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ENVIRONMENTAL INEQUALITY AND BROWNFIELD  
REDEVELOPMENT IN METRO DETROIT

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**ENVIRONMENTAL INEQUALITY AND BROWNFIELD  
REDEVELOPMENT IN METRO DETROIT**

**By**

**Beth Dieleman Dykstra**

**A THESIS**

**Submitted to  
Michigan State University  
In partial fulfillment of the requirements  
For the degree of**

**MASTER OF ARTS**

**Departments of Geography and Urban Affairs**

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## **ABSTRACT**

### **ENVIRONMENTAL INEQUALITY AND BROWNFIELD REDEVELOPMENT IN METRO DETROIT**

**By**

**Beth Dieleman Dykstra**

This study examines the demographics of brownfield communities in Metro Detroit to determine whether disadvantaged groups are more likely to live in close proximity to these brownfields. The findings are compared to the demographics of communities where state funded brownfield redevelopment is occurring to determine whether redevelopment is equitably distributed. Data were obtained from the 1990 and 2000 Census of Population and Housing to assess demographic characteristics. Data on brownfields were obtained from Michigan's Department of Environmental Quality. Difference of means tests are used to measure significance in demographic differences between communities with varying numbers of brownfields. The Index of Dissimilarity is used to determine whether the distribution of various population groups is similar to the distribution of brownfields. The results show poorer communities with lower housing values, rents, owner or occupied housing are more likely to have brownfields. Analysis of state redevelopment efforts show that for most communities, state brownfield redevelopment efforts have occurred in communities in greatest need of economic redevelopment and revitalization.

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## **I. Introduction**

Most central cities in the United States experienced a prolonged period of disinvestment and out-migration of population and economic activity in the latter half of the twentieth century. Since then, efforts to redevelop the central city have largely been ineffective. One explanation for failed efforts to revitalize them is that industrial restructuring has eroded the economic base of central cities, eliminated manufacturing jobs, and left vacant industrial properties called brownfields (Leigh and Gradeck 1996). Brownfields are “abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination” (EPA 2000). Earlier decades of industry and manufacturing have left many brownfield properties environmentally degraded; contaminated with heavy metals, organic and inorganic chemicals, and petroleum constituents; and littered with dilapidated buildings and debris (EPA 2000). Environmental contamination is a negative neighborhood externality and a source of real or perceived health risks, lowers property values, and acts as a force in widening inequalities between central cities and the rest of the nation (Leigh and Gradeck 1996).

Two recent responses to the problem of brownfields are distinct, but not necessarily opposed. The first is to view them as opportunities for economic development. In this strategy, both the removal of site contamination and the potential use of the cleaned site are considered (Hula 2001). The second response is concern for environmental justice as many brownfield sites are located in poor and minority communities (EPA 2000). Environmental justice advocates seek to “develop a paradigm to achieve socially equitable, environmentally healthy, economically secure,

psychologically vital, spiritually whole, and ecologically sustainable communities” (NEJAC 1996). They argue that brownfield redevelopment must be linked with the values of environmental justice to address the needs and concerns of all, particularly minorities and the poor, exposed to brownfield risks.

Many states, including Michigan, have created brownfield redevelopment programs aimed at cleaning up contamination while spurring economic growth (Baumer et al 1999). However, according to Leigh (2000), “the current practice of many brownfield redevelopment projects is to select only the most marketable sites for remediation and redevelopment”. This practice “excludes disadvantaged neighborhoods from programs aimed at redeveloping brownfields. Doing so creates the potential for widening existing inequalities between better-off and worse-off neighborhoods.”

Though Leigh may be correct in her assertions, a focus on economic development means that brownfield efforts are more likely to be integrated into state and community planning where additional concerns, including environmental justice, can be considered. The National Governors Association (2000) brief on brownfields showed states how they can make brownfield redevelopment a key component in their state growth management initiatives. They argue that brownfield urban redevelopment projects “help preserve farmland, rural communities, and open spaces.” In addition, the focus on economic development has encouraged support for brownfield redevelopment from diverse interest groups. In Michigan, the state manufacturers association, state and local chambers of commerce, local political leaders, community groups, and the rural community show strong support for Michigan’s brownfield development plan, called the Michigan Brownfield Initiative (Hula 2000).

## **II. Significance of the Research**

The estimated 450,000 brownfields in the United States affect both individuals and communities. If contaminated, these sites can pose health risks to those working or living nearby. Before any site became a brownfield, there was a viable industry that provided jobs for community members and contributed to the community's identity. The industry may have played an active role in the community through support of parks, recreation, schools, and cultural programs. When the business closed and abandoned the site, they became blights on the communities they once supported (Gist 1999).

Brownfields found in environmentally or economically distressed urban areas compound problems the community is already experiencing, such as crime or a decline in business. The negative effects of brownfields on individuals and communities raise serious questions regarding whether any part of the population is more likely to live in close proximity to brownfields.

Brownfield redevelopment provides benefits to individuals and communities. Public health and safety concerns are addressed since the presence and extent of contamination is identified. That contamination is removed or capped to prevent exposure. The surrounding community benefits from increased property values and a renewed tax base. Brownfield redevelopment removes blight, contributing to an improved community image. Brownfield redevelopment efforts reduce the development of greenfields, farmland, and open space, preventing the loss of diversity, habitat, and wetlands. When businesses locate on brownfields they can use existing infrastructure and public services. Such redevelopment can correct inequities between central cities



and the suburbs. Since brownfield redevelopment provides so many benefits, it is important to know whether such efforts are equitably distributed.

This study determines the extent to which certain populations groups are exposed to brownfields in Metro Detroit. The study also determines whether the State of Michigan is addressing any inequalities in exposure through brownfield redevelopment projects. Lastly, this research provides a model the MDEQ can use to continually monitor the demographics of communities where brownfields in the state are located and the demographics of communities where they fund brownfield redevelopment. Such knowledge would provide an additional factor to consider when evaluating potential redevelopment projects, putting the state at the forefront of linking the values of economic development with environmental justice.

### **III. Background to the Research Questions**

In 1999, the Anderson Economic Group examined the demographics of Michigan's urban brownfield communities to determine whether minorities or the poor were more likely to live in communities with brownfields. They defined brownfields as "contaminated, or potentially contaminated, properties" (1999:2) as a result of historic industrial activity. They identified all cities within Michigan that had brownfield authorities or were included in larger brownfield authorities. They then aggregated and analyzed the demographic characteristics of those cities and compared them to the characteristics of the state. Their findings indicated that a slightly larger percentage of the non-white population lives in brownfield authority areas compared to the state as a whole. They also found that medium household income in brownfield cities is less than that for the state (Anderson and Clemens 1999).

The Anderson Economic Group study is the only one of its kind for Michigan. Since the study only looks at environmental inequality at the scale of the city, there is need for further analysis at a finer scale to obtain more in depth information. At the city scale, the study was not able to show who is living in closest proximity to the brownfields within the city. Such knowledge would give a clearer idea of the extent to which minorities and the poor may or may not be disproportionately exposed to the negative effects of brownfields. No studies have attempted to analyze Michigan's brownfield redevelopment efforts. Such a study would provide insight into whether Michigan's goal of economic development through brownfield redevelopment also addresses environmental justice concerns.

#### **IV. The Research Questions**

Given the need for further study, my research will answer the following questions:

- 1) Is there a relationship between the spatial distribution of brownfields and the demographic and socioeconomic characteristics of neighborhoods? Specifically, is there a difference between the racial, economic, and housing characteristics of communities with and without brownfields. Also, is the percentage of minorities in a neighborhood positively related to the percentage of brownfields in a neighborhood? Is the percentage of low-income residents in a neighborhood positively related to the percentage of brownfields in the neighborhood? Is the average home value and monthly rent, percentage of occupied housing, and percentage of owner occupied housing related to the percentage of brownfields in the neighborhood?**
- 2) What are the demographics of communities where the state has invested in redevelopment? Are investments directed to neighborhoods that are already “better off”, essentially ignoring environmental justice concerns, or, are the projects specifically targeted to disadvantaged neighborhoods (i.e., those occupied by a higher percentage of racial minorities and the poor)? Does the distribution fall somewhere in between?**

## **V. Literature Review:**

### *A. Clarifying the terms*

Most research designed to determine whether some socioeconomic or racial groups are more likely to be exposed to the negative effects of pollutants does not distinguish between the terms “environmental racism” and “environmental justice”. Even less research uses or defines the terms “environmental equity” and “environmental inequality”. It is important to define these terms to ensure a consistent understanding of them.

The United States Environmental Protection Agency (2003) defines environmental justice as “the fair distribution of environmental risks across socioeconomic and racial groups” and “the fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population should be forced to shoulder a disproportionate share of exposure to the negative effects of pollution due to lack of political or economic strength”.

Bryant expands the definition to include “cultural norms and values, rules, regulations, behaviors, policies, and decisions to support sustainable communities, where people can interact with confidence that their environment is safe, nurturing, and productive” (Bryant 1995:6). According to environmental justice values, communities and populations that experience unequal exposure to any environmental hazard are suffering from an environmental injustice that should be removed. Specific examples of these environmental injustices include environmental racism and environmental inequality.

