or high poverty. The study reached this conclusion without exploring the relationship of race/ethnicity or income to metropolitan census tracts "characterized by industrial activity", and without adopting the disproportionality argument comparing means to national U.S. Census means data.

Adeola (1994) analyzed the Baton Rouge region of Louisiana through the random sampling and telephone interviewing of residents of the city's SMSA regarding their race/ethnicity and distance to perceived environmental threats (*i.e.* hazardous waste

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[78] Anderton, *et. al., op. cit.*, p. 232.

[79] *Ibid.*, pp. 232 and 243.

[80] *Ibid.*, p. 243.

[81] *Ibid.*, p. 238.

disposal and petrochemical manufacturing facilities).[82] Using cross-tabulation, he found statistically significant association between self-reported race/ethnicity and proximity to environmental threats. Specifically, African-Americans were more likely to live near a hazardous facility than any other racial/ethnic group in that region. Adeola reported, "(t)he distribution of residence location (proximity to hazardous sites)...is statistically significantly inequitable by race. 42.6% of Blacks live close to hazardous waste facilities, and 57.4% have residences located away from hazardous waste sites. Whereas for Whites, only 27.6% live in hazardous neighborhoods, and 72.4% live far away from any hazardous waste facilities".[83] Further, using multivariate analysis Adeola found that race (African-Americans only) was a statistically significant predictor of proximity to hazardous waste facilities, controlling for socio-economic factors (education, average family income, number of years resident in Baton Rouge, perceptions of neighborhood change, seriousness of toxic waste, and its concentrations).[84] Finally, Adeola found that nearly 20% of respondent reported perceived health problems due to exposure to toxic wastes, and over 18% reported that a family member had experienced hazardous waste related illness.[85]

Zimmerman (1994) undertook a methodological study of previous environmental

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[82] Adeola, Francis O., "Environmental Hazards, and Racial Inequality in Hazardous Waste Distribution", *Environment and Behavior*, Vol. 26, No. 1, 1994, pp. 99-126.

[83] *Ibid.*, p. 114.

[84] *Ibid.*, pp. 115 - 116.

[85] *Ibid.*, p. 127.

equity empirical studies. Zimmerman examined issues associated with the classification of race/ethnicity and ethnicity in the selection and definition of study subpopulations, and concluded that U.S. Census Bureau racial and ethnic classifications are definitionally vexed, dynamic, contextual, inconsistent in application, often arbitrary, and poorly determined within current census surveys. Zimmerman concluded that such categorical difficulties may result in bias in the findings of environmental equity and health studies[86]. Regarding the selection of geographic units of analysis in previous environmental equity studies, Zimmerman noted that studies have utilized the entire U.S., geographic regions of the nation, states, counties, municipalities, collections of urban areas, governmental agency service areas, zip codes, census tracts, census block groups, and census blocks[87]. According to Zimmerman, little or no agreement exists within the literature as to which geographic unit of analysis to use. However, some researchers argue the importance of using units at least as large as census tracts so as not to hide measures of social difference within study areas[88]. Still others tend to promote the use of zip code areas[89]. According to Zimmerman, geographic units of analysis defined politically are often too large to

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[86] Zimmerman, Rae, "Issues of Classification in Environmental Equity: How We Manage id How We Measure", *Fordham Urban Law Journal*, Vol. 21, 1994, pp. 633-669, and Laura Pulido, "A Critical Review Of The Methodology Of Environmental Racism Research", *Antipode*, Vol. 28, No. 2, 1996, pp. 142-159.

[87] U.S. Bureau of the Census, 19990 Census of Population and Housing, Area Classifications, Appendices A, A-3 through A-6 (1991), as cited by Zimmerman, *op. cit.*, p.652, and Cutter, *op. cit.*, pp. 119.

[88] Zimmerman, *op. cit.*, p. 646; Been, 1994, *op. cit.*, p. 1403; and Fahsbender, John, J., "Student Article: An Analytical Approach to Defining The Affected Neighborhood In The Environmental Justice Context", *New York University Environmental Law*, Vol. 5, 1996, pp. 121-145.

[89] Commission for Racial Justice, United Church of Christ, 1987, *op. cit;* Mohai and *Bryant, op. cit.*, pp. 165-169; Bryant and Hockman, *op. cit.*, p. 4; and Fahsbender, *op. cit.*, pp 132-133.

"capture a facility's immediate neighborhood", but can serve as a useful indicator of "communities encompassing a shared sense of place, identity and a set of organizations that meet the area's needs" which may or may not be geographically coterminous[90]. Zimmerman notes that federal district appellate courts considering issues of environmental justice have generally accepted or implicitly accepted the use of census tracts as the most appropriate geographic unit to analyze social difference in environmental equity studies[91].

Zimmerman further states that agreement does not exist concerning the selection of appropriate distance radii to capture known or potential migration pathways of environmental risk from varying sources. Yet, empiricists agree that determinations of risk should be the driving factor[92]. According to Zimmerman, "without additional information about the physical extent of impacted interests, it is impossible to determine appropriate distances for analyzing equity. From an analytical perspective, the differences between values for a given socioeconomic characteristic become less significant as the distance becomes greater within a few miles of the site"[93].

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[90] Zimmerman, *op. cit.*, p. 646.

[91] See Bean v.s. Southwestern Waste Management Corp., 482 F. Supp. 773; East Tibbs Neighborhood Association v.s. Macon-Bibb County Planning & Zoning Commission, 706 F. Supp. 880 (M.D. Ga.) aff'd 896 F. 2d 1264 (11 Cir. 1989); Zimmerman, *op. cit.*, pp. 659-665; and Fahsbender, *op. cit.*, pp. 130-131.

[92] Zimmerman, *op. cit.*, p. 656; Colquette, Kelly M. and Elizabeth A. H. Robertson, "Environmental Racism: The Cases, Consequences, and Condemnations", *Tulane Environmental Law Journal*, Vol. 5, 1991, p. 183; Collin, Robert W., "Environmental Equity: A Law and Planning Approach to Environmental Racism, *Virginia Environmental Law Journal*, Vol. 11, No. 4, 1992, p. 510; and testimony offered by the researcher in NAACP v.s. Engler, Circuit Court of Genesee County, MI, concerning the construction and operation of a demolition wood incinerator and electric generation facility along the northeastern limit of the City of Flint, Michigan.

[93] Zimmerman, *op. cit.* p. 656.

In terms of levels of aggregation of geographic units of analysis, Zimmerman states that studies have proposed relevant radii of risk (e.g. two miles from sites of environmental contamination and including the census data from partially captured geographic units, or the use of polygonal boundaries from other geographic units). Empirical assumptions made in either approach include the statement bisected units are homogenous with the study area, or that excluded areas are demographically heterogenous with the study area(s). According to Zimmerman, the "dampening effect" associated with the use of large geographic units of analysis tends to minimize or eliminate demographic mean differences between areas of smaller units of analysis, such as census block and block groups[94]. As stated by Zimmerman, the bias that can enter into equity studies using large geographic units of analysis "argues for working with smaller geographic units[95].

Zimmerman also considers the selection of a standard of comparison by which population distribution is evaluated relative to source(s) of environmental risk. According to Zimmerman, this area "continues to be one the more subjective, discretionary areas of environmental equity research" and can lead to bias[96]. Previous proportionality comparisons of demographic values with select geographic unit of analysis have utilized state or national means. Finally, Zimmerman contends that the

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[94] *Ibid.*, p. 655.

[95] *Ibid.*, p. 656.

[96] *Ibid.*, p. 659; and Been, *op. cit.*, p. 1384 (stating that the proportionality argument and empirical method ignores population densities of neighborhoods and fails to provide information as to how far the distribution of the population within LULU host neighborhoods deviate from national or state distributions).

comparison of study area values to state or national standards can minimize difference and introduce additional bias.

Cutter (1994) undertook a statewide analysis at the county level of acutely toxic airborne releases using 1990 TRI data from 46 South Carolina counties to begin to map that state's "geography of risk".[97] She compared the hazardous waste generation rates, TSD facility locations, TRI releases (pounds for 1992), and self-generated incidents of toxic airborne chemical release inventory (1980 - 1990) with socio-economic variables (including race/ethnicity, income, and population density). Cutter found that the most affected areas within these South Carolina counties were racially-mixed, more urbanized and with above average income. She states, "(c)ontrary to expectations, this preliminary analysis suggests that minority and less affluent residents are not unfairly exposed to toxic risks" in South Carolina.[98]

Tomboulian, *et. al.* (1995) undertook a study of the Detroit metropolitan area by mapping a number of different pollution sources, separately and as an aggregate, in Wayne, Macomb and Oakland counties.[99] This study estimated exposures to airborne particulates and volatile organic hydrocarbons (VOCs) of varying volumes and distribution as related to census information within the metro Detroit tri-county area. The study found that racial and income indicators of environmental quality are "more

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[97] Cutter, Susan L., The Burdens of Toxic Risks: Are They Fair?", *Business and Economic Review,* October - December , 1994, pp. 3-7.

[98] *Ibid.*, p. 7.

[99] Tomboulian, *et. al.*, *op. cit.*

understandable in terms of the connections between industrial land use areas and residential locations".[100] Moreover, Tomboulian, *et. al.*, concluded that lower economic status is consistently associated with poorer environmental quality; that indicators of environmental quality including 'extensive industrial land use' and 'high daily traffic' occur more frequently in the City of Detroit (approximately 75% African-American) than the surrounding tri-county area; and that no consistent pattern of disproportionate minority association with the other four indicators of environmental quality existed".[101]

Hamilton (1995) re-analyzed data used in his 1993 study of WTEF expansions/reductions and socio-economics nationally. Data were aggregated by zip code rather than by county[102]. Regression analysis of WTEF data from 1986 to 1992, found that of the 207 zip code areas with WTEFs operating in 1986, facilities in 84 zip code areas planned or undertook expansion. Zip codes with planned or completed expansions were statistically significantly associated with lower educational status, lower actual and estimated voter turnout, lower population density, lower median household income, higher percent poverty, higher percent minority, and higher percent renters.[103] Non-parametric logit probability analysis was also undertaken by Hamilton to associate WTEF decisions with demographic variables. Hamilton found statistically significant

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[100] *Ibid.*, p. 3.10.

[101] *Ibid.*, p. I.

[102] Hamilton, James T., "Testing for Environmental Racism: Prejudice, Profits, Political Power?", *Journal of Policy Analysis and Management*, Vol. 14, No. 1, 1995, pp. 107-132.

[103] Hamilton, *op. cit.*, 1995, pp. 121-123.

association between facility expansion decisions and zip code areas with lower estimated voter turnout, lower median household income, lower population density, and increased percentage of renters.[104] He reports that zip codes "targeted" for facility expansions had a 25 percent mean minority population versus a 18 percent minority population within the those areas with no WTEF expansion.[105] However, race/ethnicity was found by Hamilton not to be statistically significant in nonparametric analysis.[106] Hamilton notes that in "(e)xamining the expansion plans of commercial hazardous waste facilities for the 1987-1992 period, I find evidence that the higher potential for collective action in an area, the lower the probability that the area will be selected for further hazardous waste capacity".[107] Hamilton concludes that these findings are likely the result of market or land-economic forces.

Glickman, *et. al.* (1995) undertook a comparison of the effect of using various geographic units of analysis (census block groups, census tracks, municipality

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[104] *Ibid.*, pp. 126-127.

[105] *Ibid.*, pp. 107.

[106] *Ibid.*, p. 127.

[107] *Ibid.*, pp. 129. Hamilton notes that this finding is largely consistent with economist Ronald Coase's theorem liberally interpreted by Hamilton from Coase's "The Problem of Social Cost", *Journal of Law and Economics*, Vol. 3, October 1960, pp. 1-44. Put succinctly, the Coase theorem states that companies seeking to maximize profits will chose the most feasible alternative with least transaction costs (capital costs, potential liability, potential compensation claims, *etc.*). According to Hamilton (1995, p. 109-110) this may result in the siting of polluting or potentially polluting facilities in locations with low land values, sufficient infrastructure, and in communities that have not overcome collective action problems (*i.e.* free ridership). Collective action problems are associated with communities that have lost or little political voice due to low income or education status. Hamilton notes that Tiebout (1956) builds upon the relevant application of Coase's theorem here by suggesting the *ex post facto* "coloring of polluted areas" through the immigration of minorities into impacted areas with lower land values, and white emigration to greener areas by "voting with their feet" (Hamilton, 1995, p. 110).

boundaries, and one-half mile and one mile radius circles) in analyzing TRI site locations against with socio-economic characteristics (population density, race, income, age, employment status, vacant households, and head of household status).[108] Analyzing these various geographic areas surrounding TRI sites in greater Pittsburgh (Allegheny County), Pennsylvania area, the researchers found "the unit of analysis chosen can have profound effects on the results of an (environmental) equity analysis..and its interpretation".[109] Finally, the study recommends the expanded application of desk-top geographic information systems to undertake additional environmental equity analysis with improved methodology.[110]

Been (1995) undertook a study that has proven to be methodologically useful in the design of this study. Using more rigorous methods and statistical methods, the researcher analyzed data used by a few previous studies and criticized the statistical procedures and methodologies of the Commission for Racial Justice (1987), Goldman and Fitton (1994), and Anderton, *et. al.* (1994) in their national studies comparing the locations of locally unwanted land uses (LULUs) and social demographics.

Specifically, Been prefers the use of census tracts over zip codes as units of analysis as "they tend to reflect a community's view of where one neighborhood ends and

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[108] Glickman, Theodore S., Dominic Golding and Robert Hersh, "GIS-Based Environmental Equity Analysis: A Case Study of TRI Facilities in the Pittsburgh Area", in *Computer Supported Risk Management*; Wallace, WA., Beroggi, G. E. G., Editors, Kluwer Academic Publishers, Netherlands, 1995, p. 95-114.

[109] *Ibid.*, p. 112.

[110] *Ibid.*, p. 111.

another begins"[111], while zip codes are bureaucratically defined locations that change over time without documentation. Been finds that census tracts better reflect the areas immediately surrounding LULUs, while zip codes may be vast and include areas a long distance from sites of environmental risk. Statistically, Been is critical of the use of means comparisons and regression analyses of means in previous environmental equity studies. Been analyzed distributions of demographic variables around means, univariately finding more strength in statistical significance in the percentage of LULUs and neighborhoods (census tracts) consisting of more than 10% and less than 70% African-Americans; Hispanic neighborhoods of more than 20%; neighborhoods with median annual incomes of $10,001 to $40,000; and neighborhoods with 30% to 70% populations without high school diplomas, all bear more than their proportionate share of LULUs[112]. Multivariate analysis of these data found racially disproportionate distribution of LULUs in neighborhoods with median incomes of $10,001 to $40,000. Within that income group, African-American communities of between 10% and 60% were found by Been to bear 40% more facilities than their proportionate share, and all African-American neighborhoods considered together bear 30% more facilities than their proportionate share[113]. Been contends that their is no agreement as to what comprises an "African-

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[111] Been, Vicki, "Analyzing Evidence of Environmental Justice", *Journal of Land Use and Environmental Law*, Vol. 11, No. 1, Fall 1995, p. 5.

[112] *Ibid.*, pp. 17 - 19.

[113] *Ibid.*, p. 19.

American neighborhood"[114].

Been reanalyzes data used by CRJ and Anderton, *et. al.* using multivariate statistical methods, and compares her findings to those univariate findings of these two previous studies. Been found that univariate analyses tend not to find disproportionate burdens on African-American communities from the siting of LULUs and mask the statistically significant correlation of Hispanic communities and sources of environmental risk.[115] She criticizes previous studies for focusing only on African-American racial minorities or aggregating all racial minorities in undertaken environmental equity research. Been finds that racial aggregates tend to mask important findings regarding positive correlations between Hispanic (presumed by Been to be Catholic) and LULUs. Importantly, She suggests that measures of population density be included in any environmental equity analysis, but especially univariate analyses, to account for the influence of housing density on decisions to locate potentially polluting facilities[116].

Been concludes that the percentage of Hispanics, unemployment rates, and percentage of work force employed in manufacturing are statistically significant predictors of the location of potentially polluting facilities, while the percentage of African-Americans is a significant predictor of the presence of LULUs[117]. From her analysis of the joint distribution of income and percentage of African-Americans, Been

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[114] *Ibid.*, and see generally Fahsbender, *op. cit.*

[115] *Ibid.*, p. 6

[116] *Ibid.*, p. 7.

[117] *Ibid.*

concludes that the disproportionate burden found is more a function of income than race/ethnicity[118]. However, multivariate analyses suggest that race/ethnicity is a better predictor of LULU facilities than income[119].

Importantly, Been is the first to analyze and criticize the reliability of the data used by the CRJ and Anderton, *et. al.* studies. The federal list of hazardous waste treatment, storage, and disposal facilities (TSDFs) introduces empirical unreliability due to the listing of facility head quarters instead of TSDF location. This understates the universe of TSDFs generally, and also fails to consider qualitative differences through the weighting of different types of TSDFs. These qualitative differences, according to Been, reflect higher environmental risk, such as active hazardous waste incinerators versus containerized liquid hazardous waste storage, separation, and repackaging facilities with relatively low potential for causing human exposure or releases to the environment[120]. Re-analyzing the CRJ and Anderton, *et. al.* studies using an improved data set, Been found statistically significant correlation between TSDFs and lower median housing values and lower levels of education[121]. Been concluded that the use of the less reliable CRJ and Anderton, *et. al.* data sets found statistically significant correlation between the location of TSDs and communities of color[122]. Recognizing existing patterns of racial

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[118] *Ibid.*, pp. 20-21.

[119] *Ibid.*, p. 21.

[120] *Ibid.*, p. 9.

[121] *Ibid.*, p. 12.

[122] *Ibid.*, p. 12.

segregation in U.S. regions and cities, Been also suggests alternative definitions of communities of color through the utilization of racial ratios within study areas over comparisons to national or state percentages. The latter tends to hide disparities existing at less aggregated levels and to account for local patterns of racial housing segregation[123].

Overall, Been comments that her study suggests "a more ambiguous and complicated entanglement of class, race, educational attainment, occupational patterns, relationship between the metropolitan areas and rural or non-metropolitan cities, and possibly market dynamics" lay behind decisions to site LULUs[124]. While many of these findings had been considered in the design of this study, this research includes several of Been's methodological recommendations.

Following Been, Boerner and Lambert (1995) undertook a longitudinal study and statistical analysis of the siting of hazardous waste TSDFs and federal superfund sites in and around St. Louis, Missouri.[125] The study analyzed the incidence of these facilities in St. Louis area census tracks in association with demographic and socioeconomic characteristics including mean housing values, percentage of residents with a high school diploma or higher, residents employed in manufacturing, percentage of residents below the poverty line, and the dummy variable of whether or not such a facility was located in the census tract. Following the recommendations of previous researchers, this study

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[123] *Ibid.*, pp. 14-15.

[124] *Ibid.*, p. 21, see also Hamilton, *op. cit.*

[125] Boerner, Christopher and Thomas Lambert, *Environmental Justice in St. Louis: The Economics of Siting Industrial and Waste Facilities*, Working Paper 156, Center for the Study of American Business, Washington University, St. Louis, Missouri, April 1995.

analyzed census data from 1970, 1980 and 1990, and undertook several methods of statistical analysis, including the independent sample t-test for a difference of means, the two-sample Wilcoxon rank-sum test for equality of distribution, correlation analysis among variable, logistic regression and logit odds ratios analyses. This study concluded that market forces were largely responsible for the disproportionate exposure of poor and minority St. Louis residents to environmental risk. Residents of census tracks with polluting facilities were more likely to be employed in manufacturing than other city residents. According to these researchers, no evidence of racial discrimination was found as market forces were found to result in the poor and minorities moving into census tracks with polluting facilities since 1970.[126]

In a largely descriptive study, Nabalamba (1996) compared the Romulus, Michigan zip code area with that of nine surrounding communities in Wayne County to determine if "conditions..beyond market related conditions influence business and/or government decisions to locate environmental wast facilities" in this area.[127] This study compared income and race/ethnicity measurements within each zip code area to the occurrence of TRI, Part 201, LUST and RCRA sites. Due to the small study population size, a nonparametric statistic test (Friedman's test) was used to compare the rank ordered occurrence of each variable. Using this method, the absence of difference between variables and zip codes would indicate random distribution of a variable. This study

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[126] *Ibid.*, pp. 4 and 24.

[127] Nabalamba, Alice, *The Controversy Between Environmental Disposal Systems and Residents of the City of Romulus, MI, Over the Siting of a Deep Injection Well on Wahrman Road,* unpublished paper, University of Michigan, Urban, Technological and Environmental Planning Department, Winter 1996, p. 4.

found a statistically significant difference in the proportion of minority, median family income and TRI sites occurrence within the Romulus zip code area as compared to the nine surrounding zip codes. Given the commercial proposal to construct a deep well injection hazardous waste disposal facility in the study area, this study implies that the Romulus zip codes were unintentionally preferred by government and/or the developer due to disproportionately high proportions of low income and minority residents in the Romulus zip area[128].

Wood (1997) examined the odds ratios of living near a hazardous waste site in Detroit area zip codes according to race/ethnicity and income[129]. The association between percent minority and median family income, both in quartiles, and the number of LUST, TRI and Act 307 (Part 201) sites in 110 Detroit zip code areas were analyzed. This study found statistically significant association between race/ethnicity and exposure to hazardous waste sites, but that income was a stronger locational predictor of hazardous waste contamination sites than race/ethnicity.[130]

Zax (1997) undertook an evaluation and critique of the conceptual approach and statistical methodology of Michigan and national siting studies. He found that numerous studies fail to control for income when relating environmental condition to race/ethnicity. Specifically, Zax found that many studies including those of Asch and Seneca (1978),

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[128] *Ibid.*, p. 15.

[129] Wood, G. Craig, *Risk of Hazardous Waste Exposure for Different Levels of Percent Minority Populations in Detroit and Vicinity*, unpublished paper, University of Michigan, School of Public Health, Department of Biostatistics, 1997.

[130] *Ibid.*

Gianessi, Peskin and Wolff (1979), Gelobter (1992), and Goldman and Fitton (1994) conflate all non-white racial categories into an undifferentiated minority classification, ignoring important empirical differences regarding residential mobility.[131] Secondly, he found that numerous studies examining national data, including those by Asch and Seneca (1978), Gianessi, Peskin and Wolff (1979), United Church of Christ (1987), and Gelobter (1992), fail to control for regional differences in economy and environmental quality when comparing across regions. Third, Zax found that the common linear distance relation of gross geographic areas -- such as zip codes, census tracts, census county group or SMSA -- and the existence of a present or proposed pollution source as a "measure of exposure" is an unreliable indicator of environmental risk.[132] Fourth, Zax concluded that past empirical focus on single, narrowly-defined environmental risk by United Church of Christ (1987), Mohai and Bryant (1992), and Goldman and Fitton (1994) is misleading.

Zax suggests the substitution of measures of total neighborhood disamenities, the composition of the environmental risk associated with each disamenity being of secondary interest only[133]. He found that "virtually all" previous studies are methodologically flawed because they use bivariate analyses to "compare the effects of different population characteristics on exposure and analysis that considers on a single

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[131] Zax, *op. cit.*, p. 20.

[132] *Ibid.*, p. 21.

[133] *Ibid.*

(environmental) characteristic"[134]. In Zax's words, such studies "reveal nothing of relative importance of race and income (and the incidence of environmental risk)... informed public policy will have to await ..more rigorous studies"[135].

Regarding previous Michigan studies, Zax finds no evidence of disproportionate impact or environmental racism. Methodologically, Zax criticized Mohai and Bryant (1992) for failing to consider the higher correlation between suburban Detroit African-American residential locations and commercial hazardous waste facilities, and that minority groups other than blacks tend to live closer to hazardous waste facilities than whites or African-Americans.[136] The West, *et. al.* (1992) study, which revealed a correlation between minorities populations and high consumption rates of contaminated Great Lakes fish, is also criticized by Zax for undertaking tri-variate analyses of race/ethnicity, age and fish consumption without reporting any single analysis of the relationship of all three variables, and for failing to reveal that whites formed 91% of the sample of anglers interviewed though comprising only 83.4% of Michigan's population[137].

