RISK: Health, Safety & Environment (1990-2002)

Volume 4
Number 3 *RISK: Issues in Health & Safety*

Article 5

June 1993

# Proving Environmental Inequity in Siting Locally Unwanted Land Uses

Michael Greenberg

# Proving Environmental Inequity in Siting Locally Unwanted Land Uses*

**Michael Greenberg****

## Introduction

Hazardous waste management facilities, airports, prisons, and other locally unwanted land uses (LULUs) cause tension and political conflict. For example, hazardous waste management facilities, argue recent reports, have been deliberately sited in poor and minority neighborhoods already suffering from political, economic, and social inequities. Government, industry, and even national environmental groups have been charged with "toxic racism" and "environmental racism" for causing or ignoring the problem.[1]

Hazardous waste management facilities appear to be disproportionately located in poor and in African- and Hispanic-American communities. But are municipal landfills, electricity generating facilities, solid waste transfer stations, airports, sewage plants, highways, maximum security prisons, drug halfway houses, housing projects, hospices for people with AIDS, garbage incinerators,

* I would like to thank my colleagues Frank Popper and Dona Schneider, and Mitchell Small of Carnegie Mellon University, for their helpful comments on an earlier draft of this paper.

** Dr. Green received his Ph.D. from Columbia University and is Professor of Urban Studies and Community Health, Rutgers University, New Brunswick, New Jersey. He is also Director, Environmental Policy Division, Environmental and Occupational Health Sciences Institute.

1 COMMISSION FOR RACIAL JUSTICE, UNITED CHURCH OF CHRIST, TOXIC WASTE AND RACE IN THE UNITED STATES (1987); ROBERT BULLARD, DUMPING IN DIXIE: RACE, CLASS, AND ENVIRONMENTAL QUALITY (1990); PAT COSTNER & JOSEPH THORNTON, PLAYING WITH FIRE: HAZARDOUS WASTE INCINERATION (1990). *See also* Carol Grossman, *From Toxic Racism to Environmental Justice,* 3 ENVT'L MAG. 30 (1992); Daniel Goldberg, *The Quest for Environmental Equity,* MSW MGMT., Mar./Apr. 1992, at 27; Robert W. Collin, *Environmental Racism: A Law and Planning Approach to Environmental Racism,* 11 VA. ENVT'L L.J. 495 (1992); Sam Roberts, *In My Backyard? Where New York City Puts Its Problems,* New York Times, Dec. 6, 1992, at 54; and various articles in *Environmental Protection-Has It Been Fair,* 18 EPA J., Mar./Apr. 1992.

and other LULUs also disproportionately located in minority and poor communities? It is tempting to answer "yes," a temptation prevalent at conferences and sometimes in print. Yet, the stigma of being branded a racist organization is so odious that the accusation demands proof.

Proof begins with a definition of inequity and a formal process to test for it. This paper proposes a definition of inequity; offers a five-step process to measure it; compares the choices made in two of the best known inequity studies to those made in the five-step process; and illustrates the application of the process with national and state case studies of a particular LULU — waste-to-energy facilities. The discussion addresses some of the difficult issues that should be resolved by a representative panel.

## Definition and Process to Evaluate Inequity

Equity means different things to different people.[2] To some, equity focuses on outcome. The guiding principle is that the spatial-temporal distribution of benefits and burdens should be balanced; i.e., those who generate the need for the LULU should suffer the burden, not future generations or existing populations that gain relatively little from it. Consequently, if a disproportionate number of LULUs are found in disadvantaged communities, then inequity exists, i.e., correlation of LULUs and disadvantaged populations is sufficient to declare outcome inequity; deliberate intent (cause-and-effect) to site in areas populated by disadvantaged persons need not be proven.

A second definition focuses on process. If appropriate environmental, health, physical, legal, economic, and political criteria are applied to every area, then the results are fair even if they disproportionately burden some groups and benefit others. In other words, process inequity means that normal facility-siting criteria were deliberately ignored to locate LULUs in disadvantaged communities.

It is not the purpose of this study to choose between process and outcome inequity. Both are important. I focus on outcome because much has been written about it and little done to define criteria for

---

2 NATIONAL ACADEMY OF ENGINEERING, NRC, HAZARDS: TECHNOLOGY AND FAIRNESS (1986); ROGER E. KASPERSON, EQUITY ISSUES IN RADIOACTIVE WASTE MANAGEMENT (1983).

analyzing it.[3] I describe a five-step process to test for outcome inequity.