Environmental racism—unequal and deliberate exposure to toxic and hazardous waste on people of color—emerged in the 1980s as a framework to understand how environmental risks, known or potential, are distributed differently across demographic groups. Since 1983, many studies designed to detect environmental racism have analyzed the demographics of communities surrounding solid waste sites (dumps and landfills) and hazardous waste sites (facilities that transport, store, and dispose of hazardous industrial wastes) to determine whether such sites are more likely to be placed in poor and minority neighborhoods. A common assumption of this research is these communities were deliberately targeted for least desirable land uses.

A number of academics and organizations have begun challenging both the idea and existence of environmental racism (Anderton et al. 1994; Anderson et al. 1999). Their challenge is based on various studies that have found income, not race, to be the variable most highly correlated to the location of waste facilities. Since intentional placement is an important component of environmental racism, other studies have discredited the existence of environmental racism by focusing on what came first, the non-white population or the hazard (Been 1993; Hurley 1997; Cutter 1995). Bullard has consistently stressed that this debate is irrelevant (1994) since the end result is a discriminatory pattern (Pulido 1996). As a result, researchers concerned with discriminatory patterns have begun to change the focus from environmental racism to environmental inequality.

“Environmental inequality” expands on environmental racism to include any form of environmental hazard that burdens one social group more than another (Pellow 2000). While environmental racism focuses on the intentional placement of hazardous sites in

poor and minority communities, environmental inequality focuses on the broader dimensions of the intersection between environmental quality and social hierarchies. It addresses structural questions that focus on social inequality (the unequal distribution of power and resources in society) and environmental burdens. Environmental inequality research is interested in both the descriptive (whether injustices exist) and process (how those injustices came to be).

One complex process that results in inequalities is white privilege. Pulido (2000) argues:

“...a focus on white privilege enables us to develop a more structural, less conscious, and more deeply historicized understanding of racism. It differs from a hostile, individual, discriminatory act, in that it refers to the privileges and benefits that accrue to white people by virtue of their whiteness... Hence, instead of asking if an incinerator was placed in a Latino community because the owner was prejudiced, I ask, why is it that whites are not comparably burdened with pollution? ...Industrialization, decentralization, and residential segregation are keys to this puzzle. Because industrial land use is highly correlated with pollution concentrations and people of color, the crucial question becomes, how did whites distance themselves from both industrial pollution and nonwhites? ...White privilege allows us to see how environmental racism has been produced—not only by consciously targeting people of color (as in the incinerator cases)—but by the larger processes of urban development, including white flight, in which whites have sought to fully exploit the benefits of their whiteness.” (Pulido 2000).

Throughout this study, I use the term environmental justice as a broad term to describe the values that motivate research that measures unequal exposure to any environmental hazards. I use the term environmental inequality in my analysis of the demographics of brownfield communities in Metro Detroit. Lastly, this study measures “environmental equity”, equal protection of communities through environmental laws (Bryant 1995), by looking at the distribution of government funded brownfield redevelopment.

## *B. Environmental Justice Studies*

### *1. The Three Key Studies*

The first major study of community demographics near facilities for treatment, storage, and disposal of hazardous wastes was conducted by the U.S. Government Accounting Office (GAO 1983). The objective of this study “was to determine the correlation between the location of hazardous waste landfills and the racial and economic status of surrounding communities” (GAO 1983:2). Researchers compiled population data for census areas surrounding four hazardous waste facilities in EPA region IV (the Southeastern states). The GAO concluded that the majority of the population surrounding three of the four facilities was black (GAO 1983).

In 1987, the United Church of Christ Commission for Racial Justice published a report documenting racial and socio-economic characteristics of communities throughout the United States with commercial hazardous waste sites and uncontrolled toxic waste sites. They studied the demographic characteristics of zip code areas containing one or more of these sites. They found that race proved to be the factor most significantly correlated to the location of commercial hazardous waste facilities. Socio-economic

status was less correlated to the location of waste facilities, though incomes and home values were substantially lower in communities with commercial facilities than those without. They also found that the majority of Black and Hispanic Americans live in communities with uncontrolled toxic waste sites (1987).

A third classic study (Bullard 1990) analyzed the demographics of the census tracts that made up the 25 neighborhoods where various types of solid waste facilities were found. While neighborhoods with majority Black residents compose just over one-fourth of the city's population, 21 out of 25 of those facilities were found in these neighborhoods. Bullard's work has been monumental in that he was the first to really examine why such inequalities were occurring. His research has consistently explored the thesis that "black communities, because of their economic and political vulnerability, have been routinely targeted for the siting of noxious facilities, locally unwanted land uses, and environmental hazards" (Bullard 1990:14).

## *2. Michigan Research*

In Michigan, Mohai and Bryant (1992) assessed racial biases in distribution of commercial hazardous waste facilities within three counties surrounding the city of Detroit. They used a mail survey to obtain racial and economic data for 793 individuals. From this survey, the authors compiled the population composition within various distances of the hazardous waste facilities. Descriptive analysis found that only 3% of all whites in the three-county area lived within one mile of a facility compared with 11% of the minority population. They used multiple regression analysis with the distance of the resident to the facility as the dependent variable and race and income of the resident as the independent variables. Their analysis showed "the relationship between race and



location of commercial hazardous waste facilities in the Detroit area is independent of income” and that “race is more importantly related to the distribution of these hazards than income” (Mohai and Bryant 1992:174).

### 3. *Research on Brownfields*

A few studies have looked at the demographics of brownfield communities. Leigh and Gradeck (1996) compared the means of demographic characteristics of census tracts with varying numbers of environmentally suspect and delinquent sites in Milwaukee. They found that blacks were more likely to live in tracts containing three or more such sites than whites. As the number of sites per tract rose, so too did the tract’s percentage of black population. They also found the economic status of the population in the areas most plagued by such property was lower than that of the population of tracts with few environmentally suspect and tax-delinquent sites. As the number of sites per tract increased, median household income decreased. Education levels were lower in tracts with more potentially contaminated properties. These tracts also had higher unemployment rates and lower labor force participation rates (Leigh and Gradeck 1996).

Andrew Hurley’s (1997) historical study of the abandoned Wagner Electric Company site Wellston, Missouri, a neighborhood of St. Louis, supports the view that the role of race in skewing environmental experience is far more complicated than is usually acknowledged. His case study shows that “historic causes have more to do with deep-seated structural inequalities than with overt racial discrimination in either the siting or remediation process.” He found that real estate dynamics rather than discriminatory siting decisions were largely responsible for bringing minority populations into this brownfield community. The result was that 96.7% of the population in Wellston was

African American by 1990. Political disempowerment further sustained environmental inequality.

#### *4. Research on Scale*

One important methodological consideration increasingly being addressed in research on environmental justice is the appropriate scale or geographic unit of analysis to be studied. Several studies have found that different size units produce different results for the same area. Anderton and others (1994) compared analyses of data aggregated to the zip code level with results of aggregating to the census tract level. Disproportionate exposure depended on how the areas were defined. In 1995, Bowen and others analyzed toxic release amounts with both counties and census tracts as the unit of analysis for Ohio and Cuyahoga County (Cleveland) respectively. When the entire state was studied, the correlation between minority concentration and toxic release amounts was high, largely because industry, minority populations, and toxic releases are concentrated in urban areas. When they studied Cleveland alone at the census tract level, they found that toxic industrial facilities were more likely to be located in poorer and less affluent areas than in areas with minority concentrations.

In the Cleveland study Bowen and others argue “smaller units of spatial aggregation are more satisfying because they require more modest assumptions about causal and statistical variations in local phenomena. Also these units tend to reduce information loss regarding locational differences.” Larger units, such as counties dwarf the size of what is being studied. In Bowen’s 2002 analysis of environmental justice research he argues that studies should use geographical units of analysis that capture the underlying spatial process involved in exposure. He found that studies that relied on

aggregate data to zip codes or counties did not capture the processes of interest. Studies that focused on the census tract level were more appropriate. Monmonier (1994) also argues that census tract areas are more appropriate than zip code analysis for analysis of commercial transfer, storage, and disposal facilities.

## **VI. Federal and State Brownfield Redevelopment Policy: Economic Development, Environmental Justice, or Both?**

The Environmental Protection Agency (EPA) is the federal agency that is primarily concerned with brownfield redevelopment. In 1994, the agency developed an Environmental Justice Strategy in response to concern that minority populations and/or low-income populations bear a disproportionate amount of adverse health and environmental effects from brownfields. In this strategy they have conducted environmental risk studies in communities where there are environmental justice concerns and use GIS to identify geographic areas where sources of pollution appear to have a disproportionate effect on minority, low-income, and educationally disadvantaged populations. They co-sponsored a series of public dialogues on issues of urban revitalization and strategies to create healthy and sustainable communities. They are examining economic redevelopment opportunities to ensure that they complement environmental justice. They are developing methods to expand public involvement in siting and permitting (EPA 1996). Though the EPA is committed to environmental justice in theory, the decision to invest in brownfield cleanup is driven by the economic potential of the site, not the level of on-site contamination or the demographics of the surrounding community (Hula 1999).

The EPA does not have authority to finance redevelopment of non-Superfund brownfields and has allowed state authorities to take a leading role in redevelopment efforts. The state of Michigan has implemented a comprehensive state-level program to encourage brownfield redevelopment run by the Michigan Department of Environmental Quality (MDEQ). The primary focus is economic development. The MDEQ encourages

redevelopment by protecting buyers from liability for the cleanup and remediation costs of previous contamination. They have created flexible cleanup standards related to the proposed use of the land. Commercial and industrial standards are less demanding than those for residential development. They provide public funding for brownfield redevelopment projects through a bond of \$335 million targeted directly to brownfield redevelopment. Lastly, they allow Michigan municipalities to create brownfield redevelopment authorities (BRAs) (Hula 1999).