Bryant and Hockman (1994) are criticized by Zax for their analysis of all Michigan zip codes and the incidence of environmental risk. Zax stated that the use of numerous types of contamination sites and potentially polluting industries, and birth

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[134] *Ibid.*, p. 22.

[135] *Ibid.*, p. 23.

[136] *Ibid.*, p. 25.

[137] *Ibid.*, p. 26.

weight data to represent environmental risk fails to control for regional difference in zip code economies and "unique characters". Zax characterized this methodology as an "irresponsible" illusion toward causality between the location of licensed waste incinerators and low birth weights, and likely more "attributable to ..the nature of the zip code" area[138].

Generally, Zax concluded that industrial facilities and thus pollution is concentrated in urban core areas to enjoy "agglomerative economies"[139] and "demand coordination" to enhance profits; that residential housing patterns naturally stratify by income; that pollution is unavoidably coincident with low income and that this trend is reproducing; that blacks in the U.S. face statistically demonstrated barriers to relocation for improved housing that are much greater than any other minority group; and that there is no credible evidence of racially disproportionate impact or environmental racism in Michigan and the U.S. as demonstrated by facility siting empiricism. Finally, Zax concludes that historically African-Americans moved into areas with poor environmental quality and to "find" that blacks are nationally located in regions with higher incidence of environmental hazards is merely to restate the well-known fact that blacks are concentrated in Northern cities[140].

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[138] *Ibid.*, pp. 27-28.

[139] *Ibid.*, pp. 10-11.

[140] *Ibid.*, p. 21.

Distribution Measures of Ambient Environmental Pollution

Since Congress passed the Clean Air Act (CAA) of 1970, a total of ten studies have been undertaken to research the incidence of environmental pollution and disparity by income or race/ethnicity.[141] Krieger (1970) undertook a predictive analysis of the association between poverty and poor environmental quality, including measures of air quality, noise and open space[142]. Krieger found an association between poverty and degraded environment, and proposed that then newly created environmental U.S. environmental protection programs would likely serve to widen the gap between rich and poor environments due to the immobility of the poor. Krieger recommends that "analyses of these (substantial environmental program) expenditures need to be done..it would be interesting to see how these expenditures for environment are distributed. An interesting question is how are the extra expenses for pollution abatement devices being distributed to consumers?"[143]

The federal Council on Environmental Quality (CEQ) along with the Nixon (1971) administration undertook a study examining the distribution of poor air quality areas of Chicago and income.[144] The CEQ found significant correlation between areas of poor air quality (non-attainment areas as defined by the CAA) and poor Chicago

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[141] Goldman, *op. cit.*, 1993, p. 15.

[142] Krieger, Martin H., "Six Propositions on the Poor and Pollution", *Policy Sciences*, Volume 1, 1970, pp. 320-324.

[143] *Ibid.*, p. 321.

[144] Council on Environmental Quality, "The Second Annual Report of the Council on Environmental Quality", Washington, D.C.: U.S. Government Printing Office, 1971.

neighborhoods. Zupan (1973) found similar trends at the zip code level in the region surrounding New York City.[145]

Freeman (1972), using an air quality index in three U.S. urban centers (Kansas City, St. Louis, and Washington D.C.), found that lower income areas within these cities were exposed to higher levels of particulate matter and sulfates than areas of higher income. Particulate matter, or total suspended solids, is often used as an indicator of the air borne dispersion of heavy metals, physically entrained by air borne particulates. However, in comparing the distribution of air pollution between the lowest income areas (defined as the "under $3,000/year group") in these three cities and their racial minority neighborhoods (operationalized as census tracks), Freeman found even higher average exposures to both indicators of air pollution in minority areas. In summary, while this study explored an association between poverty and poor environmental quality on a number of levels, it was the first to suggest that race/ethnicity may be more significant than measures of income in the distribution of environmental risk within U.S. urban areas posed by air pollution.[146]

Kruvant (1975) found income and less significant racial disparity in the distribution of poor air quality in the District of Columbia.[147] Kruvant, noted, "areas

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[145] Zupan, Jeffrey, M. , *The Distribution of Air Quality in the New York Region*, Baltimore, MD: Johns Hopkins University Press, 1973, pp. 2-5; and as cited by *Goldman, op. cit.*, 1993, p. 15.

[146] Freeman, A.M., "The Distribution of Environmental Quality", in A. V. Kneese and B.T. Bower, Editors, *Environmental Quality Analysis*, Baltimore, MD: Johns Hopkins University Press for Resources for the Future, 1972.

[147] Kruvant, William, J., "People, Energy and Pollution", *The American Energy Consumer*, Newman, D. K. and Day, D., Editors; Cambridge, MA; Ballinger, 1975, pp. 125-167, cited by Goldman, *op. cit.*, 1993, p. 15, and McCaull, Julian, "Discriminatory Air Pollution: If Poor, Don't Breathe", *Environment*, Vol. 18, No. 2, March

reaching or exceeding federal pollution standards in Washington (D.C.) contain both rich and poor, and middle class...(but as a whole) the probability is much greater that poor persons will live in a high-pollution area".[148] Describing this association he reported, "the close parallel between poverty, low occupational status, low rents, segregation and pollution is not one of cause and effect...and can not be solved by air pollution control alone".[149] Kruvant found that the primary source of lead as air pollution was automobile use in affluent white communities in D.C. Burch (1976) found income but not racial disparity in the distribution of air pollution in New Haven, Connecticut.[150] Berry *et. al.* (1977) found racial and income disparity in the distribution of air pollutants and measures of noise in a dozen major U.S. cities.[151] Mann (1991) found racial disparity in the incidence of air pollution in Los Angeles, California.[152]

McCaull (1976) also undertook an early air pollution study. Following Kruvant, he focused on the population of Washington D.C. inside the beltway. Using the 1970 U.S. Census, McCaull compared indicators of auto emission (carbon monoxide and

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1976, pp. 26-31.

[148] Kruvant, *op. cit.*, p. 161.

[149] Kruvant, *op. cit.*

[150] Burch, Jr., William R., "The Peregrine Falcon and the Urban Poor: Some Sociological Interrelations", *Human Ecology An Environmental Approach*, Richerson, P.J. and James McEvoy, Editors; Belmont, CA: Duxbury Press, 1976, pp. 308-315, and as cited by Goldman, *op. cit.*, 1993, p. 15.

[151] Berry, Brian J. L., "The Social Burdens of Environmental Pollution: A Comparative Metropolitan Data Source", Cambridge, MA: Ballinger Publishing Co., 1977, and as cited by Goldman, *op. cit.*, 1993, p. 15.

[152] Mann, Eric, "L. A.'s Lethal Air: New Strategies for Policy, Organizing and Action", Los Angeles, CA: Labor/Community Watchdog, 1991, and as cited by Goldman, *op. cit.*, 1993, p. 15.

hydrocarbons) and point sources (sulfur dioxide and particulate matter) with census track data. McCaull found that the mean percentages of poverty, rental housing, and black residents increased and percentages of professional occupational status decreased with higher mean pollution levels. McCaull noted that the chances are disproportionately above average for the poor in occupations below the professional level, in low rent areas, and African-American to be exposed to poor air quality in the Washington, D.C. area.[153]

Asch and Seneca (1978) examined urban air quality in 284 U.S. cities according to racial and income demographics. This study examined particulate matter, sulfur dioxide and nitrogen dioxide census tracts within these three urban areas, comparing mean annual levels of these measures of air pollution with "white" and "nonwhite" census tracks. The researchers found that correlations between "nonwhite" percentages of tracts in these cities tended to be weaker than a measure of wealth, *i.e.* median family income. The researchers replicated the study using air pollution data from cities within 23 U.S. states, and found a similar correlation, albeit statistically weak, between air pollution and census tracks with the lowest mean family incomes.[154]

Gianessi, Peskin and Wolff (1979) published a national study of the distribution of air pollutants by income and race/ethnicity. Unlike previous studies, however, this study utilized U.S. EPA data for a single time period, and estimated measures of total property damage in U.S. dollars to receiving communities. The researchers found that

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[153] McCaull, *op. cit.*, p. 30.

[154] Asch, Peter and Joseph J. Seneca, "Some Evidence on the Distribution of Air Quality", *Land Economics*, Volume 54, Number 3, 1978, pp. 278-297.

higher levels of ambient air pollution correlated to lower income areas, and that air quality was lower in nonwhite areas. The study also concluded that, although higher income areas suffered higher levels of economic damage from air pollution, a clear correlation existed between communities of color and high levels of property damage from air borne pollution. One significant limitation to this study is its failure to quantify or estimate human health or environmental damage (in dollars or some other measure) resulting from the dispersion of air borne pollutants.[155]

Gould (1986) ranked zip code areas nationally to determine the "quality of life in American neighborhoods"[156]. Gould analyzed the location of federal Superfund and RCRA sites, toxic emissions, and cancer mortalities with U.S. Census 1980 measures of race, income, population density and age. Gould found that income was positively correlated with the number of waste sites, as income increased the number of Superfund sites significantly decreased.[157] Gould reported, "the poorest (and highest percent minority) areas are all increasingly exposed to dangers emanating from abandoned waste sites containing toxic residues of past industrial activity"[158]. Gould concluded "these findings suggest the presence of extremely high cancer mortality rates in those 5 digit Zip

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[155] Gianessi, Leonard, Henry M. Peskin, and Edward Wolff, "The Distributional Effects of Uniform Air Pollution Policy in the U.S.", *Quarterly Journal of Economics*, May, 1979, pp. 281-301.

[156] Gould, Jay M., *Quality of Life in American Neighborhoods: Levels of Affluence, Toxic Waste, and Cancer Mortality in Residential Zip Code Areas*, Alice Tepper Marlin, Editor, Westview Press, Boulder and London, 1986.

[157] *Ibid.*, pp. 21-22.

[158] *Ibid.*, pp. 22-23.

code area that are most.. urbanized...and heavily affected by toxic waste residues[159].

In perhaps the most complete and arguably the most important study of air pollution by race/ethnicity and income to date, Gelobter (1987) found greater racial than income disparity in all U.S. urban areas when examining the incidence of air pollution. Gelobter used U.S. EPA national air quality indices from 1970 to 1984, and cross-referenced these data with 1980 census race/ethnicity and income data. Gelobter used two measures of air quality - total suspended particulates, and the combined concentrations of carbon monoxide, nitrogen oxides, sulfur dioxide, ozone, and sulfates - and analyzed these data for U.S. urban areas, and the nation as a whole. When examining these data for the U.S. as a whole, Gelobter found that racial minorities lived in areas with significantly higher levels of both measures of air pollution than whites consistently through this period. When examining measures of income in urban areas and in all areas nationally, Gelobter found that lower income groups tended to be exposed to higher levels of air pollutants than higher income groups. However, Gelobter found these differences to be less dramatic than the correlation with race/ethnicity when examining rural and urban areas by income nationally. Gelobter noted that this correlation may be due to the concentration of wealth in urban areas generally.[160] Importantly, Gelobter concluded that income disparities in the incidence of air pollution nationally have increased since the passage of the CAA in 1970.

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[159] *Ibid.*, pp. 23 and 29.

[160] Gelobter, Michael, *The Distribution of Outdoor Air Pollution by Income and Race: 1970-1984* (unpublished Master's Thesis), Energy and Resource Group, University of California, Berkeley, California, 1987.

Wernette and Nieves (1992) found that African-American populations nationwide at the county level were approximately 40 percent and Hispanics were 90 percent more likely than whites to live in areas of poor air quality, or "non-attainment areas" as defined by the federal CAA.[161]

Goldman (1992) nationally ranked counties with the highest incidence of industrial hazards according to 24 measures, including the location of 150,000 industrial smokestacks in the nation, curies of emissions from nuclear power plants, tons of 45 suspected and 32 known acutely toxic and hazardous substances released to the air and water, location of hazardous waste generators, incinerators and TSDFs, and occupational exposures to toxic chemicals. Goldman found that people of color were 60 percent more likely than whites to live in counties that ranked among the top two percent of U.S. counties (or 60 U.S. counties) for concentrations of industrial hazards.[162] According to this study, Latinos, African-Americans and Asian Americans were 32 percent, 85 percent and nearly 300 percent, respectively, more likely than whites to live in these top ranking 60 counties with industrial hazards.[163] In the top ten ranked counties, the likelihood of people of color to live in these areas is two and one-half times greater than that of whites.[164] No such disparities were found by income. In fact, household incomes, levels

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[161] Wernette, D. R. And Leslie A. Nieves, "Breathing Polluted Air: Minorities Are Disproportionately Exposed", *EPA Journal*, No. 18, March/April, 1992, pp. 16-17, and as cited by Goldman, *op. cit.*, 1993, p. 15.

[162] Goldman, *op. cit.*, 1992, p. 14 (Arkansas and Hawaii were not included in this study).

[163] *Ibid.*

[164] *Ibid.*

of education and poverty rates were lower in these counties than counties within the nation as a whole. Goldman stated, however, that income levels immediately adjacent to and surrounding sources of industrial hazards were lower than the county as a whole or were skewed by higher income urban areas within study areas.[165]

Nieves and Nieves (1992) undertook a study similar to Goldman (1992) and researched the combined risk posed by air pollution, groundwater contamination, radiation releases and other environmental and human health hazards in counties surrounding over 4,000 industrial facilities nationwide of various types.[166] The researchers found statistically significant correlation between percentages of people of color and the incidence of industrially-related health and environmental risk, regardless of whether the study area was rural or urban.[167] However, the researchers did not find a correlation between industrial risk, people of color and lower income status.

Perlin, *et. al.*, (1995) studied federal Toxic Release Inventory (TRI) data for 1990 as an estimate of airborne emission for the U.S. as compared with 1990 U.S. Census data (race/ethnicity and household income) aggregated at the county level.[168] Perlin *et. al.*

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[165] *Ibid.*, p. 14.

[166] *See* Nieves, Leslie A. and Alvaro L. Nieves, *Regional Differences in the Potential Exposures of U.S. Minority Populations to Hazardous Facilities*, Chicago, IL. presentation at the Annual Meeting of the Regional Science Association, November 15, 1992, and Nieves, Leslie A., Hemphill, R. C. and Clark, D. E., *The Economic Impacts of Noxious Facilities on Wages and Property Values: An Exploratory Analysis*, Argonne, IL: Argonne National Laboratory, 1992.

[167] Nieves and Nieves, *op. cit.*, 1992, and Goldman, *op. cit.*, 1993, p. 14.

[168] Perlin, Susan A., R. Woodrow Setzer, John Creason, and Ken Sexton, "Distribution of Industrial Air Emissions By Income and Race In The United States: An Approach Using the Toxic Release Inventory", *Environmental Science & Technology*, Vol. 29, No. 1, 1995, pp. 69-80.

weighted the TRI data for population density to control for urban versus rural character. This study found no regional correlation between TRI emission and median household income, but annual household income was found to be higher in counties with higher TRI emission averages.[169] As stated by the researchers "with the exception of Native Americans, minority groups nationally are more likely on average to live in counties where TRI emissions are higher compared to the median emissions values in counties where whites live".[170] The researcher concluded that despite empirical attempts to control for population density, increased emissions were likely a function of county urbanization.[171]

Other researchers have found similar trends between racial disparity and some income disparity and the release of toxic materials on residential areas of select U.S. cities. These include Belliveau, *et. al.*, 1989; Brown, 1991; Kay, 1991; Bowen, *et. al.*, 1993; and Burke, 1993. Importantly, based upon questions received by this researcher, two studies have been undertaken to examine the question of whether minority communities "moved into" geographic areas of environmental contamination or risk, or on the other hand such polluting facilities were cited in established minority communities. Been (1993a) who followed up study by Bullard (1983) and GAO (1983), found that not only have these communities been predominantly poor and African-

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[169] Perlin, *et. al., op. cit.*, p. 77.

[170] *Ibid.*, pp. 74 and 77.

[171] *Ibid.*, pp. 75.

American prior to the citing of hazardous waste disposal facilities, but that percentages of African-Americans rose and incomes fell in these communities following the establishment of these facilities.[172]

Also as a follow-up of and compliment to the UCC 1987 study, Hamilton (1993) found that hazardous waste TSD facilities planning expansions in 1993 were significantly more often in counties predominantly of color, whereas hazardous waste facilities planning reductions in capacity were in predominantly white communities.[173]

Human Health and Exposures to Environmental Pollution

To date, there have been approximately 30 empirical studies undertaken analyzing human exposures and health effects from environmental pollution and measures of race/ethnicity and income. All of these studies have found disproportionate exposures and health effects, including disease and mortality, from environmental toxins and the poor and people of color.[174] Furthermore, these studies indicate that the environmental exposure and health gaps between racial minorities, the poor and affluent, whites is increasing in the U.S., and for the first time in the twentieth century black life-expectancy declined during the 1980s.[175]

Goldman, as previously stated, in 1992(b) correlated 24 measures of industrial hazard to the poor and communities of color, also finding age-adjusted mortality rates

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[172] Goldman, *op. cit.*, 1993, p. 12.

[173] *Ibid.*

[174] *Ibid.*, p. 15.

[175] *Ibid.*

disturbingly above national averages in nine of ten industrialized counties studied.[176] Eight counties studied ranked among the top ten percent for mortality from all cancers, and six ranked among the top ten counties in the nation for deaths due to lung cancer.[177] The ten industrial, poor and minority areas studied and all other measures of cancer were significantly above national averages.[178] Moreover, five of the counties studied were in the top ten counties nationally for breast cancer, and four have mortality rates from birth defects significantly above national averages.[179] This study also revealed that mortality rates from birth defects, cancer, and all other disease were found to be rising through the 1980s.[180] The most significant racial disparity found by Goldman (1992b) was mortality for young-adults from infectious diseases (primarily before the onset of acquired immune deficiency disorder) 4.5 times the rate suffered by whites.[181] Goldman's study correlated this trend to violations in drinking water supply standards.[182] The second largest racial disparity in adult mortality found was fatal exposure to hazardous substances.[183] According to this study, people of color in the U.S. were found to die from exposures to

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[176] Goldman, *op. cit.*, 1992, and Goldman, *op. cit.*, 1993, p. 16.

[177] *Ibid.*

[178] *Ibid.*

[179] *Ibid.*

[180] *Ibid.*

[181] *Ibid.*

[182] *Ibid.*

[183] *Ibid.*

hazardous substances, especially pesticides and radioactive mining wastes, at a rate 50 percent higher than U.S. whites.[184]

Regarding lower income and minority population workplace exposure to hazardous substances, Lloyd *et. al.*, 1970; Lucas, 1974; McMichael *et. al.*, 1976; Calabrese, 1978; Davis, 1980; Lapin and Hoffman, 1981; Robinson, 1984, 1987, 1989; and Friedman-Jimenez, 1989; Rios, *et. al.*, 1993; Swanson, 1994, and Epstien, 1994 have researched and found significant income and racial disparities in occupational health.[185] Individuals that live, work, play and/or conduct everyday activity in proximity to environmental hazards often suffer multiple exposures resulting in the highest level of risk and disease.[186] Minorities, especially African-Americans and Latinos, are subject to greater overall exposure as they are over-represented in urban populations and jobs involving work with hazardous materials, and possess disproportionately more children, women of child bearing age - the most vulnerable segment of the population.[187]

Chronic exposures to environmental toxins have been researched and documented

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[184] *Ibid.*

[185] *Ibid.*, pp. 16-17.

[186] Swanson, *op. cit.*, pp. 592-593, and Epstien, Samuel S., "Environmental And Occupational Pollutants Are Avoidable Causes Of Breast Cancer", *International Journal of Health Sciences*, Vol. 24, No. 1, 1994, pp. 146-147.

[187] Friedman-Jimenez, *op. cit.*, pp. 64-65; Swanson, *op. cit.*, p 593 and 599; Rios, Richard, *et. al.*, "Susceptibility to Environmental Pollutants Among Minorities", *Toxicological and Industrial Health*, Vol. 9, pp. 797 and 804-812; Calabrase, Edward J., *Pollutants and Higher Risk Groups: The Biological Bias of Increased Human Susceptibility to Environmental and Occupational Pollutants*, 1978, pp. 4-26; and Ong P. M. And E. Blumberg, "An Unnatural Tradeoff: Latinos and Environmental Justice", in Morales, R. And Bonilla F., Editors, *Latinos In A Changing U.S. Economy*, Sage Publications, Beverly Hills, CA: 1993, pp. 207-225.

numerous studies among poor and minority populations especially in terms of exposures to lead, pesticides in farm labor[188], and toxins through the consumption of tainted seafood and Great Lakes fish. The federal ATSDR in 1988 found that impoverished black children are exposed to levels of lead almost[189] twice that of impoverished white children.[190] Carter-Pokras *et. al.* (1990) found higher lead exposure rates among poor Latino children than poor white children.[191] Pesticides in blood and fat have been found to be disproportionate among U.S. minority and poor populations in studies undertaken by Hoffman, *et. al.*, 1967; Davies, *et. al,*. 1972; Burns, 1974; Berry, 1977; and Kutz, *et. al.*, 1977.[192] West, *et. al.*, 1992; National Oceanographic and Atmospheric Administration, 1985; McAllum, 1985; Puffer, 1981; and SRI, 1980 have all found racially disproportionate exposure to PCBs, dioxins, furans, *etc.* from the consumption of fish taken from nearby waters. A Clean Water Action Fund study (1993) found that awareness among poor, minority, urban subsistence anglers along Michigan's Detroit River of Michigan Department of Public Health (MDPH) fish consumption bans and advisories was woefully lacking, and women (some pregnant) and children were eating

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[188] 90 percent of all U.S. farm workers are minorities according to Ivette Perfecto and Baldemar Valasquez, "Farm Workers Among Least Protected", *EPA Journal*, March/April 1992, p. 13.

[189] National Academy of Sciences, "Human Health Risks Due to Consumption of Chemically Contaminated Fish Products", *Health Perspectives,* Vol. 101, October 1993, p. 297.

[190] Agency for Toxic Substances Disease Registry, *The Nature and Extent of Lead Poisoning in Children in the United States: A Report to Congress*, Centers for Disease Control, Atlanta, Georgia, 1988.

[191] Carter-Pokras, Olivia, James Pirkle, Gilberto Chaves and Elaine Gunter, "Blood Levels of 4 to 11 Year-Old Mexican American, Puerto Rican and Cuban Children", *Public Health Reports,* Vol. 105, 1990, pp. 388-391.

[192] Goldman, *op. cit.*, 1993, p. 17, and Swanson, *op. cit.*, pp. 593-595, and 597.

substantial amounts of fish unknowingly against health advisories.[193] In all studies lower income was not as significantly related as race/ethnicity to the disproportionate exposure to toxic chemicals from the consumption of tainted fish from the Great Lakes and connecting waterways.[194]

Geschwind, *et. al.* (1992) undertook a correlational study of the occurrence of congenital malformations among children born within a one mile radius of hazardous waste contamination sites in New York State.[195] This study considered populations within one mile of a site as "exposed", and selected a random sample of 17,802 births during 1983 and 1984. Maternal proximity to sites and birth defects were statistically analyzed using linear logistic regression. The study found a 12% increased risk for birth defects, especially nervous system defects, associated with maternal proximity to contamination sites controlling for maternal age, race/ethnicity, education, complications during pregnancy, number of previous births, population density, and sex of the child.[196] For this study, Geschwind weighted exposure risk by incorporating state agency site score for contamination sites of various severity of risk and for distance from sites to

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[193] Clean Water Action Fund, *If It's Broke, Fix It: Why Michigan's Environmental Health Agencies Must Make Changes to Help Detroiters and Others Fish Without Fear*, Lawton K. Jackson, Detroit Project Coordinator, January 1993.

[194] Goldman, *op. cit.*, 1993.

[195] Geschwind, Sandra A., Jan A. J. Stolwijk, Michael Bracken, Edward Fitzgerald, Alice Stark, Carolyn Olsen, and James Melius, "Risk of Congenital Malformations Associated with Proximity to Hazardous Waste Sites", *American Journal of Epidemiology*, Vol. 135, No. 11, 1992, pp. 1197-1207; and Geschwind, Sandra, A., "Should Pregnant Women Move? Linking the Risks for Birth Defects with Proximity to Toxic Waste Sites", *Chance: New Directions For Statistics and Computing*, Vol. 5, No. 3-4, 1992, p. 43.

