Street Science

Community Knowledge and Environmental Health Justice

Jason Corburn

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The Mapping of Local Knowledge

Tell me, I forget.
Show me, I remember.
Involve me, I understand.
—Anonymous

Community scientists often map what they know about environmental health in order to communicate to both local people and professionals. Maps ranging from cartoon sketches by young people to sophisticated GIS images can powerfully display and communicate *street science*. Maps may not influence professionals, though, even when community knowledge is joined with advanced technologies such as GIS. Maps, as a medium for communicating *street science* about community environmental health problems, are crucial tools for community members. But like other modes of communication, maps can distort as much as they can reveal.

The Toxic Avengers

The Toxic Avengers was founded in 1988 by a group of high school students who organized themselves to raise community awareness about environmental pollution. The name came from a comic book of the same name, whose characters were crusaders against toxic waste.[44] The students were from the El Puente Academy high school and the community organization's program on community health, youth service, and leadership. What began as a science-class project turned into an organization that raised environmental awareness in the community and helped galvanize a community coalition that would be instrumental for taking action against neighborhood environmental hazards.

The young people who formed the Toxic Avengers were part of a science class that was doing a unit on understanding the neighborhood environment. The class researched local hazards by gathering readily available information from local, state, and federal environmental agencies on the environmental performance of facilities in the community. The students also searched through newspaper archives to find references to environmental pollution in their neighborhood. They discovered, for example, that the Radiac Corporation—a storage and transfer facility for toxic, flammable, and low-level-radioactive waste located in the neighborhood—was the only facility of its kind in the entire city.

The class instructors, with the help of local environmental activists and agency professionals, organized environmental "tours" of the neighborhood. Environmental professionals and activists often led these "toxic tours" in which students visited the local sewage-treatment plant, natural-gas tank farm, waste-transfer station, scrap-metal recycling facility, Superfund site, depot for sanitation trucks, and other locally noxious industries. Students also identified the "green" spaces in the neighborhood. On the tours, the gravity of each environmental insult often was felt immediately because of fumes, odors, or noise levels. While on the tours, students took photos and recorded their observations, feelings, and perceptions about each site.

The students returned to the classroom and were tasked with developing a "community-risk map." Community-risk mapping is a process adapted from the practices of labor organizers, often in farming and other industries, where potential health and safety risks exist in the workplace (Hesperian Foundation 1998; Mujica 1992; Smith, Barret, and Box et al. 2000). In workplace-risk mapping, workers identify and categorize risks they face then plot them on maps of their work environments. Workers are encouraged to use symbols and other nontraditional mapping devices to display the locations of areas or tasks in the workplace where they have experienced or perceived dangerous or noxious conditions (Mujica 1992). Community-risk mapping emulates the workplace mapping process and generally involves a group brainstorming session to list hazards, code and symbolize these hazards, and then map them on large poster-board. The process, also analogous with commu-

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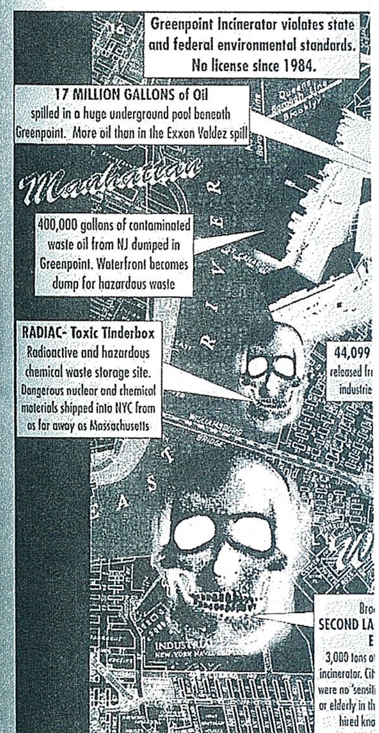

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nity "visioning" sessions commonly used for planning purposes, can be particularly effective when used in communities where residents may be uncomfortable with public speaking or technical information, are not fluent in English, and seek a means for creatively expressing how they perceive their neighborhood (Aberley 1993; Ames 1998).