BRAs create a specialized institutional structure to promote local planning and implementation of brownfield redevelopment. Brownfield authorities can pay or reimburse private or public parties for cleanup activities; lease, purchase or convey property; accept grants and donations of property or labor from public or private sources; invest the authority's money; borrow money; engage in lending and mortgage activities associated with property it acquires; and create revolving loan funds to finance projects. Brownfield authorities develop a plan for redeveloping eligible properties within its jurisdiction. If the MDEQ approves the plan, they can collect funds through increases in state and local taxes. Though the BRA has the freedom to develop any site, most develop sites in which businesses and industry express interest. No BRA in Michigan targets brownfields in communities that have a high number of brownfields for redevelopment (Hula 1999).

Though the federal government, state government and localities are committed to brownfield redevelopment, studies have found that brownfield redevelopment efforts are not always compatible with the goals of environmental justice. The nature of brownfield remediation has been found to be handled differently when it affects minorities and the

poor than when it affects other groups. Lavelle and Coyle (1992) analyzed every U.S. environmental lawsuit concluded from 1985-1992 and found penalties against pollution-law violators in minority areas were lower than those imposed for violations in largely white areas. In their analysis of every residential toxic-waste site from 1980 to 1992, they found the government takes longer to address hazards in minority communities than white communities. In addition, they were more likely to accept less stringent solutions, such as capping or other techniques that contain contamination at sites located near minority neighborhoods or in minority neighborhoods. In white neighborhoods, they were more likely to require removal. Hurley (1997) found evidence of such “white-privilege” in his study of Wellston, Missouri. The contamination at the Wagner Electric site in Wellston, a primarily African American community, was capped while the EPA removed contamination and bought the homes of property owners in the neighboring white community of Times Beach, Missouri.

## **VII. Summary**

Past research shows that a higher percentage of minorities than whites live in close proximity to hazardous waste facilities throughout the United States (GAO 1983, UCC 1987, Bullard 1990) including the Metro Detroit area (Mohai and Bryant 1992). In Milwaukee, minorities and the poor are more likely than others to live in neighborhoods with a high number of brownfields (Leigh and Gradek 1996). In Michigan, communities with Brownfield Redevelopment Authorities (BRAs) have a higher percentage of minorities and poor than those without BRAs (Anderson and Clemens 1999). Hurley's case study indicates the reasons for these inequalities are often complex (1997).

Though the federal government and Michigan is concerned about environmental justice, they admit that economic development is the primary concern. Leigh (2000) claims this practice "creates the potential for widening existing inequalities between better-off and worse-off neighborhoods." In addition, Lavelle and Coyle's 1992 study showed the penalties against polluters were found to be lower and less stringent clean-up of pollution was required in minority neighborhoods than in white neighborhoods.

Since few studies have addressed environmental inequality and brownfields, there are many gaps in the research. Leigh and Gradeck's 1996 study does not indicate whether such inequalities exist outside of Milwaukee. Though Anderson and Clemens (1999) studied brownfields in Michigan, the course scale of their analysis does not provide insight into whether individual communities and neighborhoods are more likely to experience the negative effects of brownfields. Leigh's claims are based on speculation, not evidence. Lavelle and Coyle's (1992) analysis of brownfield remediation is dated, only examine federal policy, and does not indicate whether such

practices have changed. No one has analyzed how well Michigan's brownfield redevelopment program addresses environmental justice concerns.

This study will expand on the current research to address some of these gaps. It will show the distribution of brownfields within Metro Detroit at the census tract level to determine whether some communities and groups of people are more likely to live in close proximity to them. The research will also provide insight into the brownfield remediation policies and practices of the state of Michigan by determining whether their goal of economic development is also compatible with environmental justice concerns.



## **VIII. Data and Analysis**

### *A. Data*

Currently, Michigan does not have a complete list of brownfields within the state. A number of Brownfield Redevelopment Authorities are in the process of creating databases of brownfields within their community but have not completed the task. The Michigan Department of Environmental Quality (MDEQ) has developed a database of locations where Baseline Environmental Assessments (BEAs) have been performed and then submitted to the MDEQ from 1995 to October, 2001. A BEA is an evaluation of the environmental conditions that exist at a facility at the time of purchase, occupancy, or foreclosure. It provides liability protection for new purchases, occupants, or lenders who are foreclosing. Though this is not a comprehensive list of all brownfields (and may even include some sites that do not fit the state's definition of a brownfield), it is the largest list available, and is what I use in the analysis to answer the first research questions. There are a total of 3,747 unique sites used in this study for the entire state that were submitted to the database from 1995 to October, 2001. 513 unique sites are in Wayne County, 311 in Oakland County, and 170 in Macomb County. Though each site is unique in size and level of contamination, each site is given equal value in the analysis.

To answer the second set of questions I used a database of brownfield sites where the state has allocated money for redevelopment or assessment from 1995-2000. This database, compiled by the Michigan Department of Environmental Quality, lists the addresses for a number of project funding types, including brownfield redevelopment, site reclamation, revitalization revolving loan fund, site assessment, and waterfront. There are 254 projects in the state at 248 unique sites. Thirty-seven of those projects are

in 35 unique sites in Wayne County, 12 in Oakland County, and 1 is in Macomb County. Though the state may have invested different amounts of money and time into each site, each site is given equal value in the analysis.

To make the data useable, duplicate sites from the database of Baseline Environmental Assessments database and the Site Reclamation Project database were first removed. Both databases list the address and county of each brownfield, but do not list the census tract the brownfield is located in. The addresses of the unique sites were then mapped using Tiger files in ArcView. These points were then matched to the 1990 and 2000 census tract they are located in. The accuracy of the placements was cross-checked. In the first check, some sites where the specific community the site was located in did not match the census tract assigned to it by ArcView. Those sites were located, remapped and assigned the proper census tract where necessary. In the second check, sites that had different 1990 and 2000 census tracts were located. If an error had occurred, the actual tract was reassigned to the site. For some sites, the address information was ambiguous (i.e., a site located at the intersection of two roads where the exact corner was not specified). When this happened, a portion of the site was assigned to the tracts the site could be located in, under the assumption that the site is probably affecting both tracts. When the site could have been in either of 2 tracts, each tract was assigned a value of .5. When it could have been in one of 4 tracts, each tract was assigned a value of .25. The end results were that 994 unique BEA sites were placed in census tracts. Forty four out of 50 site reclamation projects were mapped and placed in census tracts. The six that were not assigned census tracts had incomplete address information.

Demographic and socioeconomic variables pertaining to the census tracts were obtained from the 1990 census and 2000 census, as available. The census variables chosen and analyzed were grouped into five distinct categories. The 1990 variables end in 90, while 2000 variables end in 00.

**Group 1: Population**

POPULATION90	Count of total population
POPULATION00	Count of total population

**Group 2: Class**

MEDHHI90	Median household income
POVERTY90	Count of population in Poverty

**Group 3: Race**

WHITE00	Count of population that is White
BLACK00	Count of population that is Black
ASIAN00	Count of population that is Asian/Pacific Islander
HISPANIC00	Count of population that is Hispanic

**Group 4: Race and Class**

WHITEPOVERTY90	Count of white population in Poverty
BLACKPOVERTY90	Count of Black population in Poverty

## Group 5: Housing

MEDIANVALUE90	Median housing values
MEDIANRENT90	Median rent
OCCUPIED00	Count of occupied housing units
OWNER00	Count of occupied housing units that are owner occupied

### *B. Hypothesis*

I hypothesize that:

- (1) Minorities, specifically African Americans, and the poor are more likely than whites and those with higher incomes to live in communities with brownfields. A higher percentage of African Americans and the poor live in communities with a percentage of brownfields. Those communities with brownfields will also have lower average housing values, lower rents, and less occupied and owner-occupied housing.
- (2) Brownfield redevelopment efforts are positively related to communities that have a lower percentage of minorities and are less economically distressed (as measured by income, housing values, and percentage of occupied and owner-occupied housing).

### *C. Research Objectives*

There are two primary research objectives in this study. The first is to determine whether exposure or proximity in regard to the location of brownfields, exists in Metro Detroit for certain population groups. Specifically, the study will determine whether minorities and the poor are more likely to live in communities with brownfields, and

whether their spatial distribution matches the spatial distribution of brownfields. It will also determine whether communities with brownfields have different median housing values and rent, and percentage of occupied and owner occupied housing than those without. The second objective is to analyze whether brownfield redevelopment projects and money is equitably distributed across the area, and whether these efforts serve to address inequalities that may be present.

#### *D. Methodology*

To determine the first objective, I used exploratory and statistical analysis. I used exploratory analysis on the first four groups, population, class, race, and race and class to determine the percentage of total population living in tracts with brownfields for all of my study areas. Two statistical tests, the Difference of Means test, and Index of Dissimilarity were also used to measure whether some groups experience unequal exposure to these brownfields.