*(1) Who are the populations to be studied ?*

A consensual list of disadvantaged populations, e.g., African-, Hispanic- and Native-American; poor; young and old; infirm and future generations, is needed. Without it, interest groups have focused on racial, ethnic and income inequities. But there is good reason to be concerned about the very young and old, more vulnerable to environmental hazards because of immunological deficiencies, and those who are pregnant or have pre-existing health problems.[4]

*(2) What are the LULUs to be assessed?*
*What subset of each LULU is most indicative of outcome inequity?*

No definitive list of LULUs (e.g., nuclear generating stations, high and low-level nuclear waste sites, hazardous waste sites, landfills, etc.) exists, nor an index that compares them. Within any single type of land use category, a distinction can be made between larger, newer facilities located adjacent to areas with more population and smaller, older ones in areas with few inhabitants. This distinction is that old facilities may have been built before the existence of evidence that they may affect public health, environment, and community. Or they may have been built as pilot plants. The same rationalization cannot be made for large LULUs constructed or planned for population centers during the last fifteen years. Someone in the siting process should have been thinking about local concerns. Thus, greater inequity in newer and larger LULUs is implicit evidence of conscious recent efforts to target areas occupied by powerless people.

*(3) What are the burdens to be studied?*

Science measures burden by doing risk assessments and environmental and socioeconomic impact statements. But these exist only for some LULUs at some locations. Thus, researchers have

---

3 A notable exception is Roger E. Kasperson & Kirstin Dow, *Developmental and Geographical Equity in Global Environmental Change: A Framework for Analysis,* 15 EVALUATION REV. 149 (1991).

4 EDWARD CALABRESE, POLLUTANTS AND HIGH-RISK GROUPS (1978).

assumed that when outcome inequity exists, the community is disproportionately or potentially burdened by health effects, environmental contamination, property devaluation, and social and political stresses.

*(4) What are the geographical areas to be compared?*

Typically, researchers use census blocks, census tracts, zip code areas, special districts, cities, boroughs, towns, and counties as burdened areas and states or the U.S. as a whole as benefit areas. The choices can make an enormous difference. The area that most benefits should be compared to the area that bears the brunt of the fiscal, social, economic and environmental costs associated with the LULU.

*(5) What are the statistical methods to be used in evaluation?*

Ideally the location history of each LULU should be studied and a mathematical model constructed to capture that history. Lacking detailed histories and data, researchers have tended to compare the arithmetic means of benefit and burden areas.

Different statistics can lead to different conclusions about equity. In order to avoid unsubstantiated accusations, inequity should be demonstrated with at least two different types of statistics, at least one of which should be parametric (e.g., arithmetic mean) and one nonparametric (e.g., comparison of proportions).

## Two Examples from the Literature

The typical inequity report is about a disadvantaged minority neighborhood or city, or is a historical analysis of zoning, land use, and legal cases. The reports are hypothesis-generators and provide insights about process inequity. However, few studies are useful to examine outcome inequity.

PLAYING WITH FIRE and TOXIC WASTE AND RACE IN THE U.S. are exceptions.[5] The first compared average proportion of white residents, home owners, and the average income, home value, and rent of zip codes hosting 16 existing commercial hazardous waste incinerators and 24 proposed incinerators with the U.S. average values.

5 COSTNER & THORNTON and COMMISSION FOR RACIAL JUSTICE, both *supra* note 1, respectively.

The authors found average percent of minority population in zip code areas with facilities was 89% higher than the U.S.; and average income was 15% lower.

The analysts distinguished between existing and proposed commercial hazardous waste facilities. In other words, they explicitly made choices about which LULUs to compare (choice 2 of five). However, no other choice was explicit. There was no discussion of the elderly, young or other populations at risk (choice 1); no discussion of why the U.S. was the area of benefit (choice 4); and no discussion of alternative statistical methods (choice 5).

Using their raw data, I calculated 95% confidence limits for the nonwhite and income variables. These exceeded national averages, i.e., we cannot reject the null hypothesis at $p<0.05$ that their values for zip code areas with commercial hazardous waste facilities are the same as those for the U.S. average as a whole.