[196] *Ibid.*

maternal residence[197]. Importantly, this study found a dose-response relationship between birth defects and distance from contamination sites, *i.e.* mothers with the highest indexed exposure risk were 63% more likely than mothers outside of a one mile radius of a site to bear a child with birth defects[198].

Breslin (1993) examined national epidemiological data from counties hosting Superfund sites on National Priority List (NPL).[199] Her findings suggested that 40 percent of NPL sites had documented human exposure, 40 percent had potential human exposures, and proximity to hazardous waste sites is associated with a small to moderate increased risk of some kinds of birth defects and some types of cancers.[200] (p. 484).

Analyses of Agency Implementation of Environmental Regulations

In March of 1990, a consortium of environmental groups and industry, called "Clean Sites", published a study of the implementation of the federal Superfund program in poor and rural communities nationwide, entitled *Hazardous Waste Sites and the Rural Poor: A Preliminary Assessment.*[201] This report concluded that poor, rural counties (defined as having populations less than 50,000, annual per capita income at or below $9,320, and no metropolitan area) while often completely dependent upon groundwater

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[197] *Ibid.*, p. 44.

[198] *Ibid.*

[199] Breslin, Karen, "In Our Own Backyards: The Continuing Threat of Hazardous Waste", *Environmental Health Perspectives*, Vol. 101, No. 6, November 1993, pp. 484-489.

[200] *Ibid.*, p. 484.

[201] *Hazardous Waste Sites and the Rural Poor: A Preliminary Assessment*, Kate Probst, Project Director, Alexandria, Va., Clean Sites, March 1990.

for drinking water, are not considered as a high priority in evaluation for inclusion on the National Priority List (at half the rate of sites nationally) and environmental enforcement by U.S. EPA. Sites within more densely populated areas, whether solely dependent upon groundwater as a drinking water source or not, have received higher priority by the U.S. EPA. According to this report, these findings can be explained by the U.S. EPA's controversial practice of assigning higher priority to more urbanized environmental contamination sites by weighing population density more heavily than the vulnerability of drinking water sources. These researchers conclude, "(t)he decision to base priorities for remedial action in part on the number of people affected (or potentially affected) by a site may be sound national policy: there is only so much money in the Superfund program, and priorities must be set in some way. But the question remains, what happens when sites are having a significant effect on a few people? In rural areas, it is possible that these people rely on drinking water supplies which are not protected by the *Safe Drinking Water Act*."[202] Although the report examines the "rural poor", the report states that 20.6 percent of the U.S. rural poor are African-Americans, though this group makes up only 11.7 percent of the country's population. Finally, the study states that racial and ethnic minorities combined account for 26.5 percent of the U.S. rural poor, while comprising only 16.6 percent of the national population according to 1990 U.S. Census data.

A study undertaken by the *National Law Journal* (1992) analyzed the racial

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[202] *Ibid.*, p. 52.

equity of federal environmental protection programs within the U.S. according to the implementation and enforcement of regulations in areas of varying racial make-up. This study analyzed U.S. Bureau of Census data from 1990 to define four community types, ranging from communities with the highest white population relative to non-whites to communities with the highest non-white population relative to whites. As the U.S. population by race/ethnicity is predominantly white, 83.1 percent, in many cases communities as much as 70 to 80 percent white were considered minority communities due to comparatively high levels of racial integration. From an analysis of the 1,177 federal Superfund sites listed from 1985-1992, this study found that sites in minority communities take 20 percent longer and poor areas 11 percent longer to be placed on the Superfund's NPL than those in white or higher income areas, respectively. In selecting cleanup remedies at Superfund sites in white areas, the U.S. EPA chose permanent active treatment alternatives 22 percent more often than passive containment alternatives. However, in minority areas Superfund final remedies selected by the EPA involved passive containment alternatives 7 percent more frequently than active permanent treatment methods. The study also found that Superfund cleanups in one-half of the U.S. EPA's regions began 12 percent to 42 percent later at contamination sites in minority communities than in white communities. Lastly, in analyzing the penalties negotiated and accepted by the U.S. EPA from violators of all federal environmental statutes, penalties were found to be 46 percent to 56 percent lower for violations within minority communities than in white communities. Conversely, no significant disparity was found in fines levied by the U.S. EPA for environmental violations in poor versus higher

income areas. The *National Law Journal* Study serves as a primary model for research proposed herein within the State of Michigan. This study, however, did not undertake additional analysis to determine the statistical significance of these findings.

SUMMARY AND CONCLUSIONS

In summary, when examining the interlocking web of factors resulting in the disparate treatment of various groups, *i.e.* race/ethnicity, class, access to information, political representation, *etc.*, within environmental policy within the U.S., empirical evidence to date strongly suggests that race/ethnicity is an independent and the predominant factor in distribution of environmental risks.[203] Similarly, research continues to suggest that race/ethnicity is a potent variable in explaining the spatial layout of urban areas, including housing patterns, street and highway configurations, and commercial development.[204] Race/ethnicity has also been determined to be a major factor related to the presence of illegal hazardous waste disposal facilities in residential communities. As stated by the UCC Commission for Racial Justice, "all state governments should review their environmental policies to ascertain if racial and ethnic communities are being adequately protected from the dangers posed by hazardous wastes".[205] The Commission continues "(r)esearchers should initiate data gathering and demographic research to ascertain if this (the UCC's 1987) report's findings are indicative

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[203] Bullard, *Dumping In Dixie*, p. 6; Bryant and Mohai, *Race and the Incidence of Environmental Hazards: A Time for Discourse*, Westview Press, Boulder, 1992, p. 166; Mushak, *op. cit.*, p. 479; and the Commission for Racial Justice, United Church of Christ, *op. cit.*, pp. x and xiii.

[204] Bullard, *op. cit.*, p. 6.

[205] United Church of Christ, Commission for Racial Justice, *op. cit.*, p. 25.

of patterns with respect to other environmental pollutants in racial and ethnic communities".[206]

This research falls into the last category of empirical study as an analysis of agency environmental regulation implementation, and attempts to build upon the strengths, weaknesses and recommendations of these preceding studies.

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[206] *Ibid.*, p. 27.

Chapter 3

RESEARCH DESIGN

This research involved the selection of geographic study areas according to demographic categories (independent variables); the definition and operationalization of dependent variables; dependent variable data collection and coding, and the analysis of data using multiple statistical methods. The analysis of data has been undertaken in four parts consisting of the statistical analysis of raw dependent variables, of weighted dependent variables, the univariate linear regression analysis of statistically significant variables, and the comparison of dependent variables found to be statistically significant in more than one demographic category using multivariate linear regression. Finally, assumptions and limitations of this research design are also discussed.

Study Areas

This study utilized U.S. Bureau of Census data[207] from 1990 to identify ten study

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[207] *1990 Census of Population, General Population Characteristics, Michigan*, U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Census, 1990. CP-1-24, and *1990 Census of Population, General Population and Housing, Summary of Social, Economic and Housing Characteristics, Michigan*, U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Census, 1990, CPH-5-24.

areas within the State of Michigan. Select data fields from the U.S. Census data were accessed from CD ROM at the Computer Research Lab at Wayne State University under the technical guidance of Dr. Elaine Hockman. These data were sorted by zip code according to specified demographic and socioeconomic variables[208].

Study areas are defined as U.S. Postal Service zip codes areas in accordance with the methodology findings of previous empirical study.[209] Independent variables for population density were utilized to categorize study areas.[210] As noted by Been (1994), most environmental equity empirical studies have utilized zip codes, census tracts or larger census units as selected units of analysis. None used the smaller census blocks or block groups[211]. Hamilton (1995) states that zip codes may provide a closer approximation to the neighborhood character of an area surrounding a facility of interest.[212] Therefore, zip code areas are utilized in this study to define geographic areas small enough to capture common social characteristics or community attributes and large

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[208] Gould, *op. cit.*, notes that high income and minority "enclaves" exist nationally in rural areas, whereas low income, white zip code areas "turn up in unexpected places" including urban areas", p. 6.

[209] Hamilton, *op. cit.*, p. 115, Glickman, *et. al.*, p. 111; Gould, *op. cit.*, pp. 3-4; and Fahsbender, *op. cit.*, pp. 121, 138 and 141.

[210] Been, Vicki, "Locally Undesirable Land Uses in Minority Neighborhoods: Disproportionate Siting or Market Dynamics?", *The Yale Law Journal*, Vol. 103, 1994, pp. 1402-1403, and Greenberg, *op. cit.*, 1993, p. 249.

[211] *Ibid.*, pp. 1402-1403.

[212] Hamilton, *op. cit.*, p. 115. Glickman, *et. al.*, used census blocks along with census tracts and circles of various radii. Glickman, *et. al.*, rejected the use of census blocks in favor of circles.

enough to encompass a geographic area containing one or more Part 201 sites.[213]

Independent Variables

Specifically, the 1990 U.S. Census data for all Michigan zip codes were sorted and grouped by independent variables including race, population density, income, site environmental compliance status, and Part 201 site identification number. Once these data were grouped, ten zip code delineated study areas were selected randomly from within each category using a random number table.[214] Specifically, selected study areas consist of:

- Two rural and low income areas, one white and the other minority in racial/ethnic make-up.
- Two suburban and moderate income areas, one white and the other minority in racial/ethnic make-up.
- Two urban and high income areas, one white and the other minority in racial/ethnic make-up.
- Two rural and high income areas, one white and the other minority in racial/ethnic make-up.
- Two urban and low income areas, one white and the other minority in racial/ethnic make-up.

These study area categories are summarized below in Table 1.

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[213] Fahsbender, *op. cit.*, pp. 123, 135, and 144-145. The researcher notes that during 1997 participation in the City of Detroit's Community Reinvestment Strategy initiative, participants self-organized the city into zip code areas along which was attached certain status, cultural, ethnic and economic identity.

[214] Adeola, *op. cit.*, p. 107 and Cutter, *op. cit.*, p. 117.

Table 1 **Study Area Demographic Categories**

Study Areas:	Low Income	Moderate Income	High Income
Urban	One White and One Minority Study Area		One White and One Minority Study Area
Suburban		One White and One Minority Study Area	
Rural	One White and One Minority Study Area		One White and One Minority Study Area

U.S. Census Data:

Specific variables utilized from the 1990 U.S. Census data included:

Race	Income	Population Density
Percent White Population	Mean household income.	Urban Population Inside Urbanized Areas
Percent Black Population		Urban Population Outside Urbanized Areas
Percent American Indian, Eskimo and Aleut Population		Rural Population
Percent Asian and Pacific Islander Population		
Percent Other Race Population (Hispanic Origin)		
Percent Other Race Population (Not of Hispanic Origin)		

Definitions

This study defines terms and measures the demographics of social equity in Michigan's Part 201 policy as described below.

Racial/ethnicity Parameters:

While recognizing the above perspectives and potential for the introduction of bias in interpretation of findings[215], for the purpose of this study race/ethnicity is defined using the 1990 U.S. Census definitions as follows:

- **White,** comprised of persons reporting as White, Canadian, German, Italian, Lebanese, Near Easterner, Arab or Polish.
- **Black,** consisting of persons reporting as Black, Negro, African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian or Haitian.
- **American Indian, Eskimo or Aleut,** defined as persons reporting as Indian, Canadian Indian, French-American Indian, Spanish-American Indian, Eskimo, Aleut or by tribal affiliation. This category is based upon self-identification, and is without regard to tribal status or the status of U.S. federal or state governmental recognition of tribes.
- **Asian or Pacific Islander,** comprised of persons reporting as Chinese, Filipino, Japanese, Asian Indian, Korean, Vietnamese, Cambodian, Hmong, Laotian, Thai, Other Asian, Hawaiian, Samoan, Guamian, or Other Pacific Islander.
- **Other of Spanish/Hispanic Origin,** comprised of persons reporting as of Spanish/Hispanic origin (such as Mexican, Cuban, or Puerto Rican).
- **Other,** a final racial/ethnic category comprised of persons reporting as other than the above racial/ethnic groups such as multiracial, mixed, interracial or Wesort.

For the purpose of study area identification, these U.S. Census Bureau categories of race were nominally aggregated into "white" and "minority", the latter including all U.S. Census racial/ethnic categories except "white". These combined racial/ethnic categories were then converted into a ratio of minorities to whites, and converted to a

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[215] Zimmerman, *op. cit.*, pp. 663-669; Pulido, *op. cit.*, p. 152; Goldman, 1996, *op. cit.*, p. 134; and Perlin, *et. al., op. cit.*, p. 72.

logarithmic scale to divide race into quartiles along a normal distribution.[216] The variable of race was treated as such and coded to allow for statistical analysis. Specifically, race is operationalized in quartiles for study area selection as follows:

Ratio of Minorities to Whites:

1= No Minorities
2= Few Minorities
3= Some Minorities
4= Most Minorities

Codes of 1, 2 and 3 were operationalized as "white" study areas, and a code of 4 was designated as a "minority" study area.

Population Density:

The population density of study areas is defined here according to the U.S. Census definitions as follows:

- **Rural** areas are defined in this study to mean zip code areas with populations at or below 2,499 persons, and within which no metropolitan area[217] exists.
- **Suburban** areas are defined as zip code areas containing, not containing, or partially containing or be contiguous to a metropolitan area and the study area population is at or between 2,500 and 9,999 persons.
- **Urban** areas are defined as zip code areas containing a metropolitan area and the study area population is at or above 10,000 persons.

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[216] Recommendation of Fahsbender, *op. cit.*, pp. 140-142.

[217] Metropolitan areas are defined using the U.S. Census definition of an area of a large population nucleus (minimum of 50,000 or a Census Bureau defined urbanized area and a total metropolitan area population of at least 100,000 persons), together with adjacent communities that have a high degree of economic and social integration with that nucleus.

Specifically, population density categories have been similarly operationalized as a ratio of persons per square mile, and placed on a logarithmic scale. The use of the logarithmic scale achieves a normal distribution, as with race, and allowed the researcher to code and divide population density into quartiles along this normal distribution for the selection of study areas.[218]

Specifically, population density is operationalized in quartiles as follows:

1= Least Dense
2= Little Density
3= Some Density
4= Most Dense

The population density code of 1 was operationalized as "rural". Codes of 2 and 3 were considered "suburban", and code 4 was designated as "urban".

Income Status:

Income parameters of low, moderate and high income used herein are all above the U.S. Census Bureau's poverty threshold, and are based upon the researcher's examination of median annual household income for the State of Michigan.[219]

Specifically income categories are defined as follows:

- **Low Income** is defined as zip code areas with mean 1989 family income of less than $21,391.
- **Moderate Income** is defined as zip code areas with mean 1989 family income of between $21,392 and$35,042.

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[218] Recommendation of Fahsbender, *op. cit.*

[219] Recommendation of Dr. Elaine Hockman; Gould, *op. cit.*, pp. 21-22; and Perlin, *et. al.*, pp. 72-73, and 76.

- **High Income** is defined as zip code areas with mean 1989 family income of more than $35,043.

Specifically, categories of income have been operationalized as a mean family income, and similarly placed on a logarithmic scale. The use of the logarithmic scale again achieves a normal distribution, as with race and population density, and allowed the researcher to code and income into quartiles along this normal distribution for the selection of study areas. Specifically, income is operationalized in quartiles as follows[220]:

Mean Family Income:

1= < $21,391 per year
2= $21,392 - $26,999 per year
3= $27,000 - $35,042 per year
4= > $35,043 per year

Code 1 has been designated in this study to mean "low income". Income codes 2 and 3 have been defined in this study as "moderate income", and 4 has been designated as "high income".

Control of Other Factors in Study Area Selection:

This study sought to control for geographic size of study areas and potential bias resulting from the distance of Part 201 sites of environmental contamination from the nearest MDEQ, Environmental Response Division (ERD) district office and the number of ERD staff in 1990 within each district office. In all cases, all Part 201 sites within randomly selected categorized zip code study areas were evaluated to derive and record program performance measures. In the selection of study areas, no zip code area with

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[220] *Ibid.*

less than two Part 201 sites were included in the population for the random selection of sample sites. Of course, several Michigan zip code areas possessed no Part 201 sites, and were therefore discarded. Similarly, Part 201 sites lacking detail concerning compliance status reported on the MDEQ Part 201 list were not included in the study.

Data Collection - Dependent Variables

Currently, the MDEQ, ERD staff within district offices throughout Michigan are required to track and report compliance activities at sites of environmental contamination on a computerized data base known as the Incident Tracking System and through the Part 201 annual site evaluation and scoring process. Unfortunately, these data bases are not well maintained and/or easily accessed within respective MDEQ District Offices, and are often either not collected or utilized by central management and planning units in Lansing ERD Headquarters, nor designed to possess data fields of relevance to this research. No such computerized data base is known to the researcher to exist for Part 201 enforcement data. Consequently, the researcher created a site data check-list to collect data relative to all Part 201 sites within the ten chosen study areas. Given the nature of data collection and management within the MDEQ, the researcher traveled to MDEQ, ERD District offices in Morrice, Jackson, Plainwell, Livonia, Bay City, Cadillac, Gaylord and Grand Rapids, respectively, to collect these data. Refer to Appendix A for an example of the dependent variable data collection check-list used.

Data Coding and Preparation

Data collected from MDEQ Part 201 site file examination at various MDEQ District offices was recorded using site check-lists, encoded and compiled through entry

into an SPSS® data base of the researcher's design. This data set whs analyzed, and findings are reported in the form of tables, histograms and line graphs. Refer to Appendix B for a list and description of encoded variables.

Data Analysis

Following the entry of values for dependent variables for each Part 201 study site, means were calculated for Part 201 program measures. Specifically, MDEQ compliance effort measures calculated included:

- the average number of days for initial MDEQ response,
- the average number of site inspections per year,
- the average number of months needed to control environmental hazards,
- the average number of compliance oversight meetings per year,
- the average number of months to attain site cleanup,
- and a dummy variable mean indicating whether or not final site cleanup had been achieved.

MDEQ enforcement measures calculated included the average number of information requests, the logarithmic mean of enforcement notification letters sent by the MDEQ, the average dollar amount of negotiated penalties, and the average number of MDEQ enforcement referrals.

The means for each MDEQ compliance, enforcement and public funding measure were then analyzed in accordance within categories of race, income and population density. To assess the statistical significance of these findings, means comparison was undertaken through independent samples for equality of means using SPSS®. Specifically, t-Test analysis was undertaken to determine if observed variability is the result of "usual" or expected variability within the study sample or indicative of "real" or

statistically significant difference in program implementation within minority, poor or urban areas. A two-tailed significance finding of .05, or 5 percent, or less was considered statistically significant. In other words, significance findings of less than .05 place observed means at the extreme margins or tails of a normal distribution, and allowed for the rejection of the null hypothesis that demographically varied areas are not treated differently in the MDEQ implementation of the Part 201 program.

Secondly, univariate linear regression analysis was undertaken of all statistically significant and normally distributed Part 201 program measures. Finally, multivariate linear regression was undertaken for Part 201 measures statistically significant in more than one demographic category. The R square value from regression analyses explains how well independent study variables of race, income and population density "explain" the observed means difference of the dependent variables of Part 201 program implementation. The Multiple R value generated through regression analyses represents the correlation coefficient between the means difference observed in minority, poor and urban areas (*i.e.* dependent variables) and the values predicted by the regression model[221]. For interpretation of findings, a Multiple R value of 1 suggests perfect prediction of dependent variables from independent variables, and a zero value indicates that independent variables are not linearly related to the dependent variables. An examination of overall regression analysis, or F test, is utilized in this study to determine the statistical significance of multivariate regression analysis. An observed F value of less than .05

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[221] Norusis, Marijsa J., *SPSS® 6.1 Guide to Data Analysis*, Prentice Hall, New Jersey, 1995, pp. 422-423, and Andrew Hurley, *op. cit.*, p. 6.

allows for the rejection of the null hypothesis that there is no linear relationship between Part 201 program measures (*i.e.* dependent variables) and demographic categories (*i.e.* independent variables). In other words, the F value represents the ratio of the regression mean square to the residual mean square, and statistically significant F values suggest that directional (positive or negative) linear correlation exists between dependent and independent variables.[222] Finally, the study design proposes that statistically significant findings may validly be generalized to the population of all Michigan Part 201 sites.

Study Assumptions, Scope and Limitations

Due to the existence of over 11,000 sites of environmental contamination as identified by the Part 201 program, a subset or sample of the total population of sites was selected to undertake this study. Ten study areas were selected randomly by zip code from within ten categories regarding race, income and population density, as described above. This resulted in the selection of 715 zip code areas, from the approximately 1,169 zip code areas in Michigan at the time of this study, each containing at least one part 201 site from which the study sample of ten zip codes was randomly drawn.[223]

All sites of environmental contamination identified and listed by the MDEQ in 1994 were analyzed for select measures of compliance, enforcement and public funding. The researcher acknowledges that specific sites of environmental contamination identified by the Part 201 program exist at various stages of investigation and/or cleanup,

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[222] *Ibid.*, p. 478.

[223] Approximately 36,000 zip code areas exist within the U.S. in approximately 3,000 counties.

and may or may not have undergone escalated enforcement actions or required public funding. Thereby, it is acknowledged that specific sites may show varying amounts of data. In short, data were collected from all sites for all MDEQ program performance measures.

Study Assumptions

Assumptions regarding the quality of Part 201 site data collected include the absence of variation in: 1) Part 201 program implementation diligence or documentation within and between MDEQ District offices resulting from varying staffing levels and number of sites, *i.e.* workload variations; 2) professional initiative of staff or MDEQ District management; 3) past and future changes in relevant MDEQ staff and/or management; 4) in Part 201 program management philosophy and policy over time and within select MDEQ District, Regional, Headquarter Offices, and the Governor's Office; and 5) administrative policy changes, legislative amendment and agency reorganization. It is also assumed that political factors have not resulted in varying amounts of compliance, enforcement or the funding of sites of environmental contamination within the ten select study areas. Specifically, this study assumes no significant overall program changes resulting in deviation from the MDEQ's constitutional charge to protect and conserve the air, water and other natural resources as a paramount concern of the State, and to protect the public interest in the environment and the protection of public health, safety and general welfare[224].

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[224] Michigan Constitution, Article IV, Section 52, 1963.

It is also assumed that Part 201 site security and safety within select study areas have not resulted in variations in compliance, enforcement and/or funding, if found. This assumption relies upon the researcher's experience and knowledge that the assistance of trained and armed MDEQ Conservation Officers, MDEQ Environmental Conservation Offices, and Michigan State Police are available to assist in MDEQ, ERD staff in site access for initial site investigations, inspections, sample collection, compliance monitoring, *etc.*, if deemed necessary. It is recognized, however, that such precautions demand MDEQ, ERD staff to undertake additional logistical and organizational efforts in contamination site compliance and enforcement oversight.

Further, it is assumed that environmental and public health threats exist from sites of environmental contamination, as defined by Part 201, until such locations are remediated to within state standards as provided by administrative rules pursuant to Part 201. Further, this study excludes federal Superfund sites within Michigan from analysis, whether addressed by a state or federal-lead agency.

Study Scope

Importantly, this study excludes leaking underground storage tank (LUST) sites from analysis, although compliance, enforcement and funding were overseen by the ERD, MDEQ prior to the reorganization and programmatic split in 1994. LUST sites have been excluded here, in acknowledgment of the expenditure of public funds by private parties and others to address these sites from 1989 to 1996 pursuant to the Michigan Underground Storage Tank Financial Assurance Act, P.A. 518 of 1988, as amended. These expenditures, totaling over $500 million since fund inception, resulted in increased

private sector involvement in site assessment and cleanup, and, if included, would skew this study's data and veil attempts to assess MDEQ diligence in Part 201 program implementation.

Similarly, this study excludes sites of environmental contamination owned or operated by the State of Michigan's various departments. A bond fund of the amount of approximately $30 million was passed in 1989 to investigate and cleanup state-owned facilities with contamination. The inclusion of state-owned or operate Part 201 site would skew the results this study due to the relatively rapid infusion of large amounts of public funds in a short time periods for this specific subset of the universe of Part 201 sites.