The two-sample Difference of Means test compares two populations with one another to determine whether the two groups are statistically different from each other. The two-sample t test for unpaired data with unequal variances is defined as:

$$T = \bar{Y}_1 - \bar{Y}_2 / (\sqrt{s_1^2 / N_1 + s_2^2 / N_2})$$

with degrees of freedom:

$$v = (s_1^2 / N_1 + s_2^2 / N_2)^2 / ((s_1^2 / N_1)^2 / N_1 - 1) + (s_2^2 / N_2) / N_2 - 1))$$

where  $N_1$  and  $N_2$  are the sample sizes,  $Y_1$  and  $Y_2$  are the sample means, and  $S_1^2$  and  $S_2^2$  are the sample variances. The test statistic  $T$  was used to determine the p-value using the two-tailed table. Significant differences are those with a p value of less than or equal to

.05. Before calculating the means for Y1 and Y2, I transformed many of my variables. The variables POVERTY, WHITEPOVERTY, BLACKPOVERTY, WHITE, BLACK, ASIAN, and HISPANIC were divided by the total population in each tract to determine the percentage of total population each of those variables were in each tract. The variable OCCUPIED in each tract was divided by the count of total housing units in the tract to determine the percentage of occupied housing units. The variable OWNER was divided by OCCUPIED for each tract to determine the percentage of occupied housing units that are owner occupied. The variables POPULATION90, POPULATION00, TRACTAREA, MEDIANVALUE, and MEDIANRENT were not changed. The mean of all the variables were compared for tracts with no brownfields to those with one or more brownfields.

The index of dissimilarity  $D$ , is used to measure the degree to which population groups by race and class and brownfields are distributed evenly within a metropolitan area by looking at the location of brownfields. The test is defined as:

$$D = 0.5 \sum |x_i - y_i| \text{ where, for this test:}$$

$x_i$  = the percentage of total study area's population group by race and class in a given census tract;

$y_i$  = the percentage of the study area's brownfields in the same census tract; and.

$D$  = the index of dissimilarity (Darden & Tabachneck, 1980; Duncan & Duncan, 1955).

The value for the index of dissimilarity  $D$  can range from 0 indicating maximum brownfield exposure to 100 indicating minimum brownfield exposure. The lower the index of dissimilarity, the higher the level of brownfield exposure for a particular population group. I analyzed all tracts with brownfields for each of the study areas

because my purpose was to determine the unevenness in the spatial distribution of brownfields compared to the spatial distribution of certain population groups.

To determine the second objective regarding the equitable distribution of brownfield redevelopment projects in Michigan, I determined which tracts have received state money for brownfield redevelopment and which have not from the database provided by the MDEQ. I first compared the differences in means for all variables of tracts where state money has been spent to all other tracts with brownfields where no state money has been spent. The same tests, transformation of data, and parameters as used for the first objective were used.

#### *E. Unit of Analysis and Study Area*

Analysis was performed on the 1,088 census tracts in 3 of the Counties, Macomb County, Oakland County and Wayne County that traditionally have composed metro Detroit. Census tracts were chosen for a number of reasons. First, an environmental justice study in the Cleveland area measured environmental equity at both the county and census tract level. From their analysis, Bowen et al (1995) found that environmental equity research is not amenable to a county-level or city level analysis due to the coarseness of spatial association at such a large scale. Analysis using smaller spatial units, such as census tracts, was more appropriate. Second, census tracts were chosen since demographic information from the U.S. Decennial census is readily available at the level. Third, analysis in Michigan at the city level by Anderson et al 2000 study has already been done.

Lastly, to determine which unit of analysis is most appropriate for brownfields, I looked at the impact brownfields have at a variety of scales. The state or federal

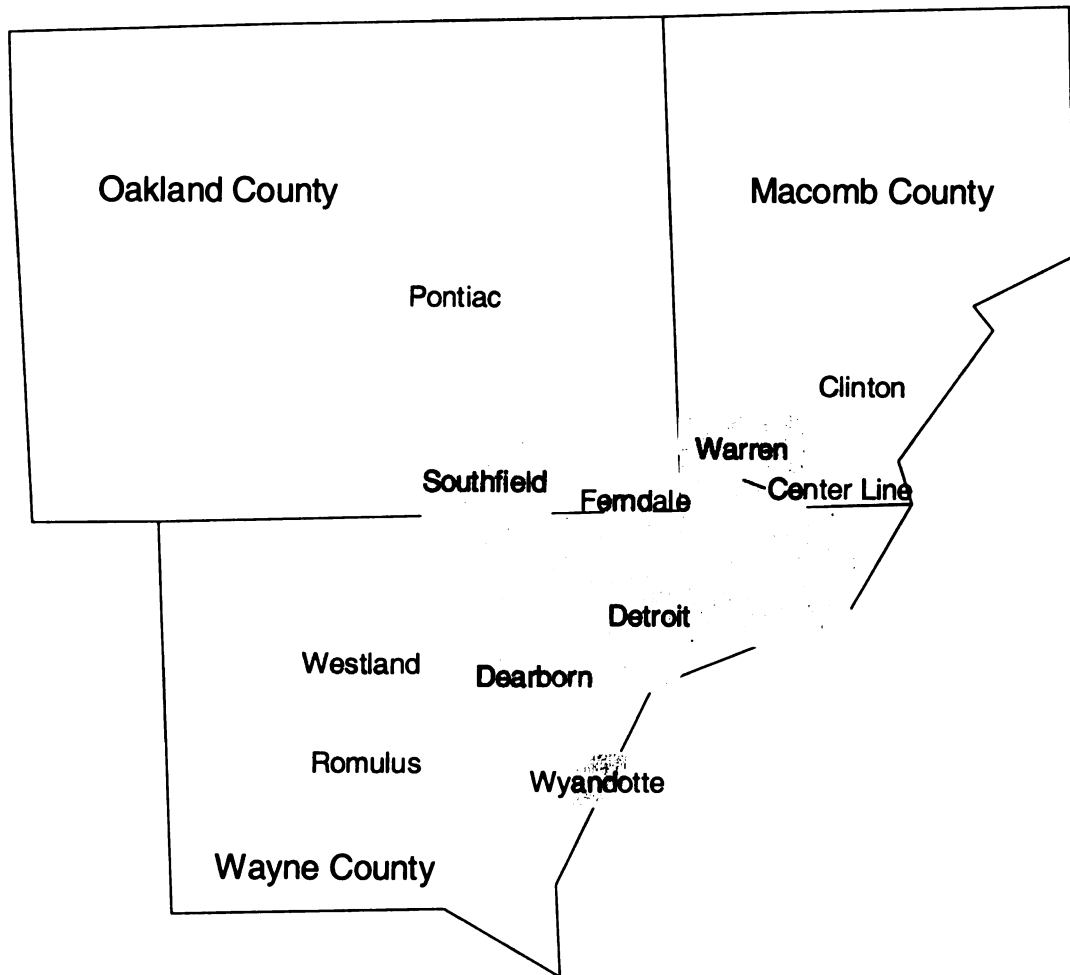
government is often responsible for allocating money for clean up. In Michigan, the County or Municipality organizes Brownfield Redevelopment Authorities. However, it is the individual neighborhoods and communities that surround a brownfield that are impacted the most on a daily basis, and is the level this study is primarily concerned. Since census tracts are defined in part by homogeneity of housing and population within communities, they are an appropriate unit of analysis when doing research on the demographics and neighborhood characteristics of brownfield communities.

Analysis was done first for combined counties of Macomb, Oakland, and Wayne. To get an idea of what was happening at a smaller geographic level, analysis was also done for the sub-areas of three counties individually and for 10 individual municipalities. The municipalities that met the following criteria were chosen: 1) The percent of people living in poverty or percent of non-white population was above the county average; 2) The municipalities had 7 or more census tracts; and 3) There was sufficient variability in the number of BEAs per census tract (i.e., at least one tract had no BEAs and at least one tract had 3 or more). The municipalities that met all three criteria are in grey on the map and include:

<b><u>Macomb County's</u></b>	<b><u>Oakland County's</u></b>	<b><u>Wayne County's</u></b>
Clinton Township	Pontiac	Detroit
Warren/Centerline	Ferndale	Dearborn
	Southfield	Romulus
		Westland
		Wyandotte



Figure 1: Map of Study Area



## **IX. Findings**

### ***A. Question 1:***

The findings for the tests used to answer question 1 are displayed in seven tables. Table 1 shows the results of exploratory analysis. Tables 2-6 shows the results of the difference of means tests. Tables 7 shows the results from the Index of Dissimilarity test.