Benjamin Goldman, the analyst for TOXIC WASTE AND RACE IN THE U.S., has been the most explicit about the five choices. With respect to types of LULUs (choice 2), he compared four sets of zip code areas: (1) without an operating commercial hazardous waste treatment, storage, and disposal facility; (2) with one facility, but no landfill; (3) with one landfill that is not among the five largest in the U.S.; and (4) with one of the five largest landfills or with one more treatment, storage, and disposal facility. In addition to comparing the four groups, tests were made with only the largest capacity facilities.

With respect to geographical areas to compare (choice 4), Goldman used zip codes hosting hazardous waste facilities as the burdened areas. Recognizing the limitation of using a single area of benefit, he compared the zip code areas to the U.S. as a whole, the zip code areas within each of the ten U.S. Environmental Protection Agency (EPA) regions; and zip code areas within each of 43 states with sufficient data.

Five statistical methods were tried (choice 5).[6] Difference-of-mean tests, matched-pair t-tests, and non-parametric versions of these tests were used to explore differences between each of the four groups of zip

6 The author of this paper was the consultant on statistical methods to this project.

code areas described above. The matched-pair tests were particularly important. Each zip code with commercial hazardous waste management facilities was compared to the parts of the surrounding county without commercial facilities to control for local variations in market conditions and socioeconomic status. Discriminant analysis was used to identify variables best able to explain differences between the four mutually exclusive sets of zip code areas.

The only obvious limitation of this study was the choice of test populations. Goldman used percent minority, mean household income, mean housing value and indicators of hazardous waste production as the test populations (choice 1). The data base included elderly and young populations. But they were not tested for inequity.

The choice 1 decision had a marked impact on the perception of this most widely sited study. The national and regional discriminant analysis test results showed percent nonwhite to be frequently a significant discriminator with p ranging from <.01 to .20.

Mean family income was a much less powerful indicator. Yet, mean family income was a more powerful variable in the matched-pair tests. For example, percent minority was statistically significant in 5 in the 10 EPA regions and 5 of the 43 state comparisons. But the comparable results for mean income were 8 of 10 EPA regions and 10 of 43 states.

In short, Goldman's study made a series of carefully reasoned choices about types of LULUs, geographical areas and statistical methods. Yet, the limited choice of test populations when combined with the lack of emphasis on the matched-pair analyses in the final report has resulted in this report being cited as the strongest evidence of outcome inequity to African- and Hispanic-Americans. There clearly is outcome inequity for nonwhites, but there may even be greater outcome inequity for other populations that were not tested.

## Empirical Analysis of Waste-to-Energy Facilities

A case study of Waste-to-Energy Facilities (WTEFs) in the U.S. is presented to illustrate the impact of different choices at each step in the five-step process. The results of four tests are presented, which highlight the importance of different steps in the five-step process.

Facilities that burn the organic parts of the waste stream to create energy and reduce the volume of waste are LULUs. Most WTEFs are large and have visible airborne emissions, some of which — like dioxin, chromium and mercury — may pollute local communities. WTEFs create ash that must be buried on-site or hauled off and buried elsewhere. WTEFs, in other words, should be the type of pariah land use that so outrages most people that they would be sited into neighborhoods and towns occupied by relatively powerless people.[7]

The location of WTEFs in the U.S. was obtained from the 1991 Resource Recovery Yearbook.[8] The report listed 294 projects. Ninety-two of the 294 WTEF projects were excluded from the analysis for two reasons: 55 had no sites because they were in a conceptual stage, and 37 were permanently closed.

The remaining 202 facilities were the data set used in this study. A total of 140 were operational or closed down for retrofit; the other 62 were under construction or in a planning stage sufficiently advanced to include. An additional 10 WTEFs had to be eliminated from some of the statistical analyses because they were located in towns of less than 2,500 people. Demographic data, such as per capita income, tend not to be reliable in towns with so few residents. Detailed locations of over 30 were not provided in the report; these were obtained by phone.

*Test 1: Choice of LULUs to Study*

To illustrate the impact of the choice of LULU to study on the results, I compared towns with many residents (100,000 or more) and large WTEFs (>1,000 tons/day (t/d) capacity) with towns with few residents (<25,000) and smaller facilities (<1,000 t/d).

Table 1 compares these population and WTEF combinations using the town as the burdened area and its actual service area (not the U.S.) as the benefit region. African- and Hispanic-Americans, and per capita income (a surrogate for poor people) were the test populations.