Lastly, this study has included site data for Part 201 sites following the implementation of major amendments to Part 201 passed by the Michigan Legislature in June of 1995. These amendments eased cleanup standards, and changed site cleanup approaches from site remediation to site risk assessment and risk management in accordance with varying land-uses and land-use plans. These amendments greatly altered the definition of a site of environmental contamination pursuant to the Part 201 program, and greatly altered cleanup approaches as to result in an overall decrease in site oversight and compliance and enforcement activity by the MDEQ and shifted increasing responsibility for determinations of risk and the completion of risk management to the private sector and to consultants.

Limitations of U.S. Census Data

Many have recognized the "problem of definition" of race, ethnicity, gender and

economic status within U.S. Census Bureau classifications and data collection methodology, and the geographic location of subpopulations based upon these measures[225]. The operationalization of such measures in this study is undertaken with knowledge of the limitations of the U.S. Census Bureau 1990 population data.

Specifically, these concepts have been questioned as valid units of measure as demonstrated by historically inconsistent racial/ethnic classification (variation in comparison among subpopulations at different points of time and locations) and misclassification (implying a valid standard of racial/ethnic determination) by institutions and researchers, reflecting dynamic social power relationships in definition[226]. Methods of racial/ethnic classification resulting in variability include self-identification, blood quantum calculation, third party classification based on visible physical features, social mores regarding the classification of off-spring from intermarriage[227], and dominant cultural ignorance. For example, U.S. Census racial/ethnic category "White" and "Black" have been questioned as being socially constructed and unidirectional[228]. In other words, "whiteness" becomes a social code for membership to dominant culture, and any amount of "blackness" stigmatizes the carrier as "non-dominant"[229]. "Asian" is reported to

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[225] Zimmerman, *op. cit.*, p. 634, and Pulido, *op. cit.*, pp. 143-148.

[226] Zimmerman, *op. cit.*, pp. 636-643, and Pulido, *op. cit.*, p. 142.

[227] *Ibid.*, pp. 639-640.

[228] See Frankenburg, Ruth, *The Social Construction of Whiteness, White Women, Race Matters*, University of Minnesota Press, 1993.

[229] See Lorber, Judith and Susan A. Farrell, *The Social Construction of Gender*, Sage Publications, 1991; Andersen, Margaret L. and Patricia Hill Collins, *Race, Class, and Gender: An Anthology*, Wadsworth, Inc. Press,

contain ten major subcategories, and "Other Asian" may contain nineteen categories[230]. "Pacific Islander" may contain three major categories and "Other Pacific Islander" may subsume seventeen categories[231]. "Hispanic" or "Spanish" may reflect colonial history more than human variability, and can be divided into approximately thirty-six subcategories based on country of origin. Of course concepts of ethnicity seldom know such political boundaries, and may or may not reflect geo-physical boundaries and historical and current migration pathways. U.S. Census categories are often based on country of origin. Similarly, the "American Indian" racial/ethnic category contains nearly six hundred distinct tribes[232]. As stated throughout sociological literature, the salient questions may be "Who decides?" and "Why?".

Pulido (1996) questions three specific assumptions regarding the operationalization of race/ethnicity common to environmental equity empirical studies: 1) that racism can be isolated from other intersecting and overlapping forms of social difference; 2) the focus on racism as distinct and measurable acts of discrimination, rather than its conceptualization as an ideology; and 3) the treatment of racism as monolithic rather than understanding its fragmented and multifaceted nature.[233] Some challenge the

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1992; and Rose M. Brewer, "Theorizing Race, Class and Gender: The New Scholarship of Black Feminist Intellectuals and Black Women's Labor", in *Theorizing Black Feminists: The Visionary Pragmatism of Black Women*, Stanlie M. James and Abena P.A. Busia, Editors, Routledge Press, 1993.

[230] Zimmerman, *op. cit.*, pp. 638.

[231] *Ibid.*

[232] *Ibid.*

[233] Pulido, *op. cit.*, pp. 152-155, and Goldman, *op. cit.*, 1996, pp 126 and 137.

conception of class as income, property values, and/or educational achievement as Weberian.[234] Further, it is difficult to separate and operationalize socio-economic variables.

For example, U.S. EPA notes that 86.1 percent of African-Americans and 91.2 percent of Latinos in the U.S. live in urban areas.[235] Further, although data does not exist for Part 201 sites in Michigan, many federal Superfund sites are located in rural areas.[236] As reported by Lavelle and Coyle (1993), 18.4 percent of Superfund sites exist in urban areas, 39.6 percent are in suburban and 42 percent are in rural areas.[237] It is recognized that such trends likely exist with Michigan Part 201 sites. This may result in the inflation of Part 201 site score in rural areas with potential human exposure to contaminated groundwater drinking sources. Thereby resulting in disparity in agency diligence and public and private spending to address rural contamination sites.

Methodological Limitations from Assumptions Used in Environmental Equity Studies

A second area of methodological limitation include the assumptions made when setting geographic boundaries for units of equity analysis, distance from sites of environmental risk, selecting a level of aggregation for demographics information, and

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[234] Pulido, *op. cit.*, p. 146.

[235] Swanson, *op. cit.*, p. 587.

[236] Swanson, *op. cit.*, and Breslin, *op. cit.*, p. 484.

[237] Lavelle and Coyle, *op. cit.*, p. S6.

choosing a standard of comparison[238].

Geographic boundaries for analysis in previous equity studies have utilized the entire U.S., geographic regions of the nation, states, counties, municipalities (and other local political jurisdictions), collections of urban areas, agency regions and service areas, zip codes, census tracts (county subdivision usually with 2,400 and 8,000 persons designed to be homogeneous with respect to population characteristics, economic status and living conditions), census block groups (clusters of blocks generally containing between 250 and 550 homes, with an ideal size of 400 housing units), and census blocks (bounded on all sides by visible features such as streets, roads, streams, and railroad tracks, and invisible boundaries including political jurisdictions, property lines and short, imaginary extensions of streets and roads)[239]. Little or no agreement exist within the literature as to which geographic unit of analysis to use.[240] Some researchers, however, have proved the importance of using units at least as large as census tracts so as not to

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[238] *Ibid.*, pp. 645-659; Perlin, *et. al.*, *op. cit.*, p. 70; Cutter, *op. cit.*, p. 4; Goldman, *op. cit.*, 1996, pp. 133-135; Greenberg, *op. cit.*, 1993, p. 235, and Glickman, *et. al.*, *op. cit.*, pp. 95-114.

[239] U.S. Bureau of the Census, 19990 Census of Population and Housing, Area Classifications, Appendices A, A-3 through A-6 (1991), as cited by Zimmerman, *op. cit.*,1994, p.652; and Perlin, *et. al.*, *op. cit.*, p. 70.

[240] Cutter, *op. cit.*, 1995, pp. 111 and 114, and Cutter, *op. cit.*,1994, p. 4. Cutter states that disagreement among the literature is largely focused on: 1) the environmental threat chosen; 2) the geographic unit of analysis used; 3) the subpopulation selected for study; and 4) the time frame analyzed (pp. 111-114). Perlin, *et. al. op. cit.*, and Zimmerman, *op. cit.* , add that substantial disagreement also exists within the literature regarding risk and exposure assumptions implied by distance selected from sites of interest, and the choice of statistical methods used to analyze data (see generally). Been, 1995, *op. cit.*, Glickman, *et. al.*, *op. cit.*, pp. 111-112, and Zimmerman, *op. cit.*, recommend the use of multiple statistical methods to analyze numerous time frames, geographic units, and levels of aggregation.

hide measures of social difference within study areas[241], and others tend to promote the use of zip code areas[242]. Jurisdictions defined politically are often too large to "capture a facility's immediate neighborhood", but can serve as a useful indicator of "communities... encompassing a shared sense of place, identity and a set of organizations that meet the area's needs" which may or may not be geographically coterminous[243]. Federal district appellate courts considering issues of environmental justice have generally accepted or implicitly accepted the use of census tracts as the most appropriate geographic unit to analyze social difference in environmental equity studies[244]. As informed by these findings and in working with the existing Part 201 data base at Wayne State University's Computer Research Lab, this study utilizes zip code designations for the selection of study areas.

As stated previously, agreement does not exist within the literature concerning the selection of an appropriate geographic distance in environmental equity studies to use as a surrogate for known or potential migration pathways of environmental risk from

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[241] Zimmerman, *op. cit.*, p. 646; Anderton, *et. al., op. cit.*, p. 232; Zax, *op. cit.*, Been, 1994, *op. cit.*, p. 1403, and Hurley, *op. cit.*, p. 6.

[242] Commission for Racial Justice, United Church of Christ, *op. cit.;* Mohai and Bryant, *op. cit.*, 1992, pp. 165-169; Nabalamba, Alice, The Controversy Between Environmental Disposal Systems and Residents of the City of Romulus, MI, Over the Siting of a Deep Injection Well on Wahrman Road, unpublished parer, University of Michigan, Winter 1996, p. 5; and Bryant and Hockman, *op. cit.*, 1994.

[243] Zimmerman, *op. cit.*

[244] See Bean v.s. Southwestern Waste Management Corp., 482 F. Supp. 773, East Tibbs Neighborhood Association v.s. Macon-Bibb County Planning & Zoning Commission, 706 F. Supp. 880 (M.D. Ga.) aff'd 896 F. 2d 1264 (11 Cir. 1989), and Zimmerman, *op. cit.*, pp. 659-665.

varying sources.[245] Researchers do agree, however, that determinations of risk should be the driving factor of such empiricism[246]. As stated by Zimmerman, "without additional information about the physical extent of impacted interests, it is impossible to determine appropriate distances for analyzing equity. From an analytical perspective, the differences between values for a given socioeconomic characteristic become less significant as the distance becomes greater within a few miles of the site"[247].

Considerations in levels of aggregation include determining a relevant distance of risk (*e.g.* a chosen number of miles from sites of environmental contamination) and including the census data from partially captured geographic units, or the use of polygonal boundaries from other geographic units. Assumptions made in either approach include the statement bisected units are homogenous with the study areas, or that excluded areas are demographically heterogenous with the study area(s). This "dampening effect" associated with the use of large geographic units of analysis tends to minimize or eliminate demographic mean differences between areas of smaller units of

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[245] Perlin, *et. al., op. cit.*, p. 70, Anderton, *et. al., op. cit.*, p. 140, and Glickman, *et. al., op. cit.*, pp. 111-112. All environmental equity studies review do this to some extent. The ASTDR's *The Nature and Extent of Lead Poisoning in Children in the United States: A Report to Congress*, ASTDR, Centers for Disease Control, Atlanta, GA, 1988 is the only study encountered during this research that examined actual human exposure data.

[246] Zimmerman, *op. cit.*, p. 656; Anderton, *et. al., op. cit.*, p. 236; Colquette and Robertson, *op. cit.*, p. 183; Collin, Robert W., "Review of the Legal Literature on Environmental Racism, Environmental Equity, and Environmental Justice", Journal of Environmental Law and Litigation, Vol. 9, 1994, pp. 157 and 159; Perlin, *et. al., op. cit.*, pp. 69-70; and March 1997 testimony given by the researcher in Genessee Circuit Court *in re* NAACP v.s. Engler concerning the construction and operation of a demolition wood incinerator and electric generation facility along the northeastern limit of the City of Flint, Michigan.

[247] Zimmerman, *op. cit.*, p. 656, and Perlin, *et. al., op. cit.*

analysis, such as census block and block groups[248]. As stated by Zimmerman the bias that can enter into equity studies using large geographic units of analysis "argues for working with smaller geographic units"[249]. Researchers warn that "this assumption may work well with total population figures, it is not likely to work well with subpopulations, which tend to cluster geographically, and are not typically distributed homogeneously", and that difference between an area circumscribed and surrounding areas tend to increase as larger geographic units of analysis are used"[250]. Conversely, others find that "studies which have been national in scope and which have provided both income and race/ethnicity information have found race to be more importantly related to the distribution of environmental hazards that income"[251].

Finally, the selection of a standard of comparison is required in equity studies by which population distribution is evaluated relative to source(s) of environmental risk. This area "continues to be one of the more subjective, discretionary areas of environmental equity research" and can lead to bias[252]. Previous comparison of demographic values with select geographic unit of analysis have been with state or

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[248] Zimmerman, *op. cit.*, p. 655.

[249] *Ibid.*, p. 656; Perlin, *et. al.*, p. 70; Anderton, *et. al.*, *op. cit.*, p. 140; and Glickman, *et. al., op. cit.*, p. 111-112.

[250] Zimmerman, *op. cit.*, pp. 653 and 655, and Glickman, *et. al., op. cit.*

[251] Mohai and Bryant, *op. cit.*, *University of Colorado Law Review*, 1992, p. 927.

[252] Zimmerman, *op. cit.*, p. 659, and Been, 1994, *op. cit.*, p. 1384 (the proportionality argument and empirical method ignores population densities of neighborhoods and fails to provide information as to how far the distribution of the population within LULU host neighborhoods deviate from national or state distributions).

national means, and represents a significant methodological consideration. Study has shown that the use of the percentage of African-Americans, Hispanics and population below the census-defined poverty line within communities with federal Superfund sites possessed higher percentages when weighted by population size than national percentages[253]. In other words, the comparison of study area values to state or national standards can a minimize difference and introduce additional bias.

This study, therefore, is conservative in methodology in that it possesses the limitation that stronger association may have been found if findings were compared to State of Michigan or U.S. 1990 Census percentages, rather than comparing means of normally distributed Part 201 measures within demographically defined and randomly selected geographic units of analysis. Further, this study analyzed the entire "life cycle", to the time of data collection, for each Part 201 site captured herein. Data were collected, therefore, from the administrative record for each 201 site from the date of discovery (as early as the 1930s) to the time of data collection (Spring through Winter 1997).

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[253] Perlin, *et. al., op. cit.*

Chapter 4

RESEARCH RESULTS

Selection of Study Sites

A computerized list of the total population of Michigan sites of environmental contamination was accessed at the Computer Research Lab at Wayne State University[254]. A data base "dump" was generated of all sites of environmental contamination listed by zip code and site identification number, environmental compliance status, and sorted by population density, income, and race/ethnicity as described in the Chapter 3. This sorted list contained a total of 2,839 sites of environmental contamination. A working list of potential study sites was created by grouping using demographic characteristics to identify ten study zip code areas. The random selection of a single zip code area within each the ten identified social demographic categories was undertaken using a random number table. The number of listed environmental sites contained within the ten selected zip code areas ranged from 4 to 21, with a mean of 8.9 sites/zip code area as summarized in Table 2 below.

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[254] *Michigan Sites of Environmental Contamination,* Volume 1, November 1994, Fiscal Year 1996

Table 2 **Listed Sites/Zip Code Area**

Income

Population Density	Low	Moderate	High
Urban	21/5	---	7/4
Suburban	---	17/8	---
Rural	6/6	---	11/4

numerator = total number of sites within minority zip code area. Mean = 8.9 sites/zip code area.
denominator = total number of sites within white zip code area. Range = 4 to 21 sites/zip code area.

This working sample was refined to form the study sample through the identification and elimination of sites with unknown environmental compliance status as listed by the MDEQ[255]. The study sample was further reduced by cross-referencing site numbers by site name, county, pollutant, and primary MDEQ oversight agency using the MDEQ 201 list[256]. Cross-referencing was also undertaken to further sample refinement through the elimination of leaking underground storage tank (LUST) sites. LUST sites were identified and eliminated from the study sample either by a site name listing a gas station or related facility, and/or pollutants listed as chemical indicators of refined petroleum products and additives, *i.e.* purgeable aromatic hydrocarbons, polynuclear aromatic hydrocarbons, methyl-tertiary butyl ether, and/or lead. Sites with primary compliance and enforcement responsibility assigned to a MDEQ division other than ERD were also eliminated, *e.g.* Underground Storage Tank Division, Waste Management

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[255] *Ibid.*

[256] *Ibid.*

Division, Surface Water Quality Division, *etc.* Additional sites were eliminated from the sample if the site name referenced state agency ownership and/or operation, *e.g.* "MDOT garage", "MDNR Field Office", or "University of Michigan", *etc.* The results of study sample identification and refinement is summarized in Table 3 below:

Table 3 **Study Subpopulation Results for Selected Zip Code Areas**

MDEQ District Office	Part 201 Sites	LUST Sites	State-Owned Sites	Unknown Sites	Total Sites
Plainwell	10	11	1	2	24
Cadillac	7	2	0	0	9
SE Michigan	6	1	0	2	9
Grayling	5	3	0	0	8
Grand Rapids	4	3	0	0	7
Saginaw Bay	7	9	0	0	16
Jackson	9	12	0	1	22
Total	48	41	1	5	95

Total MEDQ listed Part 201 sites = 2,839, source *Michigan Sites of Environmental Contamination, Volume 1, November 1994, FY 1996.* Subpopulation grouped by social demographics (population density, race/ethnicity, and income) and randomly selected by zip code.

From the above evaluation, the percent of MDEQ listed sites determined not to qualify for inclusion in this study equaled 47 of 95 total sites, or nearly 50%. Consequently, an adjusted total population of Michigan 201 sites, accounting for listed non-Part 201 sites, may equal 1,420 sites. Therefore, the 43 study sample sites represent approximately 3.0% of the total adjusted population of Michigan Part 201 environmental contamination sites.

Finally, the zip code referenced sample was cross-referenced with MDEQ District Office geographic assignments, and appointments were requested in writing to examine the selected site files pursuant to Michigan's Freedom of Information Act (FOIA). Each site file was reviewed, and chronologies of site activities were recorded to derive measures of site compliance, enforcement, and public funding as described in Chapter 3. Tracking forms created to record site file information were then encoded, and these data were entered into a computerized data base created for this study using SPSS® Version 6.1. The results of study sample refinement and FOIA requests is summarized in Table 4 below:

Table 4 **Freedom of Information Act Requested Site Files and Results**

MDEQ/Site	Part 201	LUST	State-Owned	Non-ERD or No File Found	Total
Plainwell	7	0	1	2	10
Cadillac	5	0	0	2	7
SE Michigan	6	0	0	0	6
Gaylord	5	0	0	0	5
Grand Rapids	4	0	0	0	4
Saginaw Bay	7	0	0	0	7
Jackson	9	0	0	0	9
Total	43	0	1	4	48

Missing Site Files

As shown above, the total site files sought for review MDEQ, ERD District Offices through the Freedom of Information Act was 48. Final sample refinement occurred upon researcher file review and/or the ability of the MDEQ, ERD District Office

to locate file information, *i.e.* a site's administrative record. The four missing site files were all within the MDEQ, ERD Plainwell District office, and consisted of Part 201 sites in Allegan and Kalamazoo Counties. Interestingly, each of the four site files that were reported by the MDEQ as "public record did not exist" were within minority zip code areas. Three existed within a minority, rural and high income area, and one within a minority, urban and low income area. As a result, the total number of Part 201 sites included in this study was 43, or 89.5% of 48 site files requested.

Study Sample

Table 5 below summarizes the total number of environmental contamination sites included within the ten social demographics cases in this study, including relative percentages of each within select demographic categories.

Table 5 **Study Sample by Income and Population Density**

Income

Population Density	Low	Moderate	High	Total # (% Total)
Urban	6 (13.95%)	---	6 (13.95%)	12 (27.9%)
Suburban	---	19 (44.2%)	---	19 (44.2%)
Rural	9 (20.9%)	---	3 (7.0%)	12 (27.9%)
Total # (% Total)	15 (34.9%)	19 (44.2%)	9 (20.9%)	43 (100%)

#(%)
= total number of sites/zip code area. Mean = 4.3 sites/zip code area.
(%) = percent of total number of sites/zip code area. Range = 3 to 19 sites/zip code area.

As shown below, Table 6 incorporates race/ethnicity into the summary of the number of study sites by income and population density. Sample percentages for

racial/ethnic categories of white and minority are summarized as follows.

Table 6 Study Sample by Race/ethnicity, Income and Population Density

Income

Population Density	Low	Moderate	High	Minority: # Sites (%sites) White: # Sites (% sites)
Urban	5 (16.7%) 1 (7.7%)	---	4 (13.3%) 2 (15.4%)	9 (30%) 3 (23.1%)
Suburban	---	15 (50%) 4 (30.8%)	---	15 (50%) 4 (30.8%)
Rural	4 (13.3%) 5 (38.5%)	---	2 (6.7%) 1 (7.7%)	6 (20%) 6 (46.2%)
Minority #(%) White #(%)	9 (30%) 6 (46.2%)	15 (50%) 4 (30%)	6 (20%) 3 (23.1%)	30 (100%) 13 (100%)

top = total number of sites and percent sites/minority zip code area. Mean = 3 sites/ minority zip code areas.
bottom = total number of sites percent sites/white zip code area. Mean = 1.3 sites/white zip code areas.
Range = 1 to 15 sites/zip code area.

Part 1: Analysis of Unweighted Dependent Variables

The distribution of responses for each variable was examined using SPSS®, and plotted to determine if distribution was normal. The variable for MDEQ response time (days) or "c1" was converted to a logarithmic scale to achieve a normal distribution. The other five MDEQ compliance effort variables were normally or approximately normally distributed as listed in Table 7 below.

Results of Site Compliance Evaluation

To begin to evaluate Part 201 program compliance measures (dependent variables) by demographic (independent) variables, means were calculated using SPSS®. The results of compliance measure means calculations are summarized in Table 7 below.

Table 7 **Calculation of Means - Part 201 Program Compliance:**

Means	Response Time (days)	Inspections Per Year	# Months to Control	Meetings Per Year	# Months to Cleanup	*Cleanup Ongoing?
Urban	4,624	.425	122	.137	169	.834
Suburban	1,423	.570	155	.195	181	.790
Rural	860	.486	99	.292	156	.834
Low Income	395	.503	86	.280	154	.800
Moderate Income	1,423	.570	155	.195	182	.790
High Income	6,602	.376	151	.105	176	.890
Minority	2,890	.540	149	.164	177	.767
White	684	.426	86	.303	157	.923

* Binomial variable that defines yes = 0 and no = 1. Therefore, higher decimals indicate higher likelihood that site cleanup within the specified demographic category is not complete.

MDEQ Response Time

Regarding initial agency response time, it was found that rural areas on average receive 39.5% faster response time than suburban areas, and 81% faster response time than urban areas. Response time as used here is defined as the number of days from MDEQ, ERD discovery or awareness of a potential site of environmental contamination to ERD staff follow-up investigation. According to study results, white areas received a 76% quicker response time than Part 201 sites in minority areas. Lastly, low income areas received a 73% faster response time than sites in moderate income areas, and a 94% faster response time than sites in high income areas.

MDEQ Inspections

Regarding MDEQ annual inspections at study sites, it was found that suburban area sites on average received 25% more MDEQ effort to oversee site compliance activities through site inspections than sites in urban areas, and 15% more MDEQ inspection effort than sites in rural areas. Also, rural area sites were subject to 13% more agency inspection effort than sites in urban areas. Annual inspections is used here to denote the total number of recorded MDEQ, ERD staff inspections per year from site discovery until cleanup. According to study results, minority areas received 21% more annual MDEQ compliance inspections than sites in white areas. Moderate income area sites received 12% more annual MDEQ inspection effort than sites in low income areas, and 34% more than sites in high income areas. Further, low income area sites on average received 25% more MDEQ inspection effort per year than sites in high income areas.

Time to Control Site Hazards

Table 7 also summarizes the results of means calculations regarding the number of months required to control hazards at sites of environmental contamination included in this study. Findings suggest that Part 201 sites in rural areas were brought under control nearly 19% sooner than sites in urban areas, and 36% sooner than sites in suburban areas. Site hazard control is used here to mean the fencing of a site of environmental contamination, the capping of contaminated soils, replacement of impacted drinking water supply wells, the removal of contamination source(s), and/or the initiation of ground water or soil treatment. Site hazard control results in the interim elimination or control of potential or known human and/or environmental exposure pathways.