**Table 1: Percentage of total population living in tracts with BEAs**

		Group 1: Population		Group 2: Class		Group 3: Race				Group 4: Race and Class	
	Community	POPULATION90	POPULATION00	TOTAL POVERTY90	WHITE00	BLACK00	ASIAN00	HISPANIC00	WHITE POVERTY 90	BLACK POVERTY 90	
All Counties	Macomb, Oakland, and Wayne Counties	44.7	42.7	44.4	43.1	41.0	41.5	49.5*	52.2*	39.3	
Individual Counties	Macomb County	45.4	40.6	56.3**	39.6	67.6**	40.3	45.2	54.6**	88.9**	
	Oakland County	34.8	34.6	40.3*	37.6	68.0**	50.9**	48.4**	39.5	80.9**	
	Wayne County	39.4	40.4	40.5	41.2	38.8	39.7	45.9*	47.6*	37.7	
Macomb County Municipalities	Clinton Township	47.1	40.8	70.8**	38.2	79.4**	51.3**	37.5	67.2**	98.5**	
	Warren-Centerline	32.0	32.4	46.4**	32.3	49.0**	39.6*	34.0	46.3**	87.2*	
Oakland County Municipalities	Pontiac	69.0	74.5	69.2	77.8	70.1	79.3	83.1*	64.1	74.4*	
	Southfield	45.1	40.9	35.8	41.1	40.3	45.8	45.3	36.8	32.2	
Wayne County Municipalities	Ferdale	62.8	61.5	68.0*	61.4	58.7	61.6	66.7*	68.2*	76.9*	
	Detroit	38.4	38.8	37.7	44.5*	37.7	36.3	46.8*	41.7	37.0	
	Westland	24.4	20.7	24.0	21.3	14.8	15.0	22.0	25.5	6.4	
	Dearborn	49.7	51.6	72.2**	50.0	65.2**	55.7	55.2	71.7**	100.0**	
	Wyandotte	46.3	45.3	65.1**	44.9	73.3**	50.0	43.5	65.8**	0.0	
	Romulus	50.1	80.7	48.0	88.5*	64.0	89.0*	79.9	54.4	36.8	

xx.x: Highlighted percentages indicate a greater percentage of x people living in tracts with brownfields than overall population living in tracts with brownfields.

\*: the difference in percent is 5% or greater

\*\*: the difference in percent is 10% or greater.

Table 1 shows the percentage of total x population (in columns) for the study area (in rows) living in tracts with BEAs. The percentages that are greater than the percentage of total population living in that community for the respective year are highlighted, indicating overrepresentation for that specific group. One asteric indicates a difference/ over representation of 5% or more; two indicates a difference of 10% or more. Based on the hypothesis that minorities and the poor would be more likely to experience higher exposure to brownfields, it was expected that there would be over representation for people living in poverty, White and Black people living in poverty, and Blacks, Asians, and Hispanics; and under representation of Whites. Over representation of minorities and the poor and under representation of Whites would indicate this expected inequality.

The results for All Counties do not show the expected inequality. Only Hispanics and Whites living in Poverty are over represented by more than 5% in tracts with brownfields than the population as a whole.

The results for the Counties individually indicate County differences. Macomb and Oakland County have largely similar results that demonstrate the expected inequality in most areas, except for the case of Asians and Hispanics in Macomb, and Whites in Oakland. The results show inequality in Wayne County in regard to class and race and class, but not for race alone.

The results for the municipalities also indicate city differences. Macomb's Clinton Township and Warren-Centerline, and Wayne County's Dearborn demonstrate inequality in all areas. In Pontiac, Ferndale, and Wyandotte, there is inequality in regard to class, but not race. In Detroit, Southfield, Westland, and Romulus, the results indicate very little inequality.

There are contradictory results based on the size of the community studied. The most inequality is found at the individual County level, where all three Counties demonstrate inequality in class, and the two Counties that have a small Black population (Macomb and Oakland) show inequality in regard to race. Though inequality is present in the counties separately, when they are studied together as a region, none of the inequality is visible. This loss of information indicates that inequality is more difficult to discover at a regional level. Analysis at the individual community level provides greater clarification than at the county level by providing insight into which communities do have inequality (contributing to the overall County assessment) and those that do not.

There are an equal number of communities (six) with Whites over represented as communities where Blacks are over represented. While the count is the same, the degree to which Blacks are over represented is much greater than Whites. Whites are only represented by more than 5% in the case of Detroit and Romulus. Blacks are over represented by over 10% in all six communities. In Oakland County, where both Blacks and Whites are over represented, Whites are over represented by 3 % while Blacks are by more than 30%.

Another important consideration is the fact that there are many ethnic minorities in today's society with non-European ancestry that are classified as White in the United States census. One specific group in this study is Arab-Americans living in Dearborn, Michigan. In Dearborn, the two tracts with the most BEA sites (7 and 4 respectively) have the highest percentage of population with Arab ancestry (68% and 48%), lowest median incomes (\$15,000 and \$20,000) and highest percentage of people living in

poverty (45% and 27%). Thus, caution is advised when interpreting the results of the analysis for Dearborn.

**Tables 2-6: Difference of mean test comparing tracts without BEA sites to tracts with BEA sites**

<b>Key for Tables 2-6</b>	
Mean1:	Mean value for tracts without BEAs
Mean2:	Mean value for tracts with BEAs
p-value:	p-value for Difference of Means test between Mean1 and Mean2 (highlighted values have a p-value of .05 or less)

**Table 2: All Counties**

		Mean1	Mean2	p-value
Group 1: Population	POPULATION90	3538.2	3673.6	0.165
	POPULATION00	3428.8	3531.5	0.245
Group 2: Class	TOTALPOVERTY90	14.1	15.7	0.129
	MEDHHI90	41003.5	37069.8	<b>0.001</b>
Group 3: Race	WHITE00	66.7	65.2	0.507
	BLACK00	27.8	28.4	0.817
	ASIAN00	2.3	2.3	0.739
	HISPANIC00	2.5	3.4	<b>0.053</b>
Group 4: Race and Class	WHITEPOVERTY90	4.3	6.3	<b>0.009</b>
	BLACKPOVERTY90	9.4	8.8	0.556
Group 5: Housing	MEDRENT90	502.8	474.9	<b>0.007</b>
	MEDVALUE90	71433.2	62094.4	<b>0.003</b>
	OCCUPIED00	94.5	93.4	<b>0.002</b>
	OWNER00	73.8	65.9	<b>0.000</b>

**Table 3: Individual Counties**

		Macomb County			Oakland County			Wayne County		
		Mean1	Mean2	p-value	Mean1	Mean2	p-value	Mean1	Mean2	p-value
Group 1: Population	POPULATION90	3563.9	3873.5	0.200	3980.1	4296.4	0.110	3375.7	3289.8	0.479
	POPULATION00	3602.9	3852.6	0.292	3521.3	3722.7	0.208	3320.4	3317.1	0.977
Group 2: Class	TOTALPOVERTY90	4.2	7.1	0.000	4.7	7.5	0.003	20.4	22.7	0.119
Group 3: Race	MEDHHI90	46247.4	40862.3	0.000	58349.6	48006.2	0.000	33394.4	30234.4	0.002
	WHITE00	94.5	90.1	0.000	84.1	81.1	0.208	48.0	48.0	0.985
	BLACK00	1.6	4.9	0.003	9.2	11.8	0.260	46.6	45.5	0.765
	ASIAN00	1.9	2.2	0.313	4.2	3.6	0.194	1.6	1.6	0.918
	HISPANIC00	1.4	1.7	0.074	1.8	3.1	0.001	3.3	4.2	0.223
Group 4: Race and Class	WHITEPOVERTY90	4.1	6.3	0.001	3.8	5.5	0.001	4.5	6.7	0.000
	BLACKPOVERTY90	0.1	0.6	0.024	0.7	1.6	0.121	18.3	18.5	0.987
Group 5: Housing	MEDRENT90	526.6	487.4	0.050	634.9	567.8	0.004	449.6	423.4	0.027
	MEDVALUE90	82410.9	69440.5	0.002	117326.3	94363.6	0.005	52142.1	43201.9	0.005
	OCCUPIED00	96.7	96.2	0.328	96.2	95.2	0.006	92.8	91.4	0.016
	OWNER00	82.1	75.7	0.011	81.6	71.7	0.000	66.9	59.4	0.000

**Table 4: Macomb County Municipalities**

	Clinton Township			Warren-Centerline			
	Mean1	Mean2	p-value	Mean1	Mean2	p-value	
Group 1: Population	POPULATION90	4539.7	4487.2	0.943	3223.4	3457.3	0.544
	POPULATION00	4047.2	4331.9	0.599	3047.0	3322.6	0.464
Group 2: Class	TOTALPOVERTY90	3.0	9.4	0.047	4.4	7.8	0.033
	MEDHHI90	49727.9	39539.0	0.052	44406.1	36378.2	0.009
Group 3: Race	WHITE00	95.1	85.4	0.028	94.2	88.7	0.002
	BLACK00	1.6	8.9	0.043	1.5	4.2	0.040
	ASIAN00	1.3	2.3	0.141	2.2	3.6	0.010
	HISPANIC00	1.8	1.6	0.661	1.2	1.6	0.016
	WHITEPOVERTY90	2.9	7.2	0.035	4.1	7.4	0.029
Group 4: Race and Class	BLACKPOVERTY90	0.0	1.8	0.149	0.1	0.1	0.998
	MEDRENT90	527.5	438.4	0.104	532.5	476.3	0.215
Group 5: Housing	MEDVALUE90	99500.0	76966.7	0.047	73140.9	55579.2	0.004
	OCCUPIED00	96.8	95.3	0.382	97.4	96.5	0.156
	OWNER00	71.8	68.1	0.670	80.8	75.8	0.360