The Toxic Avengers used what they learned in science class to develop a map of the community for the explicit purpose of organizing residents. After learning that an upcoming public hearing would be reviewing the operating permit of the Radiac waste storage and transfer facility, the students decided to use their map of the neighborhood to draw attention to the poorly maintained and, in their eyes, dangerous facility. The Avengers came up with a map that became affectionately known as the Skulls map (figure 6.1). The map was turned into a

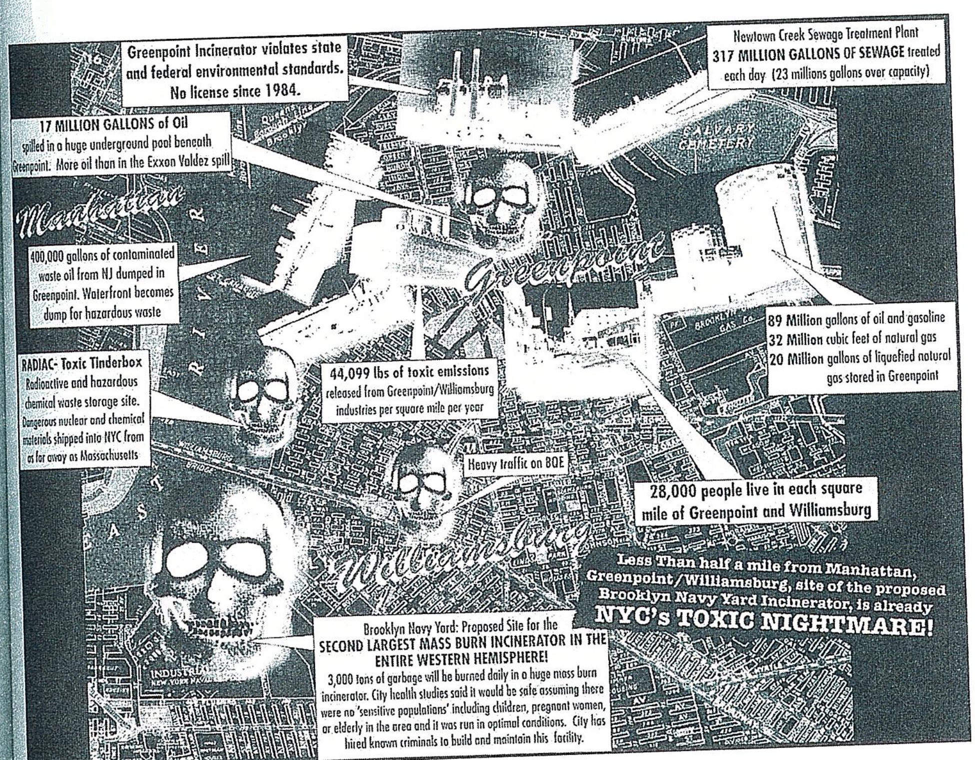

Figure 6.1.
Toxic Avengers skulls map. Source: El Puente Toxic Avengers.

poster and used to publicize the Radiac hearing throughout the neighborhood. The risk-mapping process created more than a new image of the community. The process itself helped build a new network of young activists, created a new organization for young people to express their knowledge, and helped galvanize other community members to consider the environmental-health challenges in front of them.

What Maps Do

Maps perform at least three political functions in relation to knowledge. First, maps always *aggregate and select data* and how they do this can lead to enormous differences in interpretive outcomes. Second, maps are *identity forming* devices since the symbols used to visually present information give "life" and persuasiveness to certain representations. Third, maps are always *boundary makers* by including some information and excluding others.

Aggregation

How maps aggregate information for visual presentation may lead to enormous differences in interpretive outcomes. The maps and images that are used as standard ways of seeing a problem tell us whose vision matters, what should be rendered visible, and what should be made invisible. Maps are also always made for certain purposes, such as to convince an audience of a certain point of view, and they provide rules for real-world decisions. A particular map "wins" or becomes the dominant image of the day by resonating with those in political power (Scott 1998). For example, *National Geographic* often is cited for generating maps during the Cold War with an explicitly Western perspective; the Soviet Union was portrayed as a large (and presumably dangerous) land mass compared to Europe and the United States. Similarly, maps of the world often have portrayed Africa as smaller and less prominent (and thus less important) compared to Europe and North America (Monmonier 1996).

Yet, the power of maps for (mis)representing reality remains a contentious subject in planning, science, and policymaking. Harley (1989) notes that maps represent hypothetical generalizations and are always, to some degree, inaccurate. They model a reality known to be more complex than any map can portray. Yet, at the same time, maps exert a com-

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Boundary Making

Mapmaking also can be understood as a scientific process, where some information is selected and others excluded in order to make the project legible (Lynch and Woolgar 1990). For example, Gieryn (1995) notes how mapmaking acts as a powerful metaphor for understanding the production of scientific knowledge itself. Science often is portrayed as an "empty map" that becomes filled in by certain groups or institutions in order to have influence over a particular audience. The "mapmaking" of science is the decision to include and exclude certain information, and thereby to create boundaries around what counts as science. In other words mapping, like science, always shows a limited representation of a complex reality and generates provisional, contextual, and always amendable information (Gieryn 1995, 406).