According to study results, Part 201 sites in white areas were controlled 42% sooner than sites in minority areas. Low income area Part 201 sites were controlled 43% sooner than sites in high income areas, and 44% sooner than sites in moderate income areas. Lastly, environmental and human health hazards at sites in high income areas were controlled 3% sooner than sites in moderate income areas.

MDEQ Meetings with Regulated Parties

Regarding the frequency of MDEQ meetings with PRPs for cleanup oversight, these results suggest that rural study sites on average received the most diligent agency effort to oversee and foster private party cleanup activities through face to face meetings. Specifically, study sites in rural areas were subject to 33% more MDEQ and PRP site meetings than sites in suburban areas, and 53% more than study sites in urban areas. Also, sites in suburban areas were subject to 30% more MDEQ compliance oversight meetings with PRPs than sites in urban areas. Specifically, oversight meetings is used here as an annual mean of the total number of recorded meetings between the MDEQ and PRPs from MDEQ site discovery until site cleanup. According to study results, sites in white areas were 46% more likely to be subject to MDEQ and PRP meetings than sites in minority areas. Study sites in low income areas were subject to 63% more agency and PRP meetings than sites in high income areas, and 30% more than sites in moderate income areas. Study sites in high income areas received 46% more MDEQ compliance oversight meetings when compared to sites in moderate income areas.

Site Cleanup Pace

Table 7 also summarizes the results of means calculations regarding the pace or average number of months required to cleanup sites of environmental contamination included in this study. Findings suggest that cleanup activities at study sites in rural areas were completed 8% sooner than at sites in urban areas, and 14% sooner than at sites in suburban areas. Cleanups at study sites in suburban areas were found to be completed 7% faster than cleanups at sites in urban areas. Site cleanup is used here as the average number of months required to document the removal or reduction of hazardous substances to with state cleanup standards used at the time of site closure study by the MDEQ or PRP[257]. According to study results, study sites in white areas were cleaned up 11% sooner than sites in minority areas. Low income area study sites were cleaned up 13% sooner than sites in high income areas, and 15% sooner that sites in moderate income areas. Lastly, site cleanup pace in high income areas was 3% faster than sites in moderate income areas.

Site Cleanups Completed

Regarding the number of sites at which cleanups had been completed at the time of this study, these results suggest that sites in rural and urban areas on average were

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[257] From 1982 to 1990, Part 201 cleanup standards required the return of site conditions to natural conditions or the documented removal of site contaminants to within laboratory detection limits. Administrative rules promulgated in 1990 created a tripartite cleanup standard, allowing PRPs the choice of standards including active cleanup to the original zero risk standard, and new standards based upon an acceptable risk level of one additional adult cancer increase in one million persons, or the implementation of risk assessment and management site controls to achieve the one in one million acceptable risk standard. Sweeping amendments in 1995 replaced the acceptable risk level with a one in one-hundred thousand additional adult cancers standard for four specific land uses (residential, recreational, commercial, and industrial), and emphasized the utilization of risk assessment and risk management through engineering and/or administrative site controls to prevent unacceptable human exposure and/or ecological damage.

equally likely to have been cleaned up. Sites in suburban areas, however, were 5% less likely to have been finished with cleanup than sites in urban or rural areas at the time of this study. Specifically, cleanups completed is used here to mean the total number of recorded cleanups divided by the total number sites within each social demographic category, *i.e.* population density, income, and race/ethnicity. According to study results, 17% more study sites in white study areas were cleaned up at the time of this study than sites in minority study areas. Lastly, sites in high income study areas were 11% more likely to be finished with site cleanup than sites moderate income areas, and 10% more likely to be cleaned up to within state standards than sites in low income areas. Sites in low income areas were also found to be 1% more likely to have been completed with cleanup activities that sites in moderate income areas at the time of this study.

Statistical Significance of Means Differences within Compliance Measures

To assess the statistical significance of the difference in means measured within demographic categories of race/ethnicity, income, and population density, t-Tests of independent-sample means was undertaken for Part 201 compliance measures. Assuming population means are equal within social demographic categories (race/ethnicity, income, and population density), statistical significance from independent t-Tests was used to determine if difference observed within means of dependent variables was the result of "usual" variability within a single population, or indicative of statistically significant difference in sample means. Table 8 below summarizes the results of independent sample t-Tests of Part 201 compliance measures by race/ethnicity, income, and population density.

Table 8 **t-Test for Equality of Means - MDEQ Compliance Effort**

2-tail Significance	Response Time (log)	Inspections Per Year	#Months to Control	Meetings Per Year	Months to Cleanup	Cleanup Ongoing?
Urban/Suburban	0.246	0.538	0.513	0.494	0.776	0.773
Urban/Rural	0.513	0.638	0.545	0.077	0.691	1.000
Suburban/Rural	0.669	0.721	0.274	0.267	0.560	0.773
Low /High Income	0.174	0.340	0.096	**0.050**	0.515	0.591
Moderate/Low Income	0.845	0.754	0.135	0.312	0.484	0.942
High/Moderate Income	0.129	0.471	0.941	0.311	0.909	0.539
Minority/White	0.442	0.539	0.130	0.062	0.610	0.236

Bold numbers and shaded cells are statistically significant. 95% confidence interval. 2-tail significance of <0.05 is considered statistically significant. 2-tail significance results more than 0.05 does not allow the rejection of the null hypothesis that two groups of Part 201 sites come from populations with the same average MDEQ compliance effort.

These results suggest that mean differences in MDEQ and PRP meetings at Part 201 sites in low and high income areas is statistically significant. Specifically, these results indicate that low income areas receive significantly more MDEQ compliance effort, as measured by MDEQ effort to initiate or attend face to face meetings with PRPs to foster site investigation and cleanup.

Following the recommendations of previous studies, the statistical significance of the difference in means observed was analyzed for binomial variables including whether or not site cleanup had been completed at the time of this study within demographic categories of race/ethnicity, income, and population density. The Kruskal-Wallis nonparametric one-way analysis of variation (ANOVA) among all three demographic

categories for appropriate dependent variables was undertaken for this purpose. An advantage of the Kruskal-Wallis test is that it does not assume the normal distribution of dependent variable observations. Similar to the independent t-Test above, the null hypothesis for the Kruskal-Wallis test is that the means of Part 201 program measures and the shape of their distributions are the same for social demographic categories (race/ethnicity, income, and population density). Statistical significance corrected for ties from the from Kruskal-Wallis one-way ANOVA was used to determine if the observed difference suggested "usual" variability within the population of Part 201 site, or indicative of statistically significant difference in sample means from influence of socioeconomic independent variables. Table 9 below summarizes the results of Kruskal-Wallis one-way ANOVA of completed cleanups by race/ethnicity, income, and population density.

Table 9

Kruskal-Wallis One-Way Analysis of Variance -MDEQ Compliance Effort

Significance Corrected for Ties	Completed Cleanups
Population Density	1.00
Income	0.66
Race/ethnicity	0.23

Bold numbers and shaded cells are statistically significant. 95% confidence interval

Significance Corrected for Ties of <0.05 is considered statistically significant. Significance of more than 0.05 does not allow the rejection of the null hypothesis that observations are independent samples from populations with the same non-normal distribution *(i.e.* same average MDEQ compliance effort).

These results suggest that observed means differences regarding the completion of

site cleanup at the time of data collection for this study are not statistically significant. The null hypothesis is not rejected that mean difference observations regarding site cleanup status are independent samples from populations with the same non-normal distribution.

Results of Site Enforcement Evaluation

To evaluate Part 201 program enforcement measures by demographic variables, means of enforcement measures were calculated using SPSS®. The results of Part 201 enforcement means calculations are summarized in Table 10 below.

Table 10 **Calculation of Means - MDEQ Program Enforcement**

Means	#Information Requests	# Notice Letters	# Days to Notification	Negotiated Penalties	Enforcement Referrals
Urban	0.000	1.92	8,983	$0.00	.33
Suburban	0.526	1.21	150	$5,985.71	.53
Rural	0.500	3.08	105	$0.00	.50
Low Income	0.400	3.00	329	$0.00	.47
Moderate Income	0.0526	1.21	150	$5,985.17	.53
High Income	0.000	1.67	11,135	$0.00	.33
Minority	0.233	1.70	1,276	$1,373.33	.43
White	0.000	2.46	6,555	$2,366.67	.54

The distribution of responses for each enforcement variable was examined using SPSS®, and plotted to determine if distribution was normal. The variable for PRP notification time (days) or "NOTDAYS#" was converted to a logarithmic scale to achieve

a normal distribution. The other four MDEQ enforcement effort variables were normally or approximately normally distributed.

MDEQ Information Requests

As supported by the researcher's experience, Table 10 suggests that the MDEQ seldom used the information request enforcement provisions of Part 201 as part of its enforcement effort at study sites. Specifically, the number of information requests is defined here as the total number information requests at a site over the years from discovery until cleanup. These findings further suggest that suburban area sites were 5% more likely to have MDEQ information requests of PRPs regarding the nature and extent of site contamination than rural sites. No MDEQ enforcement information requests were captured by urban study sites. According to study results, minority area sites enjoyed the occasional use of the information request by MDEQ enforcers, *i.e.* 0.233 requests per year. Study sites within white areas were not subject to any information requests. Lastly, low income area sites were subject to 24% more MDEQ information requests than at sites in moderate income areas. No high income sites captured in this study were subject to MDEQ information requests as a part of enforcement actions, if any.

MDEQ Notification of PRPs

The aggressiveness of MDEQ identification and notification of PRPs was analyzed, and these results are also summarized in Table 10. Findings suggest that rural areas on average receive the most diligent agency efforts to identify, notify and perhaps re-notify PRPs of violations of Part 201, followed by urban and then suburban areas, respectively. Specifically, MDEQ efforts to notify PRPs at rural sites were 38% greater

than at urban area sites, and 61% greater than at suburban sites. According to study results, PRPs at white area sites were 31% more likely to be initially notified of violations of Part 201 than PRPs at minority area sites. PRPs at study sites in low income areas were 60% more likely to be notified than PRPs of sites in moderate income areas, and 44% more likely than PRPs at sites high income areas. Finally, PRPs at sites in high income areas were 28% more likely to have been notified by the MDEQ of Part 201 violations than PRPs at sites in moderate income areas.

Time for MDEQ Identification and Notification of PRPs

Table 10 also summarizes the results of means calculations for the number of days required by the MDEQ to locate and notify PRPs of Part 201 responsibility to investigate and remediate sites of environmental contamination. Findings suggest that the MDEQ notified PRPs of sites in rural areas of Part 201 violations 30% sooner than PRPs at sites in suburban areas, and 99% sooner than PRPs at sites in urban areas. According to study results, PRPs of minority area study sites were on average notified 81% sooner than those at sites in white areas. Lastly, PRPs of moderate income area sites were notified 65% sooner than PRPs at sites in low income areas, and 99% sooner than PRPs at sites in high income areas.

Negotiated Penalties

If utilized by the MDEQ, successful enforcement results in the return of reluctant or recalcitrant PRPs to compliance with the provisions of Part 201. This process often concludes with the negotiation and approval of a written agreement between the MDEQ and PRPs, and respective counsel. These documents, referred to as Consent Decrees or

Consent Orders, are contractual agreements filed with a Michigan Circuit Court to insure subsequent adherence to agreement provisions through judicial enforcement. As a matter of MDEQ enforcement policy, the agency frequently requires the payment of penalties to off-set PRP financial benefit from pollution and/or damages to natural resources held within the public trust and administered by the MDEQ. Through this negotiation process, PRPs as such are often required to "stipulate" to penalties for past Part 201 non-compliance. The amount of stipulated penalties is at the discretion of the MDEQ and AG, and may serve as a useful measure of the social equity of Part 201 program enforcement.

Regarding negotiated penalties in Part 201 enforcement cases included in this study, these results suggest that negotiated penalties at sites in white areas were on average 42% higher than negotiated penalties at minority area sites. Sites with negotiated penalties did not exist within the sample for all population density or income categories, and therefore these measures were not further analyzed.

MDEQ Enforcement Referrals

Table 10 also summarizes the means calculations of the number of MDEQ enforcement referrals to the AG for sites within each demographic category. These results suggest that sites in suburban areas were 6% more likely to be referred for enforcement than sites in rural sites, and 38% more likely than sites in urban areas. Enforcement referrals are used here to mean official requests by MDEQ management for AG assistance in undertaking escalated enforcement actions against PRPs at Part 201 sites. According to study results, sites in white areas were 20% more likely to be subject

to enforcement referral than sites in minority study areas. Sites in moderate income areas were 21% more likely to be referred for AG enforcement action than sites in low income areas, and 38% more likely than sites in high income areas. Finally, sites in low income areas were 30% more likely to have been referred for AG enforcement than sites in high income areas.

MDEQ Negotiation of Cleanup Completion

Although not summarized in Table 10, means calculations were also undertaken to determine the relative frequency of MDEQ negotiation of a requirement for PRP site cleanup in association with or in lieu of penalties. Findings suggest very little variation in whether the MDEQ obtained legally enforceable agreement for PRP site cleanup as a result of enforcement actions in areas of varying population density and income. However, sites in minority areas were found to be 17% more likely to be cleaned up by a PRP as a result of enforcement action in lieu of voluntary compliance, and in association with or instead of penalties and/or MDEQ direct cleanup expenditure.

Statistical Significance of Means Differences within Enforcement Measures

To assess the statistical significance of the difference in means of MDEQ Part 201 enforcement efforts found within this study, t-Tests of independent-sample means was undertaken for each dependent variable. Assuming that population means are equal within social demographic categories (race/ethnicity, income, and population density), statistical significance from independent t-Tests was used here to determine if mean difference observed is the result of usual variability of sample means from a single population or indicative of statistically significant difference. Table 11 below

summarizes the results of independent sample t-Test of Part 201 enforcement measures by race/ethnicity, income, and population density.

Table 11 t-Test for Equality of Means - MDEQ Enforcement Effort

2-tail Significance	#Information Requests	#Notice Letters	#Days to Notification (log)	Negotiated Penalties	#Enforcement Referrals
Urban/Suburban	0.436	0.281	0.259	0.133	0.565
Urban/Rural	0.328	0.256	0.143	0.333	0.496
Suburban/Rural	0.271	**0.029**	0.667	**0.030**	0.935
Low /High Income	0.451	0.207	0.378	----	0.599
Moderate/Low Income	0.340	**0.027**	0.944	**0.018**	0.845
High/Moderate Income	0.502	0.496	0.385	0.200	0.598
Minority/White	0.454	0.307	0.916	0.657	0.696

Bold numbers and shaded cells are statistically significant. 95% confidence interval. 2-tail significance of <.05 is considered statistically significant. 2-tail significance results more than 0.05 does not allow the rejection of the null hypothesis that two groups of Part 201 sites come from populations with the same average MDEQ enforcement effort.

These results suggest that mean difference in the number of MDEQ notification letters and negotiated penalties comparing suburban and rural, and low and moderate income areas are statistically significant. Specifically, the results indicate that low income areas receive significantly more MDEQ enforcement effort than moderate income areas as measured by MDEQ notification of PRPs, but statistically significantly less negotiated penalties than enforcement cases in moderate income areas. Similarly, the results indicate that rural areas receive significantly more MDEQ enforcement effort than suburban areas as measured by MDEQ notification of PRPs, but statistically significantly

less negotiated penalties than enforcement cases in suburban areas.

Following the recommendations of previous studies, the statistical significance of the difference in means observed was additionally analyzed for binomial Part 201 program enforcement variables including: whether or not MDEQ information requests were made; if PRPs were identified and notified of Part 201 violations and obligations; if formal referrals were made by the MDEQ to the AG for escalated enforcement actions; if penalties were levied; and if site cleanup was required through negotiated settlement of enforcement proceedings at the time of this study. The Kruskal-Wallis one-way ANOVA was undertaken for nonparametric Part 201 program enforcement variables for all three demographic categories. As stated above, the Kruskal-Wallis test does not assume the normal distribution of dependent variable observations. The null hypothesis for this test is that the means of Part 201 program enforcement measures and the shape of their distributions are the same for each social demographic category. Statistical significance corrected for ties from the from Kruskal-Wallis one-way ANOVA was used to determine if the observed variability suggested usual variability within the population of Part 201 sites, or indicative of statistically significant difference in sample means from influence of socioeconomic independent variables. Table 12 below summarizes the results of Kruskal-Wallis one-way ANOVA of select Part 201 enforcement measures by race/ethnicity, income, and population density.

Table 12 Kruskal-Wallis One-Way ANOVA-MDEQ Enforcement Effort

Significance as Corrected for Ties	Information Requests	PRP Notification	Enforcement Referral	Penalties Levied	Cleanup Negotiated
Population Density	0.34	0.67	0.20	0.48	0.85
Income	0.49	0.60	0.68	0.19	0.26
Race/ethnicity	0.34	0.87	0.09	0.87	**0.02**

Bold numbers and shaded cells are statistically significant. 95% confidence interval. Significance of <0.05 is considered statistically significant. Corrected for ties significance of more than 0.05 does not allow the rejection of the null hypothesis that observations must be independent samples from populations with the same non-normal distribution *(i.e.* same average MDEQ enforcement effort).

These results suggest that means differences for court enforceable negotiated agreements for site cleanup from MDEQ enforcement was statistically significant by race/ethnicity. This allows for the rejection of the null hypothesis that the mean difference observed for negotiated site cleanup was from independent samples from the same non-normal distributed population. Results indicate that minority areas receive significantly more MDEQ enforcement effort, as measured by the negotiation of site cleanup by the PRP as the result of agency enforcement actions, in lieu of PRP cleanup from MDEQ compliance effort, or the MDEQ expenditure of public funds.

Results of Public Funding Evaluation

To begin to evaluate Part 201 program public funding measures by select demographic variables, means were also calculated using SPSS®. The results of public funding means calculations are summarized in Table 13 below.

Table 13 **Calculation of Means - MDEQ Public Funding**

Means	Funds Requested	Funds Spent	Emergency Funds Spent	Funds Recovered	Percent Recovered
Urban	$279,166.67	$215,083.33	$29,041.67	$0.00	0.00
Suburban	$34,447.39	$12,536.84	$0.00	$0.00	0.00
Rural	$140,208.33	$85,417.13	$2,083.33	$3,500.00	4%
Low Income	$332,166.67	$237,067.03	$24,900.00	$2,800.00	1%
Moderate Income	$34,447.37	$12,536.84	$0.00	$0.00	0.00
High Income	$5,555.56	$5,555.56	$0.00	$0.00	0.00
Minority	$159,000.00	$107,103.48	$12,017.24	$0.00	0.00
White	$70,538.46	$48,546.23	$1,923.08	$1,923.08	0.7%

The distribution of responses for each public funding variable was examined using SPSS®, and plotted to determine if distribution was normal. The above MDEQ public funding effort variables were normally or approximately normally distributed.

Public Funds Requested

Table 13 suggests that the MDEQ requests for public funding was nearly 88% higher for sites in urban areas than sites in suburban sites, and 50% higher than sites in rural areas. According to study results, the MDEQ requested 55% more public funds to address sites in minority areas as compared to white areas. Lastly, low income area sites were subject to the highest level of MDEQ site funding. Sites in low income areas were subject to MDEQ requests for nearly 89% more public funds than sites in moderate income areas, and 98% more than sites in high income areas.

Public Funds Spent

Actual expenditures of public funds by the MDEQ was also analyzed, and these results are summarized in Table 13. Similar to the funds requested, it was found that urban area study sites on average received 94% more site spending than study sites in suburban areas, and 96% more than study sites in rural areas. Results also indicated that the MDEQ spent 55% more public funds to address sites in minority areas than sites in white study areas. Lastly, relative percentages for expenditures were also similar to funds requested when compared to all income categories. Specifically, low income area study sites received nearly 95% more funds than sites in moderate income areas, and nearly 98% more than sites in moderate income areas.

MDEQ Emergency Fund Expenditures

Table 13 also summarizes the results of means calculations for public funds spent by the MDEQ to undertake to emergency response actions including: drum and/or surface removal of hazardous substances; the prevention of human exposure to toxic materials; or the prevention of hazardous material migration into sensitive habitats and/or public water supplies. It was found that 93% more emergency funds were spent by the MDEQ at Part 201 sites in urban areas as compared to sites in rural areas, and no emergency funds were spent at study sites in suburban areas. 84% more emergency funds were spent by the MDEQ at sites in minority areas as compared to sites in white study areas. This study did not capture sites with MDEQ emergency fund expenditure in moderate or high income areas.

Public Funds Recovered

If public funds are spent by the MDEQ to address conditions at a sites of environmental contamination, as a matter of policy the MDEQ is to undertake efforts to collect dollars from PRPs equal to the public expenditure. This process is generally referred to as agency "cost recovery". Experience and knowledge of the researcher suggests that cost recovery by the MDEQ has been somewhat discretionary, and has not been diligently undertaken by the MDEQ at numerous sites statewide. Study results indicate that cost recovery actions were undertaken in association with public fund expenditures within rural, low income, and white study areas only. This was found despite the fact that public funds were spent in each demographic category.

Statistical Significance of Means Differences within Public Funding Measures

To assess the statistical significance of the difference in means found in public funding measures, t-Tests of independent-sample means was undertaken for each measure of MDEQ Part 201 public funding effort. Assuming population means are equal within social demographic categories (race/ethnicity, income, and population density), statistical significance from independent t-Tests was used here to determine if variability observed was statistically significant. Table 14 below summarizes the results of independent sample t-Test of Part 201 public funding measures by race/ethnicity, income, and population density.

Table 14 **t-Test for Equality of Means - MDEQ Public Funding**

2-tail Significance	Funds Requested	Funds Spent	Emergency Funds Spent	Funds Recovered
Urban/Suburban	0.199	0.188	0.227	0.432
Urban/Rural	0.575	0.516	0.365	0.350
Suburban/Rural	0.124	0.067	0.227	0.241
Low /High Income	0.195	0.256	0.418	0.478
Moderate/Low Income	0.087	0.106	0.247	0.295
High/Moderate Income	0.465	0.513	0.000	0.504
Minority/White	0.561	0.629	0.581	0.128

Bold numbers and shaded cells are statistically significant. 95% confidence interval. 2-tail significance of <0.05 is considered statistically significant. 2-tail significance results more than 0.05 does not allow the rejection of the null hypothesis that two groups of Part 201 sites come from populations with the same average MDEQ compliance effort.

These results indicate that none of the mean differences observed for MDEQ public funding measures were statistically significant. Specifically, the small sample size of Part 201 sites with public fund expenditure and relatively little variance in observed difference, may have resulted in the failure to reject the null hypothesis that observed Part 201 public funding mean values come from a population of all Part 201 sites with the same means.

Part 2: Analysis of Dependent Variables Weighted by Part 201 Site Score

To reflect the varying level of risk or severity of Part 201 sites, dependent variable observations were weighted[258]. Independent variables considered for use in weighting included: the staff size of various MDEQ, ERD district offices as compared to the number of sites, *i.e.* workload; the lineal distance in miles from sites to MDEQ district offices; and Part 201 site score. Little variation was found in the application of workload and distance to the sample, therefore a site score ratio was calculated and multiplied by observations to account for the relative risk posed by each Part 201 site.

Specifically, the above means calculations and statistical analyses were replicated following the weighting of dependent variable measures by the relative risk to public health and the environment presented by each site. Dependent variable measures were weighted by multiplying by a ratio of Part 201 site score for each site. The site score ratio was found by dividing the site Part 201 score, ranging from 1 to 48, as reported by the MDEQ for fiscal year 1996 by the maximum potential site score of 48. As such, the calculated ratio existed as the relative risk posed by each site as determined by the MDEQ.

As undertaken in Part 1 above, the distribution of responses for each weighted Part 201 compliance variable was examined using SPSS®, and plotted to determine if distribution was normal. The variable for MDEQ response time (days) or "c1" was again converted to a logarithmic scale to achieve a normal distribution. The other five MDEQ

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[258] Recommendation of Greenberg, *op. cit.*, (1993), pp. 248-249; and Gould, *op. cit.*, p. 9.

compliance effort variables were normally or approximately normally distributed. Following this weighting process, means calculations were repeated for each dependent variable representing MDEQ Part 201 compliance, enforcement, and funding effort.