**Table 5: Oakland County Municipalities**

	Pontiac			Southfield			Ferndale		
	Mean1	Mean2	p-value	Mean1	Mean2	p-value	Mean1	Mean2	p-value
Group 1: Population	2771.1	4479.7	0.030	3459.8	3796.7	0.579	4645	3131.4	0.519
Group 2: Class	2427.0	4139.5	0.041	3307.5	3554.6	0.622	4256.5	2718.4	0.446
Group 3: Race	19.2	27.8	0.272	6.6	4.7	0.144	7.9	11.5	0.479
	28944.1	24169	0.612	51827.5	47477.8	0.212	38185.0	32851.2	0.549
	47.6	39.4	0.535	35.9	37.9	0.762	92.0	90.9	0.505
	43.4	47.2	0.784	57.7	54.7	0.679	3.7	3.4	0.550
	2.0	2.3	0.833	2.8	3.4	0.647	1.3	1.5	0.613
	7.1	13.8	0.026	1.1	1.4	0.177	1.4	2.0	0.393
Group 4: Race and Class	10.1	10.3	0.966	5.0	3.8	0.319	7.2	10.6	0.449
	7.3	15.6	0.171	1.4	0.8	0.228	0.2	0.3	0.647
Group 5: Housing	369.5	442.5	0.397	692.0	674.9	0.722	450.5	475.2	0.664
	72137.5	35354.5	0.417	84950.0	79366.7	0.623	51600.0	35960.0	0.473
	92.1	90.5	0.537	95.7	95.3	0.734	96.8	96.2	0.572
	51.5	54.3	0.805	58.2	55.4	0.836	71.8	69.5	0.647

**Table 6a: Wayne County Municipalities**

	Detroit			Westland			Dearborn		
	Mean1	Mean2	p-value	Mean1	Mean2	p-value	Mean1	Mean2	p-value
Group 1: Population									
POPULATION90	3261.7	3063.6	0.218	4161.4	3650.9	0.544	3740.8	4036.1	0.721
POPULATION00	3080.3	2929.3	0.332	3987.6	3130.6	0.177	3939.6	4208.3	0.706
Group 2: Class									
TOTALPOVERTY90	33.2	33.5	0.881	7.3	9.2	0.483	4.3	13.6	0.054
MEDHHI90	22534.6	22592.2	0.966	38152	36085.7	0.616	48758.2	37857.8	0.166
Group 3: Race									
WHITE00	10.7	14.3	0.067	86.7	87.3	0.849	91	85.5	0.114
BLACK00	83.9	79.1	0.097	8.0	7.1	0.772	1.2	2.0	0.299
ASIAN00	0.9	1.1	0.737	2.5	1.9	0.436	1.6	1.9	0.652
HISPANIC00	3.9	5.6	0.260	2.2	2.4	0.657	2.8	3.4	0.144
Group 4: Race and Class									
WHITEPOVERTY90	4.3	5.4	0.194	5.6	8.4	0.257	4.2	13.0	0.054
BLACKPOVERTY90	27.9	26.9	0.619	1.5	0.3	0.216	Not Applicable		
Group 5: Housing									
MEDRENT90	385.2	379.5	0.631	472.1	440.1	0.452	560.9	511.9	0.549
MEDVALUE90	25994.1	23481.2	0.255	56089.5	62728.6	0.289	92200.0	66690.9	0.294
OCCUPIED00	89.4	88.0	0.112	96.6	95.7	0.365	95.2	92.5	0.259
OWNER00	54.6	47.9	0.007	71.4	54.4	0.066	81.6	63.5	0.026

**Table 6b: Wayne County Municipalities**

		Wyandotte			Romulus		
		Mean1	Mean2	p-value	Mean1	Mean2	p-value
Group 1: Population	POPULATION90	2769.2	3580.8	0.376	3808.0	1912.3	0.356
	POPULATION00	3063.6	3172	0.874	2221.0	3089.5	0.381
Group 2:Class	TOTALPOVERTY90	6.1	15	<b>0.048</b>	13.6	15.2	0.796
	MEDHHI90	31074.2	30257	0.910	35234.3	29231.7	0.316
Group 3: Race	WHITE00	97.1	95.4	<b>0.001</b>	40.2	76.0	0.317
	BLACK00	0.2	0.8	0.052	54.7	19.6	0.301
	ASIAN00	0.3	0.4	0.834	0.4	0.5	0.671
	HISPANIC00	3.0	2.8	0.732	2.1	1.5	0.180
Group 4: Race and Class	WHITEPOVERTY90	5.8	14.6	<b>0.048</b>	5.9	11.5	0.205
	BLACKPOVERTY90	Not Applicable			7.0	3.5	0.585
Group 5: Housing	MEDRENT90	369.5	397.3	0.732	453.3	399.3	0.271
	MEDVALUE90	43233.3	43200	0.997	47633.3	48033.3	0.899
	OCCUPIED00	96.4	95.5	0.367	93.9	90.1	0.512
	OWNER00	82.7	63.3	0.116	65.7	72.7	0.746

Before doing the difference of mean tests (Tables 2-6), the data was transformed. All three variables that looked at poverty were divided by the 1990 population to give the percentage living in poverty per census tract. The 2000 race variables were divided by the 2000 population to give the respective percentage of Whites, Blacks, Asian/Pacific Islanders, and Hispanics living per census tract. In the housing variables, the count of occupied housing was divided by the total count of housing per census tract, while the count of owner occupied housing was divided by the count of occupied housing units per census tract.

There are significant differences for the entire study area, All Counties (Table 2) in Class, Race and Class, and Housing. Specifically, Median household income is lower, there are more Whites living in poverty, and lower median housing values in tracts with BEAs than in tracts without.

Within the Counties studied individually (Table 3), there are many similarities. In all, there are significant differences in Class (tracts with BEA sites are poorer), Race and Class (tracts with BEA sites have more Whites living in poverty), and Housing (in tracts with BEA sites, rents and values are lower, and there are smaller percentages of owner-occupied housing). In addition, Macomb County has a significantly smaller percentage of Whites and greater percentage of Blacks and Blacks living in poverty in communities with BEAs. Oakland County has a significantly higher percentage of Hispanics. Both Oakland and Wayne County have significantly less occupied housing in tracts with BEAs than in those without.

The Macomb County communities (Table 4) of Clinton Township and Warren-Centerline have significant differences in Class (tracts with BEAs are poorer), Race

(there are fewer Whites and more Blacks in tracts with BEAs), Race and Class (there are more Whites living in Poverty in tracts with BEAs), and in Housing (the median value of housing is lower in tracts with BEAs). Oakland County municipalities (Table 5) and Wayne County municipalities (Tables 6a and 6b) have few significant differences. In Pontiac, there are significant differences in population (the population is greater in tracts with BEAs), and in Race (there are more Hispanics in tracts with BEAs). In Wyandotte, there are significant differences in Class (tracts with BEAs are poorer), Race (there are fewer Whites in tracts with BEAs), and in Race and Class (a larger percentages of Whites live in Poverty in tracts with BEAs).

Though the remaining results do not show significant differences, there are certain trends that can be seen in Tables 4-6. In most municipalities, tracts with more people living in poverty with a lower median household income have BEAs. Many communities have fewer Whites and more Blacks. Exceptions are Southfield, Detroit, Westland, and Wyandotte. All communities but Southfield have a greater percentage of Whites living in Poverty in tracts with BEAs than in those without. More communities, such as All Counties, Southfield, Detroit, Westland, and Romulus have a smaller percentage of Blacks living in tracts with poverty.

As expected, all municipalities but Ferndale have lower rent, and all communities but Westland and Romulus have lower values in communities with brownfields than those without. There is also less occupied housing in all communities, and less owner-occupied housing in all communities but Pontiac in communities with brownfields than in those without.

**Table 7: D Values for the Index of Dissimilarity Text**

		Group 1: Population		Group 2: Class	Group 3: Race				Group 4: Race and Class	
		POPULATION ON90	POPULATION ON00	TOTAL POVERTY	WHITE	BLACK	ASIAN	HISPANIC	WHITE POVERTY	BLACK POVERTY
All Counties	Macomb, Oakland, and Wayne Counties	35.7	36.0	47.7	44.5	65.7	56.2	53.5	44.7	73.7
	Macomb County	29.1	30.6	36.5	31.4	59.2	44.6	36.5	35.6	82.4
Individual Counties	Oakland County	34.8	34.6	40.3	37.6	68.0	50.9	48.4	39.5	80.9
	Wayne County	37.4	37.7	46.7	53.4	60.1	61.5	58.4	50.5	63.7
Macomb County Municipalities	Clinton Township	24.9	19.2	28.7	22.3	34.2	27.0	23.6	28.7	62.4
	Warren-Centerline	32.0	32.4	46.4	32.3	49.0	39.6	34.0	46.3	87.2
Oakland County	Pontiac	26.7	29.4	27.9	44.4	28.4	49.3	43.1	43.7	33.5
Municipalities	Southfield	29.5	26.1	31.3	29.9	26.0	48.0	21.5	33.7	44.1
	Ferndale	23.4	23.2	21.9	23.4	23.2	31.0	22.1	20.9	66.7
Wayne County Municipalities	Detroit	43.5	44.1	42.6	58.3	48.1	63.9	71.6	58.6	49.0
	Westland	22.7	27.7	25.6	29.2	24.9	38.4	37.7	27.0	66.7
	Dearborn	26.9	26.4	33.4	28.5	38.7	29.9	32.0	33.8	75.9
	Wyandotte	33.8	33.6	40.7	33.6	31.4	29.8	42.4	41.4	0.0
	Romulus	22.4	35.1	14.7	35.2	52.4	58.1	43.2	19.9	55.2

Table 7 gives the D values from the Index of Dissimilarity Test. The test indicates whether the distribution of the variables x (in the column) is similar to the distribution of BEA sites. D can range from 0 to 100. The lower the value, the more similar the distribution, indicating exposure to brownfields for the specific population group. Values greater than 50 indicate a high dissimilar distribution, i.e., a lack of exposure to brownfields and are highlighted in the table. Since the values are dependent on the size of the spatial units used, the values can only be compared for variables analyzed using spatial units of comparable size.