Yet, the production of visual images can extend the influence of science, often taking on a life of its own. For example, Latour (1988) introduces the idea of the "immutable mobile," which is an image such as a map that is a fixed display of information and is used in different times and contexts to represent ideas or facts. One common example is the picture of the earth suspended in space, which has come to represent such things as environmentalism, holism, peace, and a number of other things. The meaning of the image, how it was produced, and by whom often is taken for granted or even ignored when it is used.

Ultimately, the legitimacy and credibility of a map is judged by what the cartographers choose to include in the physical rendering and the trustworthiness of the cartographers themselves. By creating boundaries around what is and is not important to see, maps can encourage viewers to "see like the state" or suggest some other imagined vision (Anderson 1991; Scott 1998). As Harley notes, mapmaking is a political process that deserves a critical analysis:

> All maps strive to frame their message in the context of an audience. All maps state an argument about the world and they are propositional in nature. All maps employ the common devices of rhetoric such as invocations of authority and appeals to a potential readership through the use of colors, decoration, typography, dedications, and written justifications of their method. Rhetoric may be

concealed, but it is always present, for there is no description without performance. (Harley 1989, 11)

Thus, the mapmaking "performance" should be recognized as a political process that can reveal much about the society within which the image is created.

Identity Formation

Ultimately, while maps are models of reality, they also shape that reality. In environmental planning, maps often reflect the views of scientists and policy makers about what knowledge and whose perspectives are authoritative, whether one or a plurality of plausible interpretations are legitimate, and at what scale a problem ought to be addressed (i.e., local, state, federal). For example, land-use maps are often de facto "base maps" used to describe the attributes of a place, implicitly suggesting that making physical changes to the land-use of a place is the principal means to address local issues (Hayden 1995). Peter Hall (1994) argues that the widespread institutional acceptance of land use mapping has helped perpetuate the "functionalist" view of city planning as the dominant paradigm in the field. In the functionalist view, planning is defined by how professionals label, demarcate, and separate land uses into zones and classify these areas by their function. In this case, mapping and particular types of standardized maps, have defined an entire field.

One of the most common tools used to model reality in urban planning today is the geographic information system (GIS). The GIS technology is a means of integrating spatial and nonspatial information into a single computer system for analysis and graphical display. The technology allows users to input vast amounts of information, perform statistical spatial analyses, and generate images of data analyses that extend the vision of the modern geographer. However, the reliance on computer-generated maps has been criticized for raising obstacles for public participation in and understanding of the mapping process. For instance, lay publics, especially those from disadvantaged groups, may have limited knowledge of and access to computers. Since the assumptions underlying computer-produced maps are buried within the computer application itself, GIS may further hinder lay understanding of the mapping process. Yet, at the same time, the increased availability of computing power also

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might lead to the democratization (or at least accountability) of mapmaking, precisely because citizen groups may be able to offer their own computer-generated maps.

The "GIS revolution" in planning has perpetuated an almost unfettered trust by both users and consumers of planning information in quantitative data as the most legitimate information for generating accurate spatial analyses, making maps, and ultimately characterizing places. Another emerging implication is that the technology is beginning to frame social problems as spatial research questions. In a note of irony and precaution, Monmonier (1996) reveals that the errors, inaccuracies, and imprecision inherent in GIS devolve from one of the technology's greatest strengths: the ability to collate and cross-reference many types of data and discrete data sets by location, called "geo-coding," in a single system. As new data sets are imported, the GIS also can inherit its errors and combine these with errors already in the system. Users of GIS must concern themselves as much with "cleaning" disparate data sets to match one another as with devising strategies to visually display the data.

As professionals increasingly rely on GIS in their work, some are making efforts to incorporate public stakeholders, especially community members, into the spatial mapmaking process (Aberley 1993). Efforts at public participation in GIS often include processes to incorporate local knowledge into data sets (Craig and Elwood 1998; Robbins 2003). As community members increasingly become both producers and consumers of GIS, planning processes and participants will continue to be shaped by this and other professional mapping technologies.

Maps as Organizers of Attention

The Toxic Avengers' Skulls map (figure 6.1) describes the neighborhood as "NYC's toxic nightmare." It shows skulls describing numerous local hazards and uses both graphic visuals and text. The background, or base map, is a photocopied tax-surveyor map made to look like an X-ray, enhancing the sense of urgency that pollution is compromising personal health. Photographs of industrial facilities used to identify the locations of particular polluters personalize the map for local residents since most would recognize the facilities. However, the pictures were slightly "whited out" to look almost ghostly.