Results of Weighted Site Compliance Evaluation

As described above, weighted Part 201 program compliance measures by demographic variables, means were calculated using SPSS®. The results of weighted compliance measure means calculations are summarized in Table 15 below.

Table 15

Calculation of Weighted Means - MDEQ Part 201 Program Compliance

Weighted Means	Response Time (days)	Inspections Per Year	# Months toControl	Meetings Per Year	# Months toCleanup	*Cleanup Done ?
Urban	1,991	.274	80	.093	111	.486
Suburban	1,010	.352	97	.126	115	.471
Rural	277	.261	51	.157	83	.468
Low Income	270	.309	53	.172	94	.486
Moderate Income	1,010	.352	97	.126	115	.471
High Income	2,572	.199	85	.049	102	.461
Minority	1,494	.331	92	.107	110	.447
White	190	.245	50	.170	93	.538

* Binomial variable defining yes = 0 and no = 1. Therefore higher decimals indicate higher likelihood that site cleanup within the specified demographic category is ongoing.

Weighted MDEQ Response Time

Regarding agency response time, it was found that rural areas on average receive 73% faster response time than similar sites in suburban areas, and 86% faster response

time than similar sites in urban areas. Response time as used here is defined as the weighted average of the number of days from MDEQ, ERD documented discovery or awareness of a potential site of environmental contamination and ERD staff follow-up investigation. According to study results, white area sites received a 87% quicker response time than similar sites in minority areas. Lastly, sites in low income areas received a 73% faster response time than similar sites in moderate income areas, and a 90% faster response time than similar sites in high income areas.

Weighted MDEQ Inspections

Regarding agency annual inspections at study area sites, it was found that suburban area sites on weighted average received 77% more agency inspection effort to oversee site compliance activities than similar sites in urban areas, and 74% more inspection effort than similar sites in rural areas. Urban areas received 4% more MDEQ inspection effort than similar sites in rural areas. Weighted annual inspections is used here to denote the total number of recorded MDEQ inspections from site discovery until cleanup as weighted by site score. According to weighted means results, minority area sites received 24% more MDEQ annual inspections than similar sites in white areas. Sites in moderate income areas received 43% more annual MDEQ inspection effort than similar sites in high income areas, and 11% more than similar sites in low income areas. Lastly, low income area sites received 35% more annual MDEQ inspection effort than similar sites in high income areas.

Weighted Time to Control Site Hazards

Table 15 also summarizes the results of means calculations regarding the number

of months to control hazards at sites of environmental contamination as weighted by site score. These findings suggest that Part 201 sites in rural areas were brought under control 36% sooner than similar sites in urban areas, and 47% sooner than similar sites in suburban areas. Sites in urban areas were brought under control 18% sooner than similar sites in suburban areas. Site hazard control is used here to mean the fencing of a site of environmental contamination, the capping of contaminated soils, replacement of impacted drinking water supply wells, the removal of contamination source(s), and/or the initiation of ground water or soil treatment system operation as weighted by site score. Further, Part 201 sites in white areas weighted by site score were controlled 46% sooner than similar sites in minority areas. Low income area sites were controlled 38% sooner than similar sites in high income areas, and 45% sooner than similar sites in moderate income areas. Finally, sites in high income areas were controlled 12% sooner than similar sites in moderate income areas.

MDEQ Meetings with Regulated Parties

Regarding MDEQ meetings with PRPs for cleanup oversight as weighted by site score, these results suggest that rural sites on average received the most diligent agency effort to oversee private party cleanup activities through personal meetings. Specifically, sites in rural areas were 19% more likely to be subject to MDEQ and PRP site meetings than similar sites in suburban areas, and 44% more likely than similar sites in urban areas. MDEQ meetings with PRPs in suburban areas were 30% more prevalent than meetings regarding site progress in urban areas when weighted by site score. Specifically, oversight meetings is used here as the total number of recorded meetings between the

MDEQ and PRPs from MDEQ site discovery until site cleanup, as weighted by site score. According to study results, sites in white areas were 35% more likely to be subject to MDEQ and PRP meetings than similar sites in minority areas. Sites in high income areas were 62% less likely to be subject to agency and PRP meetings than similar sites in moderate income areas, and 71% less likely to be subject to agency compliance meetings when compared to similar sites in low income areas. Sites in moderate income areas were 24% less likely to be subject to MDEQ and PRP meetings than similar sites in low income areas.

Weighted Site Cleanup Pace

Table 15 also summarizes the results of weighted means calculations regarding the number of months required to cleanup sites of environmental contamination. Findings suggest that cleanups at sites in rural areas were begun 25% faster than at similar sites in urban areas, and 28% quicker than at similar sites in suburban areas. The pace of cleanup at sites in suburban areas was found to be 3% faster than the cleanup pace at similar sites in urban areas. Site cleanup is used here to mean the average number of months required to document the removal or reduction of hazardous substances to within state cleanup standards used at the time of site closure study[259]. According to these results, the pace of cleanup at study sites in white areas was 15% faster than similar sites in minority areas. Low income area study sites cleanup pace was 8% faster than sites in high income areas, and 18% faster than similar sites in moderate income areas. Finally,

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[259] As stated above, sweeping amendments to the Part 201 program were enacted by the Michigan Legislature in 1995. Overall, these amendments resulted in the significant lessening of cleanup standards. Refer to footnote 159 *supra* for a detailed explanation.

the cleanup pace at sites in high income areas was 11% quicker than at similar sites in moderate income areas.

Site Cleanups Completed as Weighted by Site Score

Regarding the number of sites at which cleanups were complete as weighted by site score, these results suggest that sites in urban areas were on average 3% more likely to have been cleaned up at the time of this study than similar sites in suburban areas, and 4% more likely to have been cleaned up than similar sites in rural areas. Sites in suburban areas were 6% more likely to have been finished with cleanup than similar sites in rural areas. Specifically, site cleanups completed is used here to mean the total number of recorded cleanups divided by the total number sites within each social demographic category, *i.e.* population density, income, and race/ethnicity as weighted by site score. According to study results, 17% more study sites in white study areas were cleaned up at the time of this study than similar sites in minority areas. Lastly, sites in high income areas were 2% more likely to be finished with site cleanup than similar sites in moderate income areas, and 5% more likely to be cleaned up than similar sites in low income areas. Study sites in low income areas were also found to be 3% more likely to have been completed with cleanup activities at the time of this study than similar sites in moderate income areas.

Statistical Significance of Weighted Means Differences within Compliance Measures

To assess the statistical significance of the difference in weighted compliance measures within demographic categories of race/ethnicity, income, and population density, t-Tests of independent-sample means were undertaken. Assuming population

means were equal within social demographic categories (race/ethnicity, income, and population density), statistical significance from independent t-Tests was used to determine if variability observed dependent variable means was the result of typical variability within a single population, or indicative of statistically significant difference in sample means. Table 16 below summarizes the results of independent sample t-Tests of Part 201 compliance measures by race/ethnicity, income, and population density.

Table 16

t-Test for Equality of Weighted Means - MDEQ Compliance Effort

2-tail Significance	Response Time (log)	Inspections Per Year	#Months to Control	Meetings Per Year	#Months to Cleanup	Cleanup Ongoing?
Urban/Suburban	0.570	0.652	0.675	0.593	0.930	0.888
Urban/Rural	0.337	0.893	0.320	0.270	0.332	0.877
Suburban/Rural	0.489	0.598	0.254	0.572	0.411	0.973
Low /High Income	0.204	0.245	0.298	**0.036**	0.797	0.839
Moderate/Low Income	0.432	0.779	0.232	0.426	0.486	0.881
High/Moderate Income	0.432	0.440	0.796	0.197	0.791	0.931
Minority/White	0.330	0.533	0.205	0.217	0.587	0.330

Bold numbers and shaded cells are statistically significant. 95% confidence interval. 2-tail significance of <0.05 is considered statistically significant. 2-tail significance results more than 0.05 does not allow the rejection of the null hypothesis that two groups of Part 201 sites come from populations with the same average MDEQ compliance effort.

These results suggest that means differences in MDEQ and PRP meetings per year at sites in low and high income areas is statistically significant. As found in the results of the statistical analysis of unweighted means in Part 1 above, these findings indicate that

low income areas receive significantly more MDEQ compliance effort as measured by their initiation of PRP oversight meetings or willingness to attend PRP initiatives for face to face meetings to foster site cleanup.

Following the recommendations of previous studies, the statistical significance of the means difference observed for the weighted, binomial compliance effort variable of whether or not site cleanup had been completed at the time of this study was statistically tested. Specifically, the Kruskal-Wallis nonparametric one-way ANOVA for this dependent variable was undertaken for all three demographic categories. Table 17 below summarizes the results of Kruskal-Wallis one-way ANOVA of the weighted Part 201 compliance measure of completed site cleanup by race/ethnicity, income, and population density.

Table 17

Kruskal-Wallis One-Way Analysis of Variance -MDEQ Compliance Effort

Significance Corrected for Ties	Completed Cleanups
Population Density	0.99
Income	0.96
Race/ethnicity	0.29

Bold numbers and shaded cells are statistically significant. 95% confidence interval. Significance of <0.05 is considered statistically significant. Corrected for ties significance of more than 0.05 does not allow the rejection of the null hypothesis that observations must be independent samples from populations with the same non-normal distribution *(i.e.* same average MDEQ compliance effort).

These results suggest that observed means differences regarding the completion of site cleanup at the time of data collection for this study are not statistically significant. The null hypothesis is thereby not rejected that mean difference observations regarding

site cleanup status are from independent samples from within the same non-normally distributed population.

Results of MDEQ Enforcement Effort Weighted by Site Score

To evaluate weighted Part 201 program enforcement measures by demographic variables, means were again calculated and weighted by site score using SPSS®. The results of enforcement measure means calculations are summarized in Table 18 below.

Table 18 Calculation of Weighted Means - MDEQ Program Enforcement

Weighted Means	# Information Requests	# Notice Letters	# Days to Notification	Negotiated Penalties	Enforcement Referrals
Urban	0.000	1.33	7,047	$0.00	.24
Suburban	0.211	.78	69	$3,657.43	.39
Rural	0.188	1.59	45	$0.00	.26
Low Income	0.150	1.90	195	$0.00	.30
Moderate Income	0.021	.78	69	$4,788.32	.39
High Income	0.000	.71	8,790	$0.00	.17
Minority	0.089	1.10	1,018	$1,082.00	.31
White	0.000	1.29	5,017	$1,041.33	.32

The distribution of responses for each enforcement variable was examined using SPSS®, and plotted to determine if distribution was normal. The variable for PRP notification time (days) or "NOTDAYS#" was converted to a logarithmic scale to achieve a normal distribution. The other four MDEQ enforcement effort variables used were normally or approximately normally distributed.

Weighted MDEQ Information Requests

As found in Part 1, Table 18 suggests that the MDEQ relatively seldom used the

information request enforcement provisions of Part 201 as part of enforcement efforts at study sites. Specifically, the weighted number of information requests is defined as the total number information requests at a site over the years from discovery until cleanup weighted by site score. These findings suggest that suburban area sites were most likely to have MDEQ information requests of PRPs regarding the nature and extent of site contamination. Suburban sites were 11% more likely than similar rural sites to be subject to MDEQ information requests, but no information requests were made of urban sites subject to enforcement efforts. According to study results, minority area sites were subject to the infrequent use of the information requests by MDEQ enforcers, but similar sites within white areas captured in this study were not subject to any information requests. Lastly, low income area sites were subject 86% more MDEQ use of information requests than similar sites in moderate income areas, but no high income area sites undergoing enforcement and identified in this study were subject to information requests.

Weighted MDEQ Notification of PRPs

The aggressiveness of MDEQ identification and notification of PRPs was also weighted by site score and statistically analyzed. Results summarized in Table 18 suggest that rural areas on weighted average received the most diligent MDEQ effort to identify, notify and/or re-notify PRPs of violations of Part 201, followed by similar sites within urban and then suburban areas, respectively. Specifically, rural sites were 16% more likely than similar urban sites, and 51% more likely than similar suburban sites to be subject to agency PRP notification and/or re-notification. Urban area sites were 41%

more likely than suburban sites of similar relative risk to be subject to agency PRP notification. According to study results, PRPs at white area sites were 15% more likely to be notified of violation of Part 201 than PRPs at similar sites in minority areas. Finally, PRPs at sites in low income areas were 59% more likely to be notified than PRPs at similar sites in moderate income areas, and 63% more likely than PRPs at similar sites in high income areas. Sites in moderate income areas were 9% more likely to receive MDEQ notification efforts than similar sites in high income areas.

Weighted Time for MDEQ Identification and Notification of PRPs

Table 18 also summarizes the results of weighted means calculations for the number of days required by the MDEQ to locate and notify PRP(s) of potential Part 201 responsibility to investigate and remediate sites of environmental contamination. Findings suggest that PRPs at sites in rural areas were notified by the MDEQ 34% sooner than at similar sites in suburban areas, and 99% sooner than at similar sites in urban areas. PRPs at sites in suburban areas were notified 99% sooner than PRPs at similar sites in urban areas. According to study results, PRPs at minority sites were notified 80% sooner than at similar sites in white areas. PRPs at weighted moderate income area sites were notified 65% sooner than at similar sites in low income areas, and 99% sooner than at similar sites in high income areas. Finally, PRPs at sites in low income areas were notified 98% sooner than at similar sites in high income areas.

Negotiated Penalties Weighted by Site Score

If utilized by the MDEQ, successful enforcement effort brings recalcitrant PRPs back into Part 201 compliance. As stated above, this process often concludes with the

negotiation, agreement and approval of a Consent Decree including PRP stipulation to pay penalties for past Part 201 non-compliance. As stated above, the amount of stipulated penalties are ultimately at the discretion of the MDEQ and AG, and may serve as a useful measure of the social equity of Part 201 program enforcement.

Regarding negotiated penalties at Part 201 enforcement sites included in this study as weighted by site score, results suggest that negotiated penalties at sites in moderate income areas were 100 percent higher than penalties at similar sites in low and high income areas. Negotiated penalties at Part 201 sites in white areas were on average 4% higher than negotiated penalties at similar minority area sites. Negotiated penalties at sites in suburban areas were 100 percent higher than negotiated penalties at similar sites in urban and rural areas. Sites with negotiated penalties did not exist within the study sample for all population density or income categories, and therefore could not be completely analyzed.

Weighted MDEQ Enforcement Referrals

Table 18 also summarizes the means calculations of the number of MDEQ enforcement referrals to the AG for weighted study sites within each demographic category. These results suggest that the sites in suburban areas were 33% more likely to be referred for enforcement than similar sites in rural areas, and 38% more than similar sites in urban areas. Rural sites weighted by site score were 8% more likely to be referred by the MDEQ to the AG for enforcement than similar sites in urban areas. Enforcement referrals are used here to mean official requests by MDEQ management for AG assistance in undertaking escalated enforcement actions against PRPs at Part 201 sites as weighted

by site score. According to study results, weighted sites in white areas were equally subject to enforcement referral as similar sites in minority areas. Sites in moderate income study areas were 23% more likely to be referred for enforcement than similar sites in low income areas, and 56% more likely to be referred for enforcement than similar sites in high income areas. Finally, low income area sites were 43% more likely to be referred for AG enforcement than similar sites in high income areas.

Statistical Significance of Weighted Means Differences for MDEQ Enforcement Measures

To assess the statistical significance of the difference in means of weighted enforcement measures, t-Tests of independent-sample means was undertaken for Part 201 enforcement variables. Assuming population means are equal within social demographic categories (race/ethnicity, income, and population density), statistical significance from independent t-Tests is used here to determine if variability observed is statistically significant. Table 11 below summarizes the results of independent sample t-Test of Part 201 enforcement measures by race/ethnicity, income, and population density.

Table 19

t-Test for Equality of Means - Weighted MDEQ Enforcement Effort

2-tail Significance	# Information Requests	# Notice Letters	# Days to Notification (log)	Negotiated Penalties	#Enforcement Referrals
Urban/Suburban	0.436	0.276	0.138	0.090	0.571
Urban/Rural	0.328	0.666	0.107	------	0.914
Suburban/Rural	0.276	0.102	0.870	**0.020**	0.602
Low /High Income	0.451	**0.047**	0.316	------	0.456
Moderate/Low Income	0.346	**0.028**	0.565	**0.011**	0.694
High/Moderate Income	0.502	0.881	0.238	0.170	0.448
Minority/White	0.450	0.677	0.741	0.975	0.982

Bold and shaded cells are statistically significant. 95% confidence interval.
"----" denotes that the standard deviation in both comparison groups was zero, precluding the performance of t-Test. 2-tail significance of <0.05 is considered statistically significant. 2-tail significance results more than 0.05 does not allow the rejection of the null hypothesis that two groups of Part 201 sites come from populations with the same average MDEQ enforcement effort.

These results suggest that weighted means differences in the number of MDEQ notification letters and negotiated penalties between low and moderate income areas are statistically significant. Further, the number of MDEQ notice letters comparing suburban to rural areas is also statistically significant. Specifically, the results indicate that low income areas receive significantly more MDEQ enforcement effort than similar sites in moderate income areas as measured by weighted MDEQ notification of PRPs, but statistically significantly less negotiated penalties than enforcement cases at similar sites in moderate income areas. These results also indicate that rural areas receive significantly less MDEQ enforcement effort than similar sites in suburban areas, as measured by

MDEQ negotiated penalties at sites in rural areas as compared to similar sites in suburban areas.

The statistical significance of observed means difference within weighted, binomial Part 201 program enforcement variables were also analyzed. Specifically, weighted enforcement variables analyzed included: whether or not MDEQ information requests were made; if PRPs were identified and notified of Part 201 violations and obligations; if formal referrals were made by the MDEQ to the AG for escalated enforcement actions; if penalties were levied; and if site cleanup was required through negotiated settlement of enforcement proceedings at the time of this study within demographic categories of race/ethnicity, income, and population density. The Kruskal-Wallis nonparametric one-way ANOVA was undertaken for Part 201 enforcement measures within all three demographic categories.

As stated above, the Kruskal-Wallis test does not assume the normal distribution of dependent variable observations. The null hypothesis for this test is that the means of Part 201 program enforcement measures and the shape of their distributions are the same for social demographic categories (race/ethnicity, income, and population density). Statistical significance corrected for ties from the from Kruskal-Wallis one-way ANOVA was used to determine if the observed variability suggested statistically significant difference in sample means from influence of independent variables. Table 20 below summarizes the results of Kruskal-Wallis one-way ANOVA of the weighted Part 201 enforcement measures by race/ethnicity, income, and population density.

Table 20
Kruskal-Wallis One-Way ANOVA- Weighted MDEQ Enforcement Effort

Significance as Corrected for Ties	Information Requests	PRP Notification	Enforcement Referral	Penalties Levied	Cleanup Negotiated
Population Density	0.61	0.07	0.78	**0.02**	0.55
Income	0.74	**0.03**	0.88	**0.02**	0.69
Race/ethnicity	0.35	0.65	0.21	0.88	**0.04**

Bold numbers and shaded cells are statistically significant. 95% confidence interval. Significance of <.05 is considered statistically significant. Corrected for ties significance of more than 0.05 does not allow the rejection of the null hypothesis that observations must be independent samples from populations with the same non-normal distribution *(i.e.* same average MDEQ enforcement effort).

These results suggest that weighted means differences regarding PRP notification effort and Part 201 penalties by income; penalties levied by population density; and the MDEQ negotiation of an agreement for site cleanup by race/ethnicity are statistically significant. This allows for the rejection of the null hypothesis that the mean difference for these Part 201 enforcement measures are from independent samples from with the same non-normally distributed population. Specifically, these results indicate that sites in low income areas receive significantly more MDEQ effort regarding PRP notification; PRPs at sites in moderate income areas are fined significantly more than those at similar sites in low or high income areas; PRPs at sites in suburban areas were fined significantly more than those at similar sites in rural or urban areas; and that sites in minority areas receive significantly more MDEQ enforcement effort than similar sites in white areas, as measured by the negotiation of site cleanup as the result of agency enforcement actions.

Results of Weighted Public Funding Evaluation

To further evaluate the Part 201 program, public funding measures were also

weighted by site score and means were calculated by demographic variables using SPSS®. The results of weighted public funding measure means calculations are summarized in Table 21 below.

Table 21 **Calculation of Weighted Means - MDEQ Public Funding**

Weighted Means	Funds Requested	Funds Spent	Emergency Funds Spent	Funds Recovered
Urban	$2239,083.33	$175,561.67	$24,685.12	$0.00
Suburban	$26,037.89	$7,937.95	$0.00	$0.00
Rural	$77,000.00	$46,898.88	$1,000.00	$3,500.00
Low Income	$238,266.67	$176,168.44	$20,548.33	$2,800.00
Moderate Income	$26,037.89	$7,937.94	$0.00	$0.00
High Income	$3,000.00	$3,000.00	$0.00	$0.00
Minority	$122,028.33	$83,900.62	$10,214.66	$0.00
White	$33,451.54	$23,332.98	$923.08	$1,923.08

The distribution of responses for each weighted public funding variable was examined using SPSS®, and plotted to determine if distribution was normal. The above MDEQ public funding variables were normally or approximately normally distributed.

Public Funds Requested Weighted by Site Score

Table 21 suggests that weighted MDEQ requests for public funding is 88% higher for sites in urban areas than at similar sites in suburban areas, and 65% higher than at similar sites in rural areas. Further, sites in rural areas received 83% more requested funding for site investigation and cleanup than similar sites in suburban areas. According to study results, the MDEQ requested 73% more public funds to address sites in minority areas as compared to similar sites in white areas. Low income area sites were subject to

the highest level of MDEQ site funding. Low income area sites were subject to MDEQ requests for 89% more public funds than similar sites in moderate income areas, and 98% more than similar sites in high income areas. Finally, sites in moderate income areas were subject to 88% more requested funds than similar sites in high income areas.

Weighted Public Funds Spent

Actual mean expenditures of public funds by the MDEQ were also weighted by sites score and statistically analyzed. These results are also summarized in Table 21 above. Similar to the results of analysis of funds requested, it was found that sites in urban areas on average received 95% more public spending than at similar sites in suburban areas, and 73% more than at similar sites in rural areas. Further, sites in rural areas received 83% more public funding than similar sites in suburban areas. These results also indicated that the MDEQ spent 72% more public funds to address sites in minority areas than similar sites in white areas. Lastly, relative percentages of public expenditures at weighted sites were similar to funds requested when compared to income categories. Specifically, low income area study sites received 95% public funds than similar sites in moderate income areas, and 98% more than similar sites in high income areas. Sites in moderate income areas received 62% more public funds than similar sites in high income areas.

MDEQ Emergency Fund Expenditures as Weighted by Site Score

Table 21 also summarizes the results of weighted means calculations for public funds spent by the MDEQ to undertake to emergency response actions including: drum and/or surface removal of hazardous substances; the prevention of human exposure to

toxic materials; the prevention of hazardous material migration into public water supplies and/or sensitive habitats. It was found that 96% more emergency funds were spent at sites in urban study areas as compared to similar sites in rural areas. No emergency funds were spent at sites in suburban areas captured by this study. 91% more emergency funds were spent by the MDEQ at sites in minority areas as compared to similar sites in white areas. This study also did not capture sites with MDEQ emergency fund expenditures in moderate or high income areas.

Public Funds Recovered as Weighted by Site Score

As stated above, results indicated that cost recovery actions were only undertaken in association with public fund expenditures within rural, low income, and white study areas precluding further statistical analyses. This was found despite the fact that public funds were spent in each demographic category.

Statistical Significance of Means Differences within Weighted Public Funding Measures

To assess the statistical significance of the difference in means found, t-Tests of independent-sample means was undertaken for each weighted MDEQ Part 201 public funding measure. Assuming population means are equal within social demographic categories (race/ethnicity, income, and population density), statistical significance from independent t-Tests is used here to determine if variability observed was the result of usual variability of sample means from a single population or indicative of statistically significant difference. Table 22 below summarizes the results of independent sample t-Tests of Part 201 public funding measures by race/ethnicity, income, and population

density as weighted by site score.