In All Counties, the distribution of BEAs is similar to the distribution of the 1990 and 2000 population. The distribution is similar for Group 2, Class, as well as the distribution of Total poverty is somewhat similar to that of BEAs. In regard to race, only the White population has a D value less than 50. When race and class intersect, only Whites living in poverty have a similar distribution with a D value of 44.7.

The results for the Counties of Macomb, Oakland, and Wayne County are similar to the results for All Counties with a BEA distribution similar to the 1990 and 2000 population, and individuals living in poverty. The results for race and the intersection of race and class show County differences. The White and Hispanic population, and Whites living in Poverty in Oakland and Macomb County are similar to that of BEAs. The D-value for Asians in Oakland County is also below 50. In Wayne County, none of the D-values for race were below 50. In addition, for all three Counties, the D-value for Blacks living in poverty is above 50.

The results for the individual municipalities also indicate that the distribution of BEAs and the 1990 and 2000 population are similar. As expected, the distribution of

BEA sites and persons living below poverty is also similar (D values range from 14.7 in Romulus to 46.4 in Warren-Centerline), indicating that the poor are likely to live in tracts with brownfields.

When race is examined alone, the results for Whites were unexpected. In all communities, except for Detroit which does not have a large percentage White population, the distribution of Whites and brownfields is similar. Only Blacks living in Pontiac, Southfield, Ferndale, Detroit, Westland, and Wyandotte are more likely to live in communities with more brownfields than Whites are. In addition, the distribution of Blacks in Clinton Township, Warren-Centerline, and Dearborn is similar to the distribution of brownfields, though not as much so for the Whites. The distribution of other non-White groups studied, Asian Islanders and Hispanics, does match the distribution of BEA sites in many communities, as hypothesized.

When poverty and race intersect, the distribution of Whites living in poverty is similar to the distribution of brownfields in all communities Detroit. In all of the communities that have a larger percentage of Blacks distributed throughout the community (Pontiac, Southfield, and Detroit), the distribution of Blacks living in poverty and brownfields is similar.



**B. Question 2**

The findings for the Difference of Means tests used to answer question 2 are displayed in Tables 8-11.

**Tables 8-11: Difference of mean test comparing tracts with BEA sites with projects to tracts with BEA sites without projects**

Key for Tables 8-11	
Mean1:	Mean value for tracts with BEAs without redevelopment projects
Mean2:	Mean value for tracts with BEAs with redevelopment projects
p-value:	p-value for Difference of Means test between Mean1 and Mean2 (highlighted values have a p-value of .05 or less)

**Table 8: All Counties**

	Variable	Mean1	Mean2	p-value
Group 1: Population	POPULATION90	3712.7	3259.0	0.075
	POPULATION00	3563.8	3240.2	0.212
Group 2: Class	TOTALPOVERTY90	15.0	21.9	
	MEDHHI90	37839.8	28939.2	
Group 3: Race	WHITE00	65.5	65.8	0.972
	BLACK00	28.2	26.4	0.775
	ASIAN00	2.3	1.2	
	HISPANIC00	3.2	6.0	0.167
Group 4: Race and Class	WHITEPOVERTY90	6.1	9.6	
	BLACKPOVERTY90	8.5	10.8	0.435
Group 5: Housing	MEDRENT90	479.1	417.2	
	MEDVALUE90	64282.2	37339.4	
	OCCUPIED00	93.5	92.3	0.220
	OWNER00	66.6	58.9	0.068
Group 6: BEA Count	BEA90	2.1	2.4	0.445
	BEA00	2.0	2.4	0.424

**Table 9: Individual Counties**

	Oakland			Wayne		
	Mean1	Mean2	p-value	Mean1	Mean2	p-value
Group 1: Population						
POPULATION90	4321.0	4040.8	0.589	3320.1	3083.6	0.401
POPULATION00	3739.3	3591.9	0.755	3344.8	3204.8	0.652
Group 2: Class						
TOTALPOVERTY90	6.6	20.7	0.055	22.3	22.8	0.878
MEDHHI90	49269.3	28702.1	0.000	30632.9	29029.0	0.586
Group 3: Race						
WHITE00	82.4	63.8	0.227	46.8	65.4	0.004
BLACK00	10.4	30.9	0.186	47.1	25.8	0.003
ASIAN00	3.7	1.0	0.000	1.6	1.3	0.419
HISPANIC00	3.1	2.6	0.675	3.9	7.2	0.218
Group 4: Race and Class						
WHITEPOVERTY90	5.4	7.7	0.190	6.3	10.4	0.001
BLACKPOVERTY90	0.8	12.2	0.124	15.4	10.7	0.186
Group 5: Housing						
MEDRENT90	577.7	407.9	0.001	423.9	417.5	0.830
MEDVALUE90	97921.3	36633.3	0.000	44467.3	37324.9	0.211
OCCUPIED00	95.4	92.4	0.293	91.4	92.2	0.417
OWNER00	72.4	61.1	0.108	59.9	57.3	0.619
Group 6: BEA						
BEA90	2.4	2.7	0.740	2.0	2.1	0.834
Count	2.1	2.7	0.563	2.0	2.0	0.953

**Table 10: Oakland County Municipalities**

		Pontiac			Ferndale		
		Mean1	Mean2	p-value	Mean1	Mean2	p-value
Group 1: Population	POPULATION90	4761.0	3214.0	0.339	1888.7	4820.3	0.001
	POPULATION00	4481.5	2429.5	0.325	1677.3	4268.3	0.001
Group 2:Class	TOTALPOVERTY90	22.3	52.5	0.092	11.0	10.1	0.715
	MEDHHI90	27086.9	11038.5	0.037	33431.3	35083.0	0.667
Group 3: Race	WHITE00	45.2	10.4	0.001	90.5	91.8	0.505
	BLACK00	40.0	83.1	0.004	3.3	3.6	0.782
	ASIAN00	2.7	0.1	0.005	1.8	1.2	0.459
	HISPANIC00	15.4	5.7	0.182	2.1	1.7	0.310
Group 4: Race and Class	WHITEPOVERTY90	11.3	5.8	0.371	10.1	9.3	0.748
	BLACKPOVERTY90	9.3	44.2	0.137	0.2	0.3	0.697
Group 5: Housing	MEDRENT90	483.2	259.0	0.093	481.7	458.0	0.353
	MEDVALUE90	36833.3	28700.0	0.002	36133.3	43650.0	0.391
	OCCUPIED00	92.8	79.4	0.291	96.2	96.5	0.736
	OWNER00	57.8	36.9	0.001	68.7	71.4	0.740
Group 6: BEA Count	BEA90	2.6	5	0.650	2.0	1.5	0.723
	BEA00	2.3	5	0.622	2.0	1.5	0.723

**Table 11: Wayne County Municipalities**

	Detroit			Dearborn			Wyandotte		
	Mean1	Mean2	p-value	Mean1	Mean2	p-value	Mean1	Mean2	p-value
Group 1: Population	POPULATION90	3139.6	1443.3	0.010	3791.0	4689.7	0.392	3273.0	4004.0
Group 2: Class	POPULATION00	3004.1	1433.7	0.002	3838.8	5317	0.287	2858.7	3667.5
Group 3: Race	TOTALPOVERTY90	30.0	40.0	0.367	12.2	17.5	0.587	14.9	12.1
	MEDHHI90	22706.0	20380.3	0.795	39456.1	33595.7	0.494	29586.3	33441.0
	WHITE00	13.5	30.8	0.113	86.1	84.0	0.784	95.4	95.9
	BLACK00	80.3	54.6	0.110	2.3	1.1	0.165	0.9	0.4
	ASIAN00	1.0	1.4	0.639	2.2	0.9	0.076	0.4	0.4
	HISPANIC00	5.0	19.0	0.264	3.5	3.0	0.558	2.7	2.9
Group 4: Race and Class	WHITEPOVERTY90	5.3	8.9	0.310	11.7	16.6	0.608	14.4	11.5
	BLACKPOVERTY90								0.627
Group 5: Housing	MEDRENT90	26.9	24.7	0.821	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
	MEDVALUE90	376.4	436.3	0.633	508.5	521.0	0.898	413.3	400.0
	OCCUPIED00	24152.3	10532.8	0.007	71800.0	53066.7	0.161	42200.0	48850.0
	OWNER00	88.1	86.5	0.108	91.7	95	0.251	95.7	95.6
Group 6: BEA Count	BEA90	48.7	32.4	0.158	60.6	72.2	0.430	70.4	60.5
	BEA00	2.0	4.7	0.057	2.6	2.7	0.967	3.3	0.5
		2.1	4.5	0.093	2.3	2.7	0.735	3.3	0.5

Tables 8-11 gives the results for difference of mean tests where the mean of the variables for tracts with BEA sites where state money has been invested in redevelopment, assessment, etc. was compared to the mean in tracts with BEA sites where no state money has been invested. Significant differences would indicate that the state has invested in communities that are significantly more likely to have a higher percentage of population with certain characteristics. Some communities studied in previous tests do not have any redevelopment and were not analyzed in this test.