The Toxic Avengers brought the map to Luis Garden-Acosta, El Puente's founder and executive director, in an effort to encourage him to personally invite the neighborhood's Hasidic Jewish population to the Radiac hearing. After seeing the map, Acosta was convinced that all the community's ethnic groups would need to work together to improve environmental conditions (Hevesi 1994). According to Garden-Acosta:

> It was nothing but confrontation [with the Hasidim] before young people from the Toxic Avengers came to me and said, "Isn't it time to ask the Hasidim to join forces with us in reclaiming our environment?" It was their request and their graphic map gave me the "ah ha" that we all breathe the same air. (quoted in Hevesi 1994)

Acosta sent an invitation to Rabbi David Niederman, executive director of the UJO of Williamsburg, to come to a planning meeting for the Radiac event. Niederman agreed to meet with El Puente and bring other Hasidim with him after El Puente agreed to hire police to guarantee their security. As Garden-Acosta recounts those events in May 1991:

> It was a historic moment when a Hasidic rabbi, a leader of the Satmar, walked through the doors of El Puente. We were planning a march to a hearing on Radiac emergency procedures, and Rabbi Niederman volunteered to help lead that march through Latino streets. I can't describe what a change that meant. It was a clear act of courage on the part of David Niederman. (quoted in Hevesi 1994)

The multiethnic march raised interest in the issues, and over 200 people attended the hearing. The success of the event encouraged the two groups to organize an "environmental town meeting" to raise awareness about local hazards and specifically to educate residents about a proposed municipal waste incinerator in the Brooklyn Navy Yard. According to Niederman, the meeting was necessary because no group alone could confront the multiple environmental threats the community faced: "We were facing the incinerator, lead poisoning, garbage transfer stations, chemicals from abandoned factories around here, sandblasting from the bridge and Radiac. We had to come together" (quoted in Hevesi 1994).

The incinerator proposal galvanized the community, which saw the project as treating their homes as the dumping ground for unwanted garbage. The incinerator was supposed to be the most cost-effective way for the City to dispose of municipal solid waste. In the 1980s, after closing all but one landfill and most of its incinerators, New York City feared a garbage-disposal crisis. The possibility of a crisis made headlines in 1987 when a garbage barge called the "Mobro," carrying 32,206 tons of NY refuse, left Islip on a six-month journey in search of a place to unload. The barge, turned away by several states and three countries, eventually returned to New York; most of its garbage was burned at the Southwest Brooklyn incinerator (Miller 2000). Soon thereafter, the City devised a comprehensive solid-waste management plan that would close the 22 City-operated incinerators and the over 1,200 private apartment-building incinerators. In order to handle its waste, the City planned to build eight new incinerators and the Williamsburg facility was planned as the first and largest (Miller 2000).

The Brooklyn Navy Yard incinerator was proposed as a "state of the art" facility that could burn nearly one-third of the city's daily municipal waste (approximately 3,000 tons per day at the time of the proposal) and was supposed to ease the burden on the only operating landfill site in the city, Fresh Kills on Staten Island (Waldman 1997). At the time, the largest incinerator in the city was burning 550 tons per day. Neighborhood residents, along with city, state, and national environmental groups sued the City to stop the proposed project based on the expected increased truck traffic and unsafe air emissions (Liff 1992; Sullivan 1995). Barry Commoner, who emerged as a vocal opponent of the project, claimed that dioxins from the incinerator would poison local residents (Commoner 1992, 109–119).

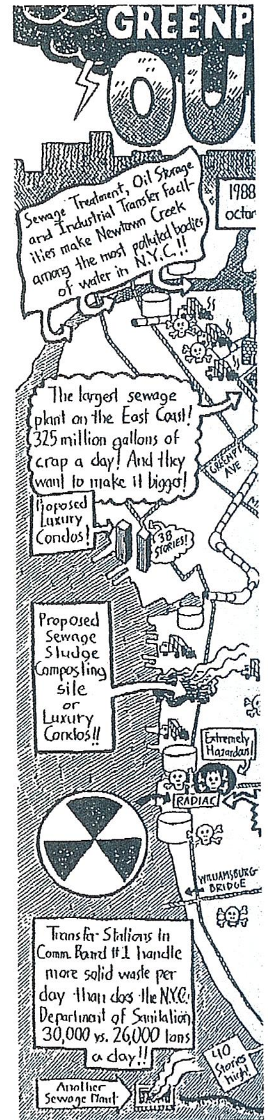
The town meeting brought together community leaders representing different issues and ethnic groups to speak about hazards in the community and the need to organize together to stop the incinerator. According to Elizabeth Colon, executive officer of the Brooklyn Navy Yard corporation, the meting was as much about the future direction of community development, particularly concerns over the changing economic realities in the neighborhood, including "unemployment and a deteriorating economic base," as about environmental issues (Hevesi 1994). Residents also feared that if the City was allowed to build an incinerator on the property of one obsolete industrial site, a similar fate would await the hundreds of other decaying and abandoned industrial properties scattered around the neighborhood.

The Toxic Avengers helped develop another map of the community. The "Our Town" map (figure 6.2) was intended to show that the community was under multiple environmental stressors, not just the