Table 22 t-Test for Equality of Weighted Means - MDEQ Public Funding

2-tail Significance	Funds Requested	Funds Spent	Emergency Funds Spent	Funds Recovered
Urban/Suburban	0.221	0.199	0.227	0.432
Urban/Rural	0.476	0.441	0.348	0.350
Suburban/Rural	0.232	0.070	0.227	0.241
Low /High Income	0.262	0.313	0.432	0.478
Moderate/Low Income	0.142	0.150	0.261	0.295
High/Moderate Income	0.468	0.466	0.000	0.504
Minority/White	0.480	0.549	0.549	0.128

Bold numbers and shaded cells are statistically significant. 95% confidence interval. 2-tail significance of <0.05 is considered statistically significant. 2-tail significance results more than 0.05 does not allow the rejection of the null hypothesis that two groups of Part 201 sites come from populations with the same average MDEQ compliance effort.

These results indicate that none of the means differences observed for weighted MDEQ public funding measures were statistically significant. Specifically, the small sample size of Part 201 sites with public fund expenditures, and relatively little variance in observed difference likely resulted in the failure to reject the null hypothesis that observed Part 201 public funding mean values come from a population of all Part 201 sites with the same means.

Part 3: Linear Regression and Correlation of Statistically Significant Measures

Based on the recommendations of previous studies, statistically significant Part 201 compliance, enforcement, and public funding measures, as weighted by site score, were further analyzed using univariate linear regression to determine the direction and

strength of correlation to demographic categories of race/ethnicity, income, and population density.

The weighted number of meetings per year was the only Part 201 compliance measure found to be statistically significant by one-way ANOVA. Specifically, the weighted means difference of the number of meetings per year was found to be significant between low and high income areas. Regarding Part 201 enforcement measures, statistical significance was found in the comparison of the weighted means of: MDEQ notification effort between low and high income areas, and between moderate and low income areas; negotiated penalties between moderate and low income areas; and negotiated penalties between suburban and rural areas.

For binomial or nonparametric weighted enforcement measures, statistical significance was found for penalties levied by population density; PRP notification and penalties levied by income; and MDEQ cleanup negotiation by race/ethnicity. No weighted Part 201 public funding measures were found with statistical significance in any demographic category.

Consequently, statistically significant measures of ordinal, ratio, or interval scales were further analyzed using univariate linear regression to determine the direction and strength of correlation between demographic (independent) and Part 201 MDEQ evaluation (dependent) variables. Statistically significant binomial variables of nominal scale reported as above, were not further analyzed.

For the purposes of linear regression analyses, "R" represents the Pearson correlation coefficient ranging from -1 to +1. A strongly positively correlated outcome

approaches +1, and a strongly negative correlation outcome nears -1. The "R square" represents the percent of observed variability within the dependent variable that is "explained" by the independent variable. The "Multiple of R" indicates how well the regression "fits", as it represents the correlation coefficient between the observed values of the dependent variable and the value predicted by the regression model. The F statistic is the ratio of mean squares that is used to test the null hypothesis that all coefficients are equal to zero, or in other words that the dependent and independent variables are not correlated. If the univariate linear regression coefficient is not zero, the Significance of F, or "overall regression F test", will be less than 0.05 at the 95% confidence interval. The finding of an overall regression F value of <0.05 allows for the rejection of the null, and indicates statistically significant positive or negative linear correlation.

Findings of univariate linear regression are summarized in Table 23 below.

Table 23

Univariate Linear Regression for Statistically Significant Weighted Part 201 Measures

	Meetings/Year by Income	PRP Notifications by Income	Penalties by Income	Penalties by Population Density
Multiple R	0.291	0.354	0.182	0.094
R Square	0.085	0.126	0.033	0.009
F	3.780	5.884	0.755	0.194
Significance of F	0.0582	**0.0198**	0.394	0.664

Bold numbers and shaded cells are statistically significant. 95% confidence interval. Significance of F of <0.05 is considered statistically significant. Significance of F results more than 0.05 does not allow the rejection of the null hypothesis that there is no linear relationship between the independent and dependent variables.

These findings indicate that each of the above Part 201 measures are positively correlated with relevant independent demographic variables. In other words, as the income of the area decreased, MDEQ compliance efforts increased to oversee and foster site cleanup through in-person meetings with PRPs, as did MDEQ enforcement effort to identify and notify PRPs to undertake site investigation and cleanup. But, as area income increased, so did MDEQ negotiated penalties levying against PRPs for violations of Part 201. Similarly, the less rural the area within which a Part 201 site existed, the higher MDEQ levied penalties for Part 201 non-compliance. Further, statistically significant positive correlation exists between the number of notifications of PRPs made by the MDEQ and the income level of the areas within which the site exists. Refer to Figures 2 through 5, pp. 161 through 165 for scatterplots of the linear relationships of these variables. Refer to Appendix D for copies of univariate linear regression analyses for each pair of dependent and independent variables.

Note that the Multiple of R for meetings per year by income and PRP negotiations by income indicate that relatively strong positive linear relationships exist for both Part 201 measures. However, the R square results above indicate that only 8.5% of the variability observed in meetings per year, and 12.6% of PRP notifications, was respectively "explained" by the independent variable of income. Also refer to Figures 2 and 3, pp. 161 and 162 for further description. Further, the positive correlation between penalties by income and penalties by population density are weakly correlated, as indicated in Table 23 above and in Figures 4 and 5, pp. 163 and 164.

Part 4: Multivariate Linear Regression of Statistically Significant Weighted Part 201 Measures

Also based on the recommendations of previous studies, weighted Part 201 compliance, enforcement, and public funding measures statistically significant in more than one demographic category, were further analyzed using multivariate linear regression to determine the strength of correlation and predictability of demographic categories of race/ethnicity, income, and population density. Specifically, the Part 201 enforcement measure of negotiated penalties was found to be statistically significant by income and population density. No other enforcement, compliance, or public funding measures were found to be statistically significant in more than one demographic category.

Consequently, the enforcement measure of negotiated penalties was further analyzed using multivariate linear regression between income and population density to determine their comparative correlative strength and predictability for this dependent variable. The findings of this multivariate linear regression analysis are summarized in Table 24 below.

Table 24

Multivariate Linear Regression for Statistically Significant Weighted Part 201 Measures

	Penalties by Income and Population Density
Multiple R	0.210
R Square	0.044
F	0.484
Significance of F	0.623

Bold numbers and shaded cells are statistically significant. 95% confidence interval. Significance of F of <0.05 is considered statistically significant. Significance of F results more than 0.05 does not allow the rejection of the null hypothesis that there is no linear relationship between the independent and dependent variables.

These findings indicate that penalties levied by the MDEQ is weakly positively correlated with income and population density. In other words, as the income increased and rural character of the area decreased, MDEQ enforcement increased as reflected by the levying of penalties for violation of Part 201. However, these correlations are not statistically significant. Refer to Figure 6, p. 165 for a scatterplot of the linear relationship of these variables, and Appendix D for a copy of multivariate linear regression analyses for weighted negotiated penalties by income and population density.

Note that the R square results for penalties by income and population density indicates that only 4.4% of the observed variability is "'explained" by these two independent variables, and that income was a stronger predictor of penalties than the population density of the area.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

This study examined performance measures to determine the presence and degree of social discrimination, if any, in the implementation and enforcement of Michigan's Part 201 program. As defined in this study, social equity is "the distribution of amenities and disadvantages across individuals and groups"[260] that may result in "the disparate treatment of a group or community based upon race, class .. or some other distinguishing characteristic"[261].

Findings of Compliance Equity Analysis

Regarding the analysis of measures of compliance equity within the Part 201 program as weighted by site score it was found that:

1) Part 201 sites in rural areas received 73 percent faster MDEQ response time than similar sites in suburban areas, and 86 percent faster response time than similar sites in urban areas. White area sites received a 73 percent faster response time

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[260] Zimmerman, Rae, "Issues of Classification in Environmental Equity: How We Manage is How We Measure", *Fordham Urban Law Review*, Vol. 21, 1994, p. 633.

[261] Gelobter, *op. cit.*, p. 9, and Bullard, *op. cit.*

than similar sites in minority areas. And low income areas received 73 percent faster response time than similar sites in moderate income areas, and 90 percent faster response time than similar sites in high income areas. Using an equality means (t-Test) analysis, none of these findings was found to be statistically significant within a 95 percent confidence interval. These findings, while not statistically significant, are generally consistent with a study hypothesis, except that response time at low income area exceeded moderate and high income areas.

2) Part 201 sites in suburban areas received 77 percent more MDEQ compliance inspections per year than similar sites in urban areas, and 74 percent more inspections than similar sites in rural areas. Minority area sites received 24 percent more MDEQ inspection effort than similar sites in white areas. And moderate income area sites received 43 percent more MDEQ annual inspection effort than similar sites in high, and 11 percent more than similar sites in low income areas. Using an equality means (t-Test) analysis, none of these findings was found to be statistically significant within a 95 percent confidence interval. These findings are generally inconsistent with a study hypothesis, except that MDEQ inspections at moderate income area sites slightly exceeded those at similar sites in low income areas.

3) Part 201 sites in rural area sites were brought under control 36 percent sooner than similar sites in urban areas, and 47 percent sooner than similar sites in suburban areas. White area sites were controlled 46 percent sooner than similar sites in minority areas. And low income area sites were brought under control 38 percent

sooner than similar sites in high income areas, and 45 percent sooner than similar sites in low income areas. Using an equality means (t-Test) analysis, none of these findings was found to be statistically significant within a 95 percent confidence interval. These findings are generally consistent with a study hypothesis, except that cleanup pace at low income area sites exceeded those at moderate and high income areas.

4) Part 201 sites in rural areas were subject to 19 percent more meetings between the MDEQ and polluters than at similar sites in suburban, and 44 percent more than at similar sites in urban areas. Sites in white areas were subject to 35 percent more MDEQ oversight meetings than similar sites in minority areas. High income area sites were subject to 62 percent less MDEQ meetings than similar sites in moderate, and 71 percent less meetings than similar sites in low income areas. Using an equality means (t-Test) analysis, the difference in prevalence of oversight meetings between the MDEQ and polluters between low and high income areas was found to be statistically significant within a 95 percent confidence interval. Univariate linear regression indicated a statistically significant correlation between income and meetings per year. As income decreased, MDEQ effort to arrange and attend oversight meetings significantly increased. These findings are generally consistent with a study hypothesis, except that meetings in low income areas exceeded both moderate and high income areas.

5) The cleanup pace at Part 201 sites in rural area sites was 25 percent faster than at

similar sites in urban, and 28 percent faster than at similar sites in suburban areas. The cleanup pace at white area sites was 15 percent faster than at similar sites in minority areas. And the cleanup pace at sites in low income areas was 8 percent faster than similar sites in high, and 18 percent faster than similar sites in moderate income areas. Using an equality means (t-Test) analysis, none of these results was found to be statistically significant within a 95 percent confidence interval. These findings are generally consistent with this study's hypothesis, except that cleanup pace in low income areas slightly exceeded that of both moderate and high income areas.

6) At the time of this study, three percent more Part 201 sites were completed with cleanup in urban areas than at similar sites in suburban areas, and 4 percent more than at similar sites in rural areas. Seventeen percent more white area sites were completed with cleanups than similar sites in minority areas. Two percent more high income sites had finished cleanups than similar sites in moderate income areas, and 5 percent more than similar sites in low income areas. Using an equality means (t-Test) analysis, none of these results was found to be statistically significant within a 95 percent confidence interval.

These results may be a function of the frequency of ground water cleanups (expensive and time consuming) that were required rural sites, and not as likely to be required by the MDEQ at more urbanized sites are more likely to be supplied by municipal water supplies. However, the comparatively few completed cleanups in minority and low income areas, given the success of cleanup in urban

areas, may be a cause for concern by policy makers and the MDEQ.

Findings of Enforcement Equity Analysis

Regarding the analysis of measures of enforcement equity within the Part 201 program as weighted by site score it was found that:

1) Part 201 sites in suburban areas were subject to 11 percent more MDEQ information requests for enforcement than similar sites in rural areas. Low income area sites were subject to 86 percent more MDEQ information requests than similar sites in moderate income areas. Information was not available for urban, minority, white and high income area sites for this measure of MDEQ Part 201 enforcement equity. Using an equality means (t-Test) analysis, none of these findings was found to be statistically significant within a 95 percent confidence interval. These findings were not statistically significant or complete, and are generally inconsistent with a study hypothesis.

2) Part 201 sites in rural areas were subject to 16 percent more MDEQ enforcement effort, as measured by the number of official MDEQ enforcement notifications of polluters, than similar sites in urban areas, and 51 percent more than similar sites in suburban areas. White area sites received 15 percent more MDEQ enforcement notification effort than similar sites in minority areas. And low income area sites received 59 percent more MDEQ enforcement notification effort than similar sites in moderate, and 63 percent more than similar sites in high income areas.

Using an equality means (t-Test) and non-parametric one-way analysis of variance, the differences found between low and high, and between low and

moderate income area sites, were found to be statistically significant within a 95 percent confidence interval. Univariate linear regression analysis of these findings evidenced a positive, statistically significant correlation between enforcement notification and income. Specifically, as income decreased, MDEQ enforcement notification effort significantly increased. These findings are generally consistent with a study hypothesis, except the statistically significant finding of strong MDEQ enforcement notification effort in low income over high and moderate income areas.

3) Parties deemed responsible by the MDEQ for creating Part 201 sites in rural area sites were notified of enforcement actions 34 percent sooner than those responsible for similar sites in suburban areas, and 99 percent sooner than at similar sites in urban areas. Enforcement notifications for polluters at minority area sites were 80 percent quicker than at similar sites in white areas. And polluters at moderate income area sites were notified of MDEQ enforcement actions 65 percent sooner than at similar sites in low, and 99 percent sooner than at similar sites in high income areas. Using an equality means (t-Test) analysis, none of these findings were found to be statistically significant within a 95 percent confidence interval. These findings are, in part, consistent with a study hypothesis. Results indicating more MDEQ enforcement effort at sites in minority over white, and low over high income areas are not consistent with the hypothesis of this study.

4) Part 201 sites in white areas were subject to 4 percent higher enforcement

penalties than similar site in minority areas. Enforcement penalties were 100 percent higher at sites in moderate income areas as compared with low and high income areas. And penalties levied by the MDEQ for sites in suburban areas were 100 percent higher that at sites in urban and rural areas. Insufficient data for income and population density categories precluded complete analysis.

Using an equality means (t-Test) and non-parametric one-way analysis of variance, the difference in penalties found between moderate and low income, and suburban and rural income areas were found to be statistically significant within a 95 percent confidence interval. Univariate linear regression analysis of these findings evidenced a positive, though statistically insignificant, correlation between penalties and income, and penalties and population density. Specifically, as income and population density increased, so did MDEQ negotiated penalties. Multivariate linear regression of penalties by income and population density evidenced a weak, positive correlation. Specifically, as income increased and rural character decreased, penalties levied by the MDEQ increased, though not at a statistically significant level. Finally, income was determined to be a stronger indicator of Part 201 penalties than the population density of an area. These findings are partially consistent with this study's hypothesis.

5) The referral of Part 201 sites by the MDEQ to the AG for enforcement proceedings in suburban areas exceeded that of similar sites in rural areas by 33 percent, and exceeded that at similar sites in urban areas by 38 percent. No difference was found in enforcement referral between white and minority area

sites. Enforcement referral for sites in moderate income areas exceeded those for similar sites in low income areas by 23 percent, and exceeded those at similar sites high income areas by 56 percent. Using an equality means (t-Test) analysis, none of these results was found to be statistically significant within a 95 percent confidence interval. This findings are primarily inconsistent with a study hypothesis.

6) Finally, whether or not site cleanup was required as a part of a court-enforceable settlement agreement between the MDEQ and a polluter was statistically determined to be significantly more likely for Part 201 sites in minority over white areas. Through the use of non-parametric one-way analysis of variance, difference observed within income and population density categories were not determined to be significant. This finding refutes the study hypothesis regarding race/ethnicity and Part 201 enforcement, and neither refutes nor confirms hypotheses regarding income and population density.

Findings of Public Funding Equity Analysis

Regarding the analysis of measures of public funding equity within the Part 201 program as weighted by site score it was found that:

1) Public funds requested by the MDEQ to address orphaned Part 201 sites in urban areas were 88 percent higher than requests for similar sites in suburban, and 65 percent higher than similar sites in rural areas. Seventy-three percent more public funds were requested by the MDEQ to address similar orphaned sites in minority areas over similar sites in white areas. Low income area sites were subject to 89

percent more MDEQ funding requests than similar sites in moderate income areas, and 98 more than similar sites in high income areas. Using an equality means (t-Test) analysis, none of these findings was found to be statistically significant within a 95 percent confidence interval. These findings were not statistically significant and are contrary to a study hypothesis.

2) Public funds spent by the MDEQ to address orphaned Part 201 sites in urban areas were 95 percent higher than funds spent by the MDEQ at similar sites in suburban areas, and 73 percent higher than similar sites in rural areas. Seventy-two percent more public funds were requested to address orphaned sites in minority areas over similar sites in white areas. Low income area sites were subject to 95 percent more MDEQ funding than similar sites in moderate income areas, and 98 more than similar sites in high income areas. Using an equality means (t-Test) analysis, none of these findings was found to be statistically significant within a 95 percent confidence interval. These findings were not statistically significant and are inconsistent with a study hypothesis.

3) Emergency funds spent by the MDEQ to address Part 201 sites posing imminent hazards to human health or the environment in urban areas were 96 percent higher than funds spent at similar sites in rural areas. No emergency funds were spent at suburban sites captured in this study. Ninety-one percent more emergency funds were spent at in minority areas over similar sites in white areas. This study also did not capture sites with emergency expenditures in moderate or high income areas. Using an equality means (t-Test) analysis, none of these findings was

found to be statistically significant within a 95 percent confidence interval. These findings were not statistically significant and are inconsistent with this study's hypothesis.

4) MEDQ efforts to recover costs of public expenditures at orphaned Part 201 sites occurred only at sites within rural, white and low income areas. Using an equality means (t-Test) analysis, these findings were not found to be statistically significant within a 95 percent confidence interval. These findings, while not statistically significant, are partially consistent with a study hypothesis.

CONCLUSIONS

This study hypothesized that measurable and statistically significant difference exists within minority, urban, and/or low income communities in Michigan in the implementation and enforcement of the Part 201 program. Based on these findings, the null hypothesis was not rejected. Specifically, it was found that:

1) Low income is strongly correlated with increased MDEQ compliance effort to foster and oversee site cleanup through frequent face to face meetings.

2) Low income is strongly correlated with increased MDEQ Part 201 enforcement effort to locate and notify PRPs.

3) Higher income was found to be strongly correlated with increased MDEQ penalties levied against PRPs in Part 201 enforcement cases.

4) The more suburbanized an area, the higher penalties imposed upon PRPs by the MDEQ.

5) Sites in minority areas are more likely to be compelled by the MDEQ to be

cleaned up in enforcement negotiations and settlement agreements.

6) Income was a stronger predictor than population density of higher Part 201 penalties in enforcement cases.

INTERPRETATIONS AND IMPRESSIONS

This study hypothesizes that significant bias against poor, minority, and urban areas exists in Michigan's Part 201 program. Due to the relatively few sites undergoing enforcement or subject to public funding in Michigan, this hypothesis is supported only in part by these findings. However, several implications regarding the implementation of the Part 201 program extend from these results. Major program and/or policy implications include:

1) Missing site files, over 8 percent of those requested, only existed for sites within minority areas. This finding could be interpreted critically by those seeking to monitor and/or participate in the cleanup of sites of environmental contamination in these areas. The MDEQ should take special care to maintain the public record for sites of environmental contamination, and forgo any perception of bias in doing so.

2) The MDEQ should collect, evaluate and report the social impact of their implementation of "socially-blind" environmental and human health protection programs, such as the Part 201 Environmental Response Program. If inequity is found, that policy reform should be undertaken in the light of day to address it. To date, the MDEQ does not track, let alone evaluate, program performance measures regarding "Where" and "For whom" it is spending its compliance,

enforcement, and public funding effort under this program.

3) Very little research has been previously undertaken regarding the social equity of environmental and human health protection programs, state or federal. Previous research has been openly or allegedly politically motivated[262]. Some past research has been undertaken by opposing sides in "NIMBY" debates or commissioned for use in site-specific litigation. It is important to begin to develop and refine this area of study to consider potential social inequity in program implementation. Such research if done by implementing agencies, should be guided by and/or open to public evaluation and participation. Although not required currently by Michigan's Part 201, enhanced opportunities for public participation in overall site cleanup is an important first step to enhancing sustainable community development and the reuse of contaminated or potentially contaminated facilities.

4) Research and public debate regarding environmental justice issues generally should be widened to consider social equity in terms of income, gender, age, inter-generational equity, and other forms of social difference. Current debate and research is dominated by issues of race, and fails to consider the interbedded nature of social oppression. A good start may be made by shifting the focus public environmental policy to the most vulnerable segments of the population in determining public policy issues of "acceptable risk" or "safe levels".

5) As suggested by these findings, it is important to insure MDEQ compliance effort

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[262] See Zax, *op. cit.* and Goldman, *op. cit.*, 1992.

is effective and equitable in minority areas. Concern is raised by the finding that cleanup in minority areas was significantly associated with MDEQ enforcement effort, as relatively little enforcement is undertaken within the universe of Part 201 sites. These findings suggest potential bias against the effective and efficient cleanup at sites in minority areas.

RECOMMENDATIONS FOR FURTHER RESEARCH

State and federal environmental and human health agencies have been criticized for disassociating themselves from the structural and social contexts within which they exist, and for approaching environmental protection in a socially-neutral manner. Agencies have also been criticized for implementing compliance and enforcement programs without any "appreciation, or acknowledgment, of the social context and structural dynamics that influence choices, mobility, and employment of people of color"[263].

To most accurately assess the social equity of the implementation of governmental programs, it is critical that a wide variety of performance measures be operationalized and analyzed using multiple statistical methods. Further, based upon the findings of relevant performance measures, an overall assessment of an environmental program of interest should be undertaken. The presence of one or more measures of inequity, while perhaps not representing institutionalized discrimination, may be sufficient for the public to request and guide governmental reform. However, the degree

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[263] Foster, *op. cit.*, pp. 729, and 736-737. Also see Hurley, *op. cit.*

of discrimination, if found, that is "acceptable" is as much a public policy decision as the degree of risk deemed acceptable from the public's environmental exposure to hazardous materials.

Based on this and previous research, it is recommended that future research consider the following:

1) Sample size of similar studies must be sufficiently large to capture meaningful variation within the population of cases subject to a governmental environmental protection program. This study may have failed to support its hypothesis, especially concerning MDEQ enforcement and public funding measures, due the relatively small sample size. On the other hand, relatively few Part 201 sites are subject to MDEQ enforcement or the recipient of public funding to address hazardous waste contamination.

2) Based upon the lack of agreement within the literature, it is important to undertake analyses using both zip code, census track and other geographic units of analysis to represent the "affected community" or neighborhood. Once meaningful comparative study has been undertaken, this methodological problem thus far vexing environment equity studies may finally be resolved.

3) It is important to search for more informed and meaningful demographic measures of race/ethnicity, income, and population. In an attempt to do so, it is recommended that previous national or statewide study be replicated using several geographic units of analysis and additional study be undertaken within specific communities. This local focus may better capture significant social difference

potentially masked at the state or national level, and lend more meaning and relevance to findings regarding environmental program implementation by various levels of government within the U.S.

4) More qualitative, community-led research should be undertaken regarding environmental justice. Community perceptions of the location and meaning of environmental risk are not well understood.

5) Further research should attempt to move to a more nuanced understanding of environmental discrimination, its many forms, and how it is produced and reproduced. Such research should include more radical social analyses of how to enhance democratic participation and self-determination in public policy decisions with deleterious environmental consequences. Further research should include consideration of how to dramatically limit and eventually eliminate exposure to toxins for all, rather than the equitable distribution of risk and/or harm.[264]

6) A paradigmatic shift is needed from spatial, locational equity empiricism to the processes that create inequity in which unjust outcomes are imbedded.[265] As stated by Lake (1996), "focus (should be) on the structure of production and ..the ways in which communities are linked (or not linked) to ...decisions (through which negative environmental consequences are created) and to the process of

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[264] Pulido, *op. cit.*, p. 143; Swanson, *op. cit.*, p. 602; Michael K. Heiman, "Race, Waste And Class: New Perspectives On Environmental Justice", *Antipode*, Vol. 28, No. 2, 1996, pp. 113-114; and Robert Lake, "Volunteers, NIMBYs, And Environmental Justice: Dilemmas Of Democratic Practice, *Antipode*, Vol. 28, No. 2, 1996, p. 162.