The results indicate that in the entire region (Table 8), Class and Housing plays a role in where the state has provided redevelopment, as poorer areas with lower housing values were more likely to receive state money. The race of the community does not seem to matter, except for Whites living in poverty.

The results for the Counties individually (Table 9), demonstrate County differences. In Oakland County, Class and Housing differences are significant as poorer areas with lower housing values were more likely to have state projects. In Wayne County, Race plays a role, while class does not. Tracts with a greater percentage of Whites and a lower percentage of Blacks are more likely to have state investment in redevelopment. Significantly more Whites living in poverty are in tracts with redevelopment than those without.

Only the individual municipalities (Tables 10 and 11) of Pontiac, Ferndale, and Detroit show significant differences. In Pontiac, Class, Race, and Housing must be considered. Poorer tracts with smaller amounts of Whites and greater amounts of Blacks, with lower housing values and fewer owner occupied units are more likely to experience redevelopment. In Ferndale, the differences are only in regard to population, as more

people live in tracts where redevelopment has occurred. In Detroit, there are fewer people in those tracts, and significantly lower housing values.

The remaining results do not have significant differences. However, trends can be identified. Most communities have fewer people living in tracts where the state has invested in redevelopment. In most communities, except for Ferndale and Wyandotte, the tracts have a poorer population. Like Wayne County, All Counties, Detroit, and Wyandotte have more whites and fewer Blacks in tracts where the state has invested in redevelopment. Like Pontiac, Oakland County has fewer Whites and more Blacks in tracts with redevelopment. All of the communities but Wyandotte have a higher mean of White Poverty and/or Black Poverty in tracts with BEA sites than in tracts without. Most of the communities have lower median rents and/or lower median values in communities with redevelopment sites than in those without. Ferndale and Wyandotte demonstrate the opposite. All communities except for Ferndale, Wayne County, and Dearborn have less occupied and owner-occupied housing in tracts with BEA sites than those without. In all communities but Ferndale and Wyandotte, there are more BEA sites in the tracts where the state has invested money than in tracts where the state has not.

## **IX. Discussion**

### ***A. Does environmental inequality exist in Metro Detroit?***

The first objective of this study was to determine whether exposure to the location of brownfields exists for certain population groups in Metro Detroit. The results indicate that in most of the communities, exposure is greater for some population groups and less for others.

The following table shows these results. For the first three factors (Race, Class, and Race and Class) YES means that exposure is greater due to the factors specified according to two of three tests. Specifically, the percent of the specific population living in tracts with brownfields is at least 5 percent greater than the percent of population living in tracts with out brownfields; and/or the p value is less than .1 for the difference of means test; and/or, the D value is less than 50. For the fourth category, Housing, YES means that at least one of the Housing factors had a value p value of less than .1 in the difference of mean test.

	<b>Community</b>	<b>Race</b>	<b>Class</b>	<b>Race and Class</b>	<b>Housing</b>
<b>All Counties</b>	Macomb, Oakland, and Wayne Counties		YES	YES (White)	YES
<b>Individual Counties</b>	Macomb County	YES (Black, Hispanic)	YES	YES (White, Black)	YES
	Oakland County	YES (Hispanic)	YES	YES (White, Black)	YES
	Wayne County		YES	YES (White)	YES
<b>Macomb County Municipalities</b>	Clinton Township	YES (Black, Asian)	YES	YES (Black)	YES
	Warren-Centerline	YES (Black)	YES	YES (White)	YES
<b>Oakland County Municipalities</b>	Pontiac	YES (Hispanic)	YES	YES (Black)	
	Ferndale		YES	YES (White, Black)	
	Southfield				
<b>Wayne County Municipalities</b>	Detroit				YES
	Dearborn	YES (Black)	YES	YES (White, Black)	YES
	Romulus	YES (White)			
	Wyandotte	YES (Black)	YES	YES (White)	
	Westland				YES

All communities but Southfield demonstrate some level of population exposure in regard to the location of brownfields. In Macomb County (both the entire county and individual communities), the unequal exposure to brownfields is severe. Minorities and the poor are both more likely to experience the negative effects of brownfields than Whites or those with higher incomes. In Oakland County communities, the poor and



Hispanics experience environmental inequality. In Wayne County communities, the results are mixed.

Though inequalities do exist, the only clear pattern that exists is in regard to class, regardless of race, and housing, as poorer communities with lower housing values, rents, owner or occupied housing are more likely to have brownfields. A clear pattern of Black disadvantage is not present outside of Macomb County.

The absence of a pattern may be in part a reflection of the data available for study. BEA sites are properties that are assessed when being purchased, changing occupancy, or being foreclosed. These are potentially contaminated properties with the highest economic potential, and would most likely not be found in the most depressed neighborhoods. In a 1991 assessment of a sample of BEA sites filed from 1995-99, Hula et al found that of the 300 observed sites, 203, or 69 percent, showed some level of economic activity. Only 14 percent were reported as vacant or abandoned. These findings indicate that there may be many brownfields, particularly those in communities like Detroit that are overrun with abandoned properties that have little commercial interest to developers, that remain undiscovered and have not yet been assessed for contamination.

*B. Have the state's efforts to redevelop brownfields been equitably distributed? Do state redevelopment efforts directly address inequalities that exist?*

The second objective of this study is to determine whether Michigan's brownfield redevelopment policies have been able to link the values of environmental justice and economic development. The analysis of environmental inequality in the area does indicate that some groups are more likely to experience the negative effects of brownfields. Brownfield redevelopment efforts have the potential to correct or perpetuate those inequities.

The following chart describes the demographics of the communities where redevelopment has occurred. "NO" indicates that for the specific variable, the mean is significantly lower in communities with brownfields where redevelopment has occurred than in those where they have not. The implication of "NO" is that redevelopment efforts have not been equitably distributed for the specified group. "YES" indicates that there is a higher mean percentage in communities with redevelopment than those without.

	<b>Community</b>	<b>Race</b>	<b>Class</b>	<b>Race and Class</b>	<b>Housing</b>
All Counties	Macomb, Oakland, and Wayne Counties	NO (Asian)	YES (poorer)	YES (White)	YES (lower values)
Individual Counties	Oakland County	NO (Asian)	YES (poorer)		YES (lower values)
	Wayne County	NO (Black)		YES (White)	
Oakland County Municipalities	Pontiac	NO (White, Asian) YES (Black)	YES (poorer)		YES (lower values)
	Ferndale				
Wayne County Municipalities	Detroit				YES
	Dearborn	NO (Asian)			
	Wyandotte				

The results indicate that for most communities, state brownfield redevelopment efforts have occurred in communities in greatest need of economic redevelopment and revitalization. These are communities that are poorer, have lower median incomes, lower median rents and housing values, and less occupied and owner occupied housing.

In All Counties and in Detroit, redevelopment efforts are directly addressing inequalities that exist. Other communities are directly addressing some inequalities. To address all, they would need to target specific groups. Oakland County would need to target redevelopment to Hispanic communities. Pontiac would need to target communities with poor Blacks, while Ferndale should target poorer communities. Wayne County needs to target poor communities more extensively. Wyandotte and Dearborn need to target minority and poor communities.

A “NO” response indicates that brownfield redevelopment efforts are not equitably distributed for the specific group. Though the Asian community is relatively small throughout the region, they are living in tracts with brownfields that are less likely to have redevelopment activities. In addition, Whites living in Pontiac are living in communities that have less redevelopment, and those communities should be targeted if equity is a goal. In Wayne County, Black communities are less likely to have brownfield redevelopment. Fortunately, all of the “NO” responses in the table are for groups that do not already experience environmental inequality in regard to BEA sites within the area studied.

## **XI. Conclusions and the Need for Further Research**

This study has addressed the descriptive aspect of environmental inequality research to show where inequality is present in metro Detroit's brownfield communities. The methods used in this study could be used in additional communities to determine the extent of environmental inequality in other areas. The results indicate that for the most part, state brownfield redevelopment efforts are equitably distributed and are targeting communities in greatest need of redevelopment. Michigan has achieved success in linking environmental justice with economic development through Brownfield Redevelopment Grants funded by the Clean Michigan Initiative bond fund. However, there is more communities could do to correct the inequalities that do exist. Most troubling is Macomb County and its communities. The results show evidence of extensive environmental inequality in those areas, but no state funded brownfield redevelopment initiatives have occurred.

In Detroit, the next step for future research is to look at process by focusing on the history of communities where environmental inequality is present. A case-study similar to Hurley's study of the Wagner Electric site in Wellston, Missouri would provide useful information into some of the complex processes at work in creating and sustaining environmental inequality in Metro Detroit. This history could also be compared to that in communities where inequality has not been found.

Future research is needed to analyze why come communities have had significant redevelopment that is compatible with environmental justice values while others have not. A study comparing local policies, the role of Brownfield Redevelopment Authorities in various communities, the extent of community participation and creative land

purchasing strategies as well as other factors would provide greater insight into this question (Godschalk 1994, Kirshenber et al 1997, Davies 1999, Leitmann 1999, Leigh 2000, Rogers 2000). The understanding gained from this analysis would provide additional knowledge to tailor new and creative redevelopment strategies to where they are most needed.

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