7 Peter Sandman, *Risk Communication: Facing Public Outrage,* EPA J., Nov., 1987, at 21-22; JOHN SELEY, THE POLITICS OF PUBLIC-FACILITY PLANNING (1983); S. Crim, *The NIMBY Syndrome in the 1990s: Where Do You Go After Getting "No"?* Environmental Reporter, May 4, 1990, at 132.

8 EILEEN BERENYI & ROBERT GOULD, 1991 RESOURCE RECOVERY YEARBOOK.

Means and 95% confidence limits were calculated and compared to the U.S. as a whole. If LULUs are inequitably located in poor areas, then the arithmetic mean of per capita income in the towns should be significantly lower than the income of the U.S. To be sure that results did not depend on a single statistic, a simple non-parametric test statistic, difference-of-proportions and 95% confidence limits, was added to these initial tests. Either a town had a higher proportion of poor than its service area, or it did not. I computed 95% confidence limits for these proportions. If LULUs were randomly sited in towns, then half of the towns should have had lower incomes then their service areas and half the service areas should have lower incomes than the towns that host the LULUs. If LULUs were disproportionately located in poor towns, then far more than half of LULUs were sited in towns with poor people.

**Table 1**
**Test 1: Choice of LULUs to Compare**

| *Outcome Statistic* | | *Per capita income* | *% African- and Hispanic-Americans* |
|---|---|---|---|
| Design capacity and town population: | | | |
| >1,000 t/d and 100,000 people | | | |
| (n=17) | proportions [a] | 23.5%* | 88.2%* |
| | | (3.3 to 43.7) | (72.9 to 100.0) |
| | arithmetic mean [b] | −13.4* | 77.0* |
| | | (−21.9 to −5.0) | (21.2 to 132.8) |
| <1,000 t/d and <25,000 people | | | |
| (n=58) | proportions [a] | 60.3% | 43.1% |
| | | (47.7 to 72.9) | (30.4 to 55.8) |
| | arithmetic average [b] | 1.7 | 17.3 |
| | | (−3.6 to 7.2) | (−33.3 to 68.0) |

* Significantly different from service area at p<.05.
[a] The values in the table are the percentages of towns that have higher income than their service areas. For example, 30% means that only 30% of WTEF towns were more affluent than their service areas.
[b] The values are percentage differences between the towns and their service areas. For example, 5% means that the arithmetic mean for the towns is 5% higher than the comparative value of the service areas; −5% means that the towns' average is 5% lower.

To simplify the presentation, the results for distressed areas were expressed as a percentage of the results for the areas that benefit. For example, if the average burdened town had a per capita income of $20,000 and benefit area of $30,000, then the result was presented as –33.3% along with 95% confidence limits.

Marked differences were found between the 17 WTEFs with larger design capacities (>1,000 t/d) located in towns with at least 100,000 residents and the 58 WTEFs with smaller design capacities located in towns with populations less than 25,000. The larger facility-populous town combination had statistically significant inequities for per capita income and minorities. The smaller facility-less populated town combination had slightly higher per capita income than their service areas and much less minority inequity.

From these data, it would be difficult to convincingly argue that the WTEF industry as a whole has outcome inequity. Yet, the industry does have an inequity problem with large facilities located in populous cities and towns.

*Test 2: Choice of Areas to Compare*

I illustrate the impact of varying the region of benefit by comparing WTEF towns to the U.S. and to the service areas of the WTEFs. The service areas were reported in the 1991 Resource Recovery Yearbook or were obtained by a phone call.[9] The per capita income and the percentage African- and Hispanic-American were calculated for the WTEF towns and for their service areas. To make the WTEF town/service area comparisons, we eliminated 34 of the 192 WTEFs that served only one town, airport, hospital, military facility or university.

Table 2 compares the WTEF town/U.S. and WTEF town/service areas using the arithmetic mean and 95% confidence limits. The results for per capita income were not effected by the service area. WTEF towns had lower per capita incomes than the U.S. as a whole and lower incomes than their service areas. But the minority results depend upon the selection of benefit area. The WTEF town/U.S. comparisons show

9 *Id.*

less minorities than expected (4.2% less African- and Hispanic-Americans than the U.S.) In sharp contrast, WTEF towns averaged 45% more minorities than their service areas. In other words, racial/ethnic inequity existed if the service area was chosen as the area of benefit; it did not exist if the U.S. was the area of benefit.

**Table 2**
**Test 2: Choice of Areas to Compare**

| *Outcome Statistic* | | *Per capita income* | *% African- and Hispanic-Americans* |
|---|---|---|---|
| Proportions: [a] | | | |
| (n=192): | town % > U.S.% | 28.6%* (22.2 to 35.0) | 38.0%* (31.1 to 44.9) |
| (n=158): | town % > Service area% | 38.0%* (30.4 to 45.6) | 60.1%* (52.5 to 67.7) |
| Arithmetic mean of towns, % different | | | |
| (n=192): | from U.S. [b] | –4.9* (–7.6 to –2.1%) | –4.2 (–19.7 to 11.4%) |
| (n=158): | from service area | –5.4* (–8.4 to 0) | 45.1* (17.3 to 73.0) |

*Significantly different from the U.S. or service area at $p<.05$.
[a] The values in the table are the percentages of towns that have higher income than their service areas. For example, 30% means that only 30% of WTEF towns were more affluent than their service areas.
[b] The values are percentage differences between the towns and their service areas. For example, 5% means that the arithmetic mean for the towns is 5% higher than the comparative value of the service areas; –5% means that the towns' average is 5% lower.

*Test 3: Choice of Populations to Compare and Statistics*

I illustrate the complexity introduced by varying both the choice of populations and statistics. The areas compared are limited to the 192 WTEF towns and the U.S. The percentage of the population that was elderly was added as a test population. Besides the arithmetic mean and proportions statistics, I added the population-weighted statistic, i.e., the value for each town was multiplied by its population.[10] The population-weighted value was compared to the national value as above.

[10] *Consider, e.g.*, three towns with per capita incomes of $10,000, $20,000 and $30,000 and populations of 1,000, 2000 and 3000, respectively. Income for each was multiplied by its population, and these numbers were added, i.e., (10 x 1) + (20 x 2) + (30 x 3) = 140 (thousands). This sum was then divided by the sum of the populations of all the towns — 6,000 — to get the weighted value, $23,333.

Each of three evaluation statistics reveals something different about equity. The comparison of proportions makes each town equally important. Towns of 10,000 are as important as ones with 1 million. Yet, the dichotomy is biased against people living in large population centers. For example, every resident of a town of 10,000 is 100 times as important as a resident of a town of 1 million.

A second limitation is that the proportions test ignores extreme values. For example, suppose the percentage of minorities in the U.S. as a whole was 10%, and those in two sets of five towns were 2%, 6%, 8%, 30% and 90%; and 2%, 6%, 8%, 11% and 11%, respectively. The judgment based on proportions is the same for both sets of towns. That is, two of the five in both sets of towns had higher proportions of minorities (>10%) than the U.S. In other words, the non-parametric dichotomy is insensitive to the obvious greater inequity in the first set of towns (30 and 90 in the first set compared to 11 and 11 in the second).

The arithmetic mean and the population-weighted value overcome these two shortcomings, but have other limitations. For example, the arithmetic means of the above two sets of five places were 27.2% and 7.6%, respectively. The problem is that a few extreme values can drive the statistic. Ninety-five percent confidence limits tell the analyst that extreme values affect the results. But rarely are 95% confidence limits or other measures of dispersion around the arithmetic mean presented as part of inequity studies.

The population-weighted value corrects for bias against population centers, but is biased itself against towns without many residents. In order to correct for this, towns were divided into those with populations of 100,000 or more (42) and those with fewer than 100,000 (150).

Table 3 shows that per capita income results were not effected by the choice of statistic. The four negative percentages and 28.6% value for the proportions test in Table 3 show that WTEF towns had a disproportionate number of relatively poor Americans, irrespective of the statistical measure.

But the evaluation statistic clearly effected the minority population results. Only 38% of WTEF towns had a higher percentage of Africanand Hispanic-Americans than the U.S. as a whole (p<.05). Yet, the comparison of arithmetic means (–4.2%) and 95% confidence limits (–19.7% to 11.4%) show that WTEF towns had about the same proportion of minorities as the U.S. as a whole. The population-weighted value (65.1% higher than the U.S.) suggests inequity toward African- and Hispanic-Americans. That is, when the reality that African- and Hispanic-Americans tend to be located in cities is taken into account by the population-weighted value, then WTEFs appear to disproportionately burden these minority populations.

**Table 3**
**Test 3: Choice of Populations and Statistics**

| *Outcome Statistic* | *Per capita income* | *% African- and Hispanic-Americans* | *% elderly* |
|---|---|---|---|
| Proportions: town% > U.S.% [a] | 28.6%* (22.2 to 35.0) | 38.0%* (31.1 to 44.9) | 60.9%* (54.0 to 67.8) |
| Arithmetic mean of towns, % different from U.S. [b] | –4.9* (–7.6 to –2.1) | –4.2 (–19.7 to 11.4) | 9.0* (2.2 to 15.8) |
| Population-weighted, % different from U.S. [b] | –5.8 | 65.1 | 9.6 |
| Arithmetic mean of towns, % different from U.S.: [b] | | | |
| population ≥ 100,000 | –2.7 | 62.9* | 10.7* |
| (–8.6 to 3.2) | (28.5 to 97.4) | (1.0 to 20.4) | |
| population < 100,000 | –5.4* (–8.7 to –2.3) | –22.9* (–39.3 to –6.6) | 8.5* (0.3 to 16.8) |

*Significantly different from U.S. at p<.05.
[a] The values in the table are the percentages of towns that have higher income than their service areas. For example, 30% means that only 30% of WTEF towns were more affluent than their service areas.
[b] The values are percentage differences between the towns and their service areas. For example, 5% means that the arithmetic mean for the towns is 5% higher than the comparative value of the service areas; –5% means that the towns' average is 5% lower.

In short, using the comparison of proportions, we can argue that African- and Hispanic-Americans are underrepresented in WTEF towns. The population-weighted value suggests that they are overrepresented. The conclusion depends on the choice of evaluation statistic.

Sorting towns by population size helped clarify the relationship between WTEFs and population distribution. The 42 WTEF towns with populations of at least 100,000 had a disproportionate number of minorities (ave. 62.9% higher than the U.S.), yet the 150 that had populations less than 100,000 had disproportionately less minorities (ave. –22.9%) than the U.S. as a whole. Both of these proportions were statistically significant at $p<.05$ (Table 3). In other words, inequity in the case of WTEFs depends not only on the geography of LULUs, but also the geography of the characteristic being tested for inequity. This finding shows that it is improper to draw conclusions about equity without evaluation by different statistics, including a parametric one such as the arithmetic mean or population-weighted value and a nonparametric one such as the comparison of proportions.

Table 3 also showed that the most consistent and strong inequity was for the elderly, not for income and race/ethnicity. Towns with WTEFs had more elderly than the U.S. for all five comparisons. By comparison, racial/ethnic inequity was only observed for two of the five comparisons (population-weighted value, population 100,000 or more). Inequity was observed for all five measures of income. But for all four of the parametric statistic comparisons, there was greater inequity for the elderly (9, 9.6, 10.7 and 8.5 for the elderly compared to –4.9, –5.8, –2.7 and –5.4 for per capita income).

*Test 4: New Jersey Case Study*

New Jersey has among the most difficult solid waste management problems in the U.S.[11] The most densely populated state in the country, it has gone from an importer of solid waste to an exporter in a decade. This changeover has caused the state government to argue against proposed federal legislation that would ban interstate garbage shipments; to increase tipping fees at disposal sites by more than ten times; to institute a mandatory recycling program that has already captured almost 60% of formerly landfilled waste; and to consider constructing many large incinerators. Using town and zip code data, and adding percent population 0–4 years old as a fourth population at risk, I

---

11 Glen Belnay & Michael Greenberg, *Participation Politics, Factors that Influence Recycling,* MSW MGMT., July/Aug. 1992, at 39.

use New Jersey to study the question of inequity in WTEF location in one state.

The 1991 Resource Recovery Yearbook listed thirteen New Jersey projects. One serves only a military facility. The remaining twelve serve or were proposed to serve areas ranging from a single county to several. We used the proportions, arithmetic mean and weighted value as the evaluation statistics; the service area as the region of benefit; and the zip code of the facility and the town of the facility as the impacted areas.

**Table 4**
**Test 4: New Jersey Case Study**
**(Based on twelve towns in New Jersey with WTEF)**

| *Outcome Statistic* | *Per capita income* | *% African- and Hispanic-Americans* | *% elderly* | *% young* |
|---|---|---|---|---|
| Proportions: [a] | | | | |
| town% > service area % | 41.7% | 25.0%* | 41.7% | 50.0% |
| | (13.8 to 69.6) | (0 to 49.5) | (13.8 to 69.6) | (21.7 to 78.3) |
| zip code% > service area% | 41.7% | 16.7%* | 66.7% | 25.0%* |
| | (13.8 to 69.6) | (0 to 37.8) | (40 to 93.4) | (0 to 49.5) |
| Arithmetic mean: [b] | | | | |
| town, % different | –9.0 | 33.8 | –7.0 | 6.2 |
| from service area | (–22.1 to 4.0) | (–56.7 to 124.3) | (–24 to 10.3) | (–9.1 to 21.6) |
| zip code, % different | –11.1* | –1.0 | 6.2 | 0.8 |
| from service area | (–20.3 to –2.0) | (–72.2 to 70.2) | (–7.8 to 20.1) | (–12.9 to 14.4) |
| Population-weighted value: [b] | | | | |
| town, % different from service area | –24.0 | 171.9 | –12.6 | 18.8 |
| zip code, % different from service area | –8.6 | 6.6 | 2.3 | –1.7 |

*Significantly different from service area at p<.05.
[a] The values in the table are the percentages of towns or zip code areas that have higher income than their service areas. For example, 30% means that only 30% of WTEF towns were more affluent than their service areas.
[b] The values are percentage differences between the towns or zip code areas and their service areas. For example, 5% means that the arithmetic mean for the towns is 5% higher than the comparative value of the service areas; –5% means that the towns' average is 5% lower.

The results illustrate how difficult it is to evaluate even a few populations at a few geographical scales, especially when the number of facilities is limited. Table 4 provides 24 comparisons of the towns and zip code areas with the WTEF service areas. The six measures of income showed that relatively poor towns and zip code areas tend to be selected. The arithmetic mean values at the zip code scale was statistically significant (zip code, average –11.1%, $p<.05$).

None of the other three populations studied demonstrated consistent results. For example, nine of the twelve towns with existing or proposed WTEFs have a smaller proportion of minorities than their service areas. Thus minority towns did not seem to have been targeted. But several WTEFs were located in or proposed for towns with much higher proportions of African- and Hispanic-Americans than their service areas. Hence the arithmetic mean (33.8% higher than their service areas) and population-weighted value (171.9% higher than their service areas) for towns show racial/ethnic inequity.

The zip code areas surrounding the WTEF sites show no evidence of racial/ethnic inequity. The proportional comparisons (only 16.7% were higher than their service areas) clearly suggests that the host zip code areas had relatively fewer nonwhites (1980 census definition) than their service areas. The average (–1%) and weighted average (6.6% higher) showed that the host zip codes are about the same as their service areas.

All three elderly tests showed that the towns have slightly less elderly than their service areas (ave. –7%). But all the zip code tests manifested slightly more elderly than their service areas (ave. 6.2% higher).

The results of the tests for distributions of young New Jersey residents also were inconsistent. For example, nine of the twelve zip code areas had a lower proportion of young than their service areas. But the average values, being affected by extreme values, showed more young in the burdened towns than in the service areas.

I will not further complicate this presentation with more data, but I do note that comparisons of the towns and zip code areas with the U.S. and New Jersey as a whole were also conducted, along with comparisons based on size of facility and tests using other statistics. Rather than forming a consensus result about inequity, these additional tests further demonstrated that it was not feasible to arrive at one.

## Discussion

Perhaps WTEFs are an unusual breed of LULU. Landfills, chemical plants and petroleum refineries, electricity generating stations, sewage plants and other LULUs might present an unequivocal "yes" or "no" when tested for outcome inequity. Yet, most LULUs have gone through technological innovations, and I would expect complex patterns on the ground.

Because "environmental racism" and similar slogans can lead to serious political and economic impacts for owners and operators, I urge the U.S. government to ask an organization with high credibility and objectivity to conduct a policy analysis of environmental inequity based upon an agreed upon protocol devised by representatives of government, industry, advocate groups and university scientists.

EPA has unilaterally begun an effort. In response to reports and charges of environmental racism, Administrator William Reilly stated that "talk of environmental racism at EPA and charges that the agency's efforts pay less regard to the environments of poor people infuriate me. I am determined to get to the bottom of these charges to refute or respond to them."[12] He appointed an Environmental Equity Working Group of 40 EPA professionals to consider the evidence and recommend a response. Among the recommendations of the group were to increase the priority given to environmental equity issues, establish and maintain a data base by income and race, and develop a research plan.

While I applaud EPA's initiatives, I do not believe that an internal working group of one agency can do a comprehensive analysis that will be recognized by all the stakeholders. At a minimum, I recommend that representatives of Housing and Urban Development, the Department of Justice, state and local governments, labor unions, as well as EPA be included. Furthermore, the interests of racial/ethnic minorities, labor unions, the impaired, the elderly, children and global environment groups must all be represented in a consensus on a set of principles for

---

12 William Reilly, *Environmental Equity: EPA's Position,* EPA J., Mar./Apr. 1992, at 18; OFFICE OF POLICY, PLANNING AND EVALUATION, EPA, ENVIRONMENTAL EQUITY: REDUCING RISK FOR ALL COMMUNITIES, REPORT TO THE ADMINISTRATOR (1992).

assessing process and outcome inequity. A government-wide commission is probably necessary.

To fairly assess process equity requires a protocol that can evaluate the inequity of commonly used siting processes. It also requires principles that can suggest the rights and responsibilities of different government, corporate, and private organizations, as well as individuals in siting and managing LULUs. A good deal of interesting academic and practical work has already been done on process equity.[13] In comparison, little empirical work has been done on a protocol for outcome inequity. Each of the steps defined above raises issues that should be considered. For example, with respect to Step 1 (choice of populations to study), a list of disadvantaged populations is needed. African- Hispanic-, Native- and poor Americans seem to be the focus of attention. The young and elderly should also be included.

But should recent immigrant groups also be included? Or must they also be poor? In addition, consideration should be given to future generations. But how should future generations be represented? One way is by including aquifers and forest areas, salt-water swamps, and endangered species, all of which may be extremely important to future generations, as well as those already living.[14]

With respect to Step 2, a panel needs to provide a prioritized list of LULUs to evaluate. Steps 2 and 3 (list of burdens) need to be considered simultaneously. Health risk is the most obvious way to rank them. But environmental risk should be considered. Also, economic impact, social and political implications cannot be neglected because they affect public perceptions. Selection of burdens to evaluate influences choice of LULUs to evaluate.

At a minimum, the closest approximation to neighborhood (zip code, census blocks or tracts) and municipality should be used as areas

---

13 LAWRENCE SUSSKIND, BREAKING THE IMPASSE: CONSENSUAL APPROACHES TO RESOLVING DISPUTES (1987); NATIONAL ACADEMY OF ENGINEERING, *supra* note 2; SELEY, *supra* note 7; B.J. HANCE, CARON CHESS & PETER SANDMAN, INDUSTRY RISK COMMUNICATION MANUAL: IMPROVING DIALOGUE WITH THE COMMUNITY (1990).

14 Edith Brown Weiss, *In Fairness to Future Generations,* 32 ENV'T 7-11, 30-31 (1990).

of potential burden (Step 4). Careful consideration needs to be given to a method of defining primary and secondary areas of benefit for each type of LULU and a way of weighting these areas in an overall aggregate analysis.

It is inevitable that landfills, power plants and other types of LULU will burden someone. The burden becomes inequitable when a specific type of LULU consistently burdens many powerless populations. Having chosen populations to be tested, LULUs to be examined, burdens to be studied, and areas of burden and benefit, it remains to select methods for testing the hypothesis that outcome inequity exists (Step 5). This paper has demonstrated that one parametric and one nonparametric method should be used at a minimum. But more are doubtlessly needed, including perhaps a multivariate statistical model that can control for the reality that variables, such as poverty, race, and age are frequently related.

Finally, we need a protocol that covers adequate reporting of results. Does adequate reporting include formally stated hypotheses and null hypotheses, and require pre-selected levels of statistical significance? What should be the requirements for reporting data quality and limitations? Should researchers be required to state the power of the statistical tests to detect false results, especially false negatives? Most important, what should be the responsibilities to report both findings of equity and inequity for each type of LULU?.

It is not my goal to state how existing inequities should be addressed, nor which should be given priority. Rather, my goal is to suggest that we can only avoid unfair branding of owners and operators of LULUs by arriving at consensual principles of outcome and process inequity and protocols for fairly testing for them. I hope the five steps presented and illustrated here engage others who will join in searching for a scientifically sound and fair process of resolving conflicting interests in the location of LULUs.