[265] Lake, *op. cit.*, p. 170.

uneven development".[266]

7) More study should be done such the *National Law Journal* 1992 report and this research, to focus on equity within the implementation of environmental protection programs.[267] The literature should seek to mature from the plethora of hazard or risk proximity studies that exist vexed by methodological shortcomings to the analyses of program implementation and their consequences.

8) Future research should seek to reflect a broader conceptualization of environmental justice beyond the "chicken and egg"debate of which came first, social or environmental decay in urban cores. The focus should shift to exploring and testing ways in which to improve the overall situation.

9) As common in all other developed economies, the MDEQ and other U.S. environmental regulatory agencies, should discard the "socially-blind" approach to policy and program implementation, and begin to collect and analyze demographic information to augment the monitoring of the efficiency and social efficacy of programs.

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[266] *Ibid.*

[267] Lavelle and Coyle, *op. cit.*, and Goldman, *op. cit.*, 1996, pp. 132, 138.

FIGURES

Figure 1

Part 201 Process

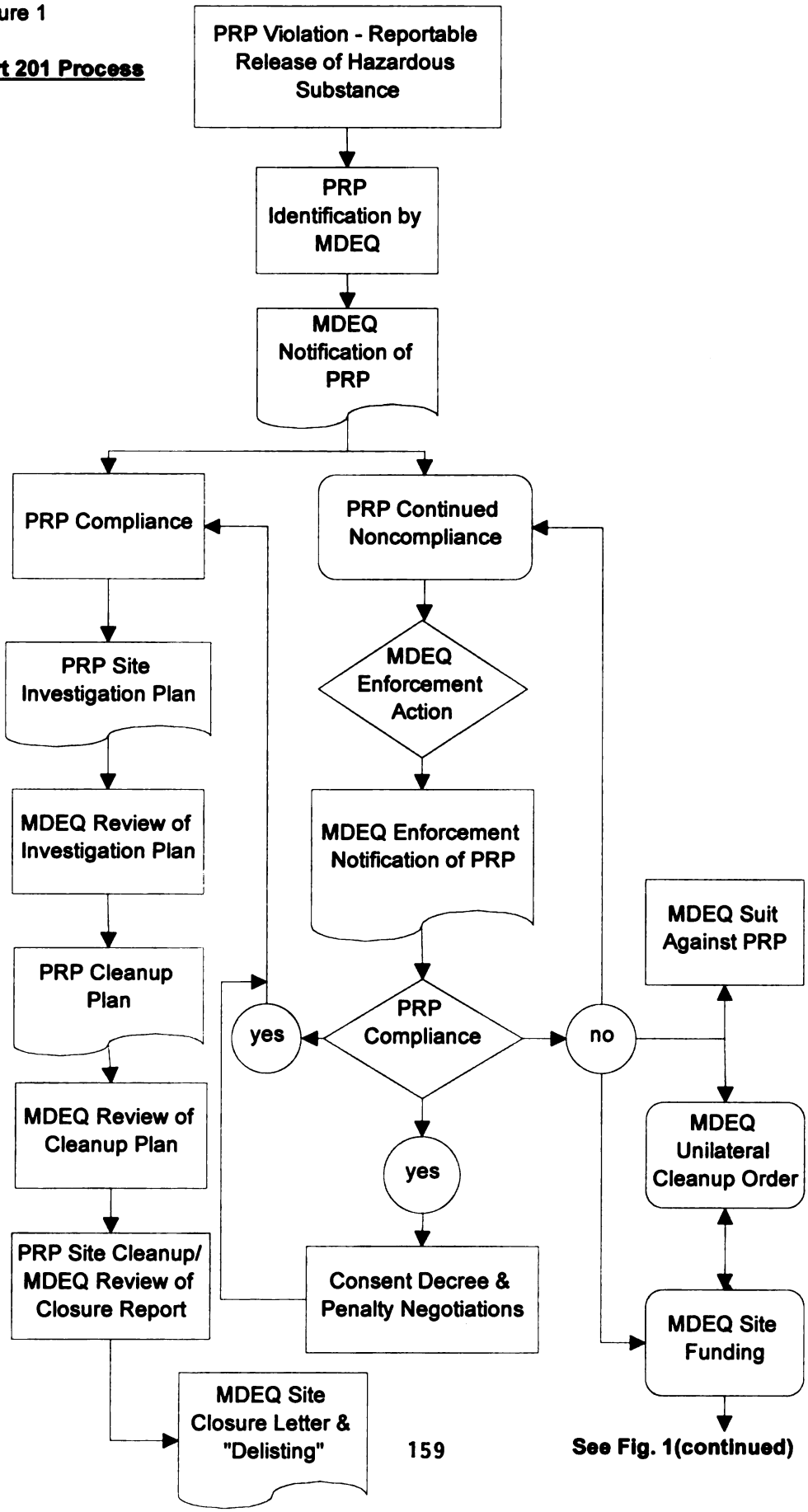
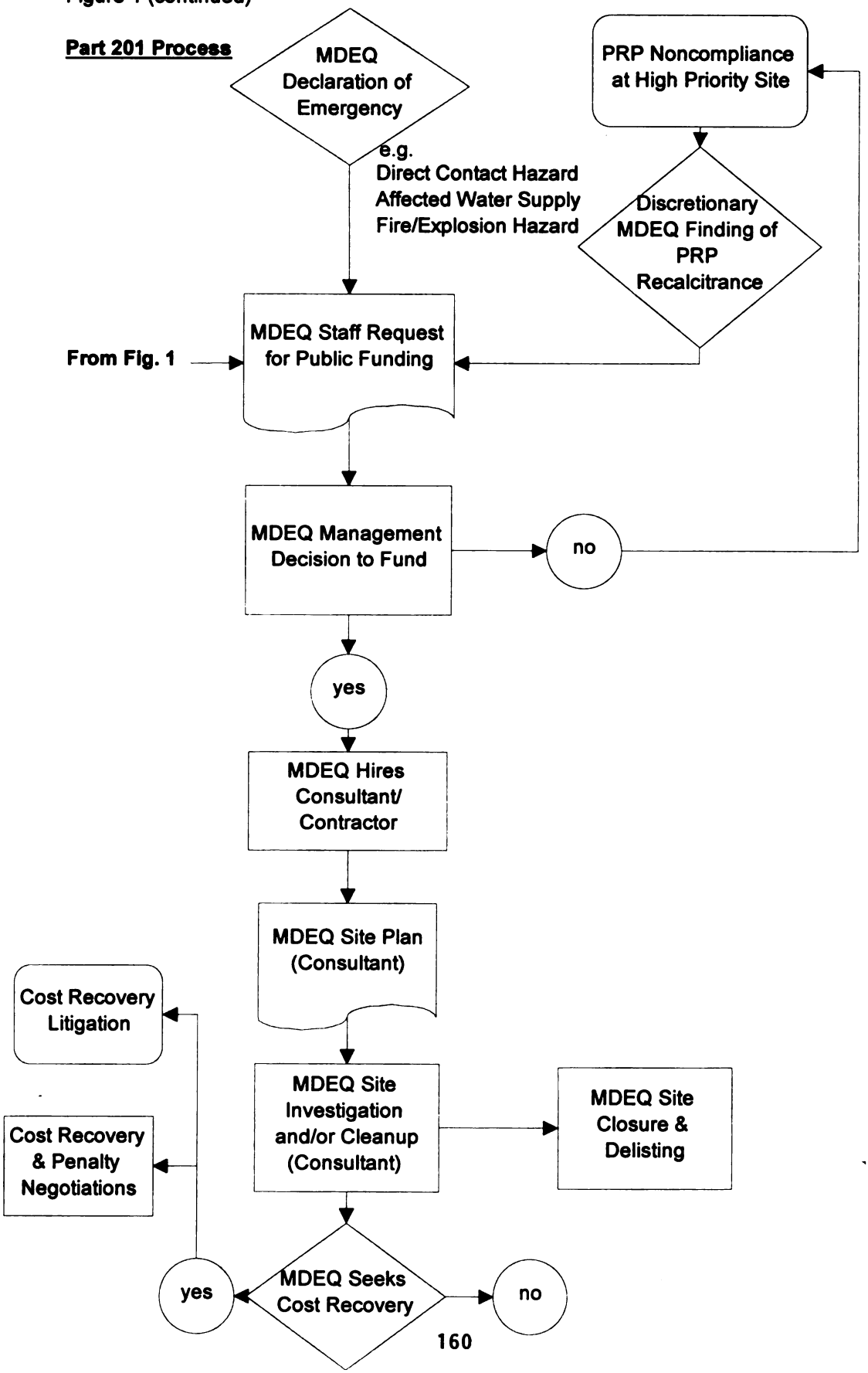


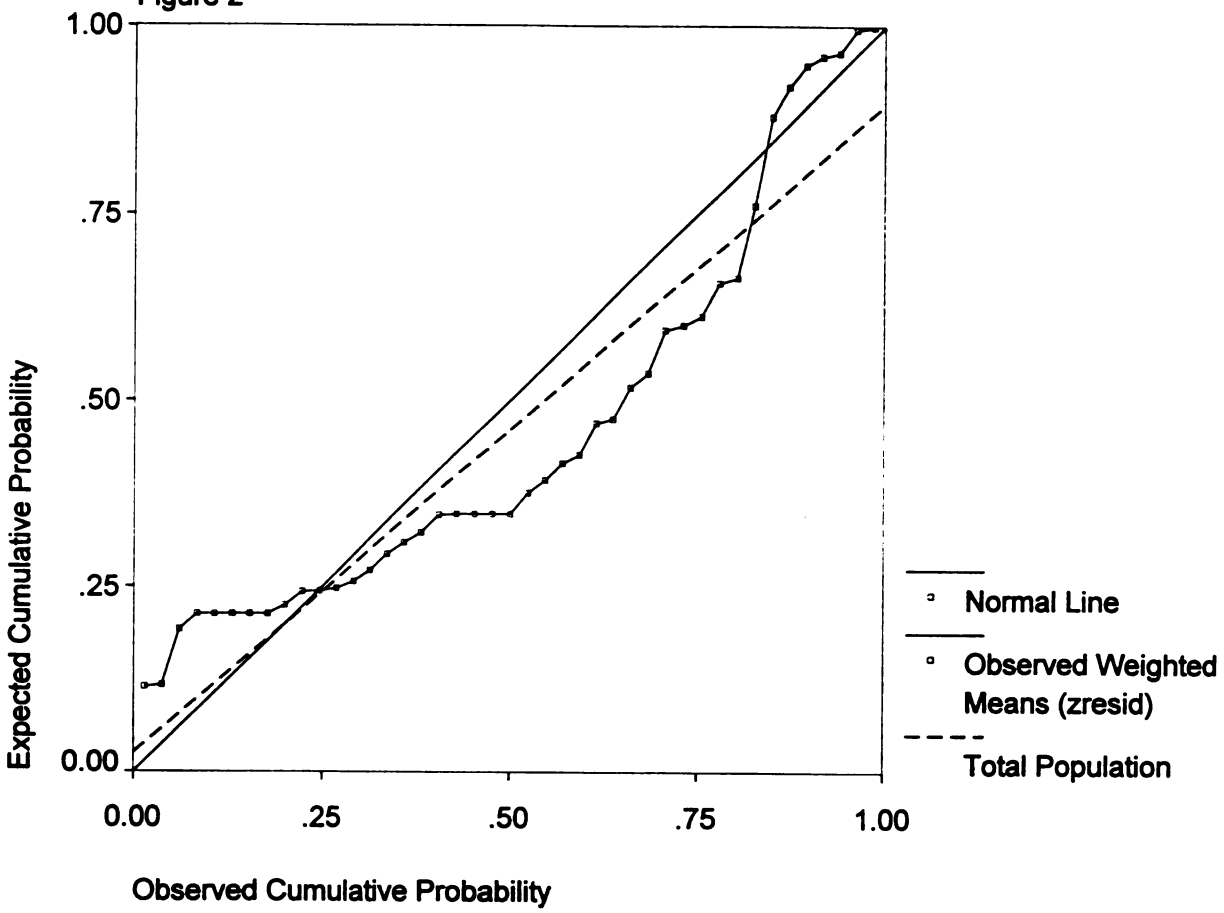
Figure 1 (continued)



Normal P-P Plot of Regression Standardized Residual

Meetings/Year by Income

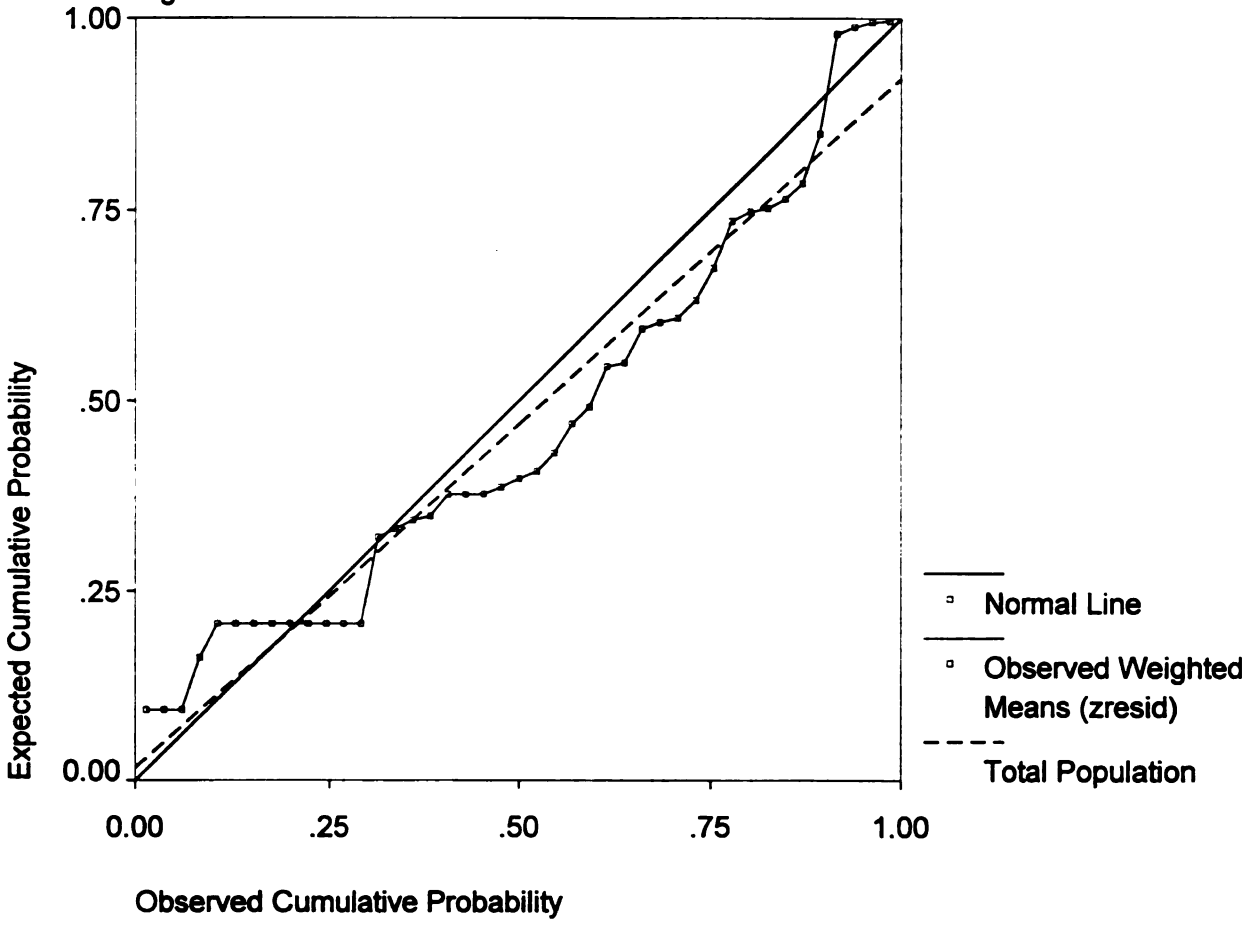
Figure 2



Normal P-P Plot of Regression Standardized Residual

PRP Notifications by Income

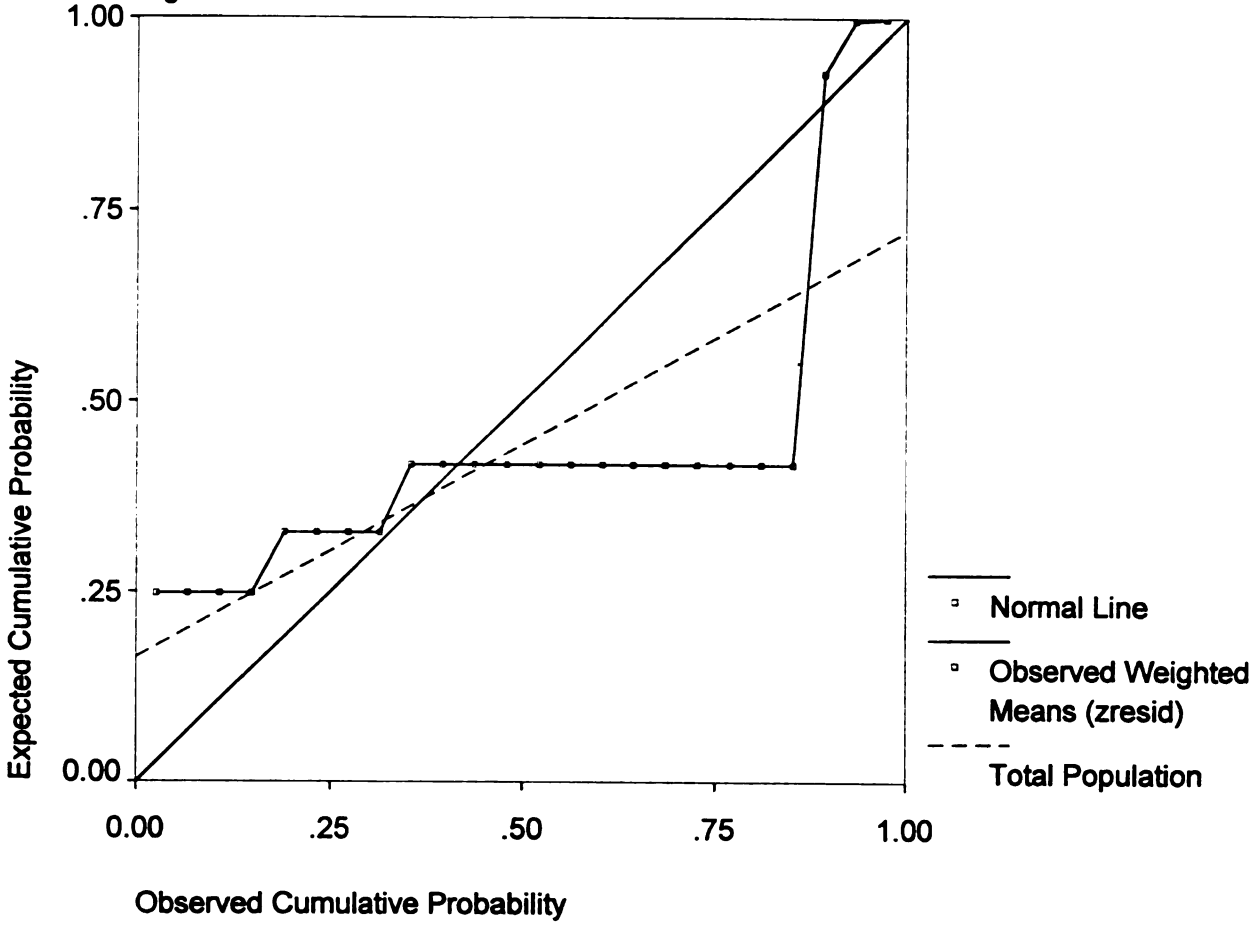
Figure 3



Normal P-P Plot of Regression Standardized Residual

Enforcement Penalties by Income

Figure 4



APPENDICES

APPENDIX A

Data Collection Sheet

Site Name:_____ MDEQ District:_____
Site Number:_____ Date:_____

Compliance:

_____ C1 - number of days (discovery to response)
_____ C2 - inspections per year (after discovery)
_____ C3 - meetings per year (MDEQ & PRP)
_____ C4 - number of months to control
_____ C5 - number of months to cleanup

Enforcement:

_____ E1 - number of information requests
_____ E1d - date of information request (earliest)
_____ E1d2- date of information request (latest)
_____ E2 - number of notice letters (Part 201)
_____ E2d - date of notice letter (earliest)
_____ E2d2- date of notice letter (latest)
_____ E3 - number of enforcement referral(s)
_____ E3d - date of enforcement referral(s)
_____ E3d2- date of enforcement referral(s)
_____ E4 - number of months (referral to start to negotiate)
_____ E5 - number of months (conclude settlement)
_____ E6 - amount of financial settlement
_____ E7 - date of lawsuit (earliest)
_____ E8 - date of lawsuit (finish)
_____ E9 - financial penalties (lawsuit)

Funding:

_____ F1 - funds ($) requested
_____ F2 - funds ($) spent
_____ F3 - funds ($) cost recovered
_____ F4 - emergency funds ($) spent
_____ F5 - number of private dollars spent

APPENDIX B

List of Variables

Variable Name	Label	Type	Width (decimal)
SITEID#	MERA#	String	8
SITENAME	NAME	String	20
SCORE	Site List Score	Numeric	2(0)
SCORERAT	Site Score Ratio	Numeric	4(2)
COUNTY	County	String	18
ZIP	Zip Code	Numeric	5
INCOME	Income	String	12
INCODE	Income Code	Numeric	1(0)

Value Label
1 Low
2 Moderate
3 High

RACE	Race	String	12
RCODE	Race Code	Numeric	1(0)

Value Label
1 Minority
2 White

DENSITY	Density	String	8
DCODE	Density Code	Numeric	1(0)

Value Label
1 Urban
2 Suburban

3 Rural

DISCOVER	Discovery Date	Date	8
C1	# Days Response	Numeric	8(0)
LOGC1	Log # Days Rep	Numeric	8(2)
C2	#Inspections/Year	Numeric	8(4)
C3	#Meetings/Year	Numeric	8(4)
FIRSTMTG	First Mtg	Date	8
C4	#Months to Control	Numeric	8(0)
C5	#Months to Cleanup	Numeric	8(0)
C6	Ongoing	Numeric	1(0)

Value	Label
0	Cleanup done
1	Cleanup ongoing

E1	Information requests	Numeric	1(0)
E1D	Info Request Date	Date	8
E1D2	2nd Info Request	Date	8
E2	#Enf Notices	Numeric	2(0)
NOTDAYS#	#Days Until Notice	Numeric	6(0)
LOGNOT#D	Log #Days to Notify	Numeric	8(2)
E2D	Enforce Notice Date	Date	8
E2D2	2nd Notice Date	Date	8
E3	#Enforce Referral	Numeric	1(0)
E3D	Enf Referral Date	Date	8

E3D2	Last Enf Notice	Date	8
E4	Enf Start Date Date		8
E5	Enf Complete Date	Date	8
E6	Enf Settlement	Dollar	15(2)
INJUNC	Injunctive Relief	Numeric	1(0)

Value	Label
0	No
1	Yes

E7	Litigation Start	Date	8
E8	Done Litigation	Date	8
E9	Penalties	Dollars	15(2)
F1	Funds Requested	Dollars	15(2)
F2	Funds Spent	Dollars	15(2)
F3	Cost Recovery	Dollars	15(2)
F4	Emergency Funds	Dollars	15(2)
DISTRICT	MDEQ District	String	20
STAFF#	1990 #Staff	Numeric	2(0)
DISTANCE	Distance (Miles)	Numeric	3(0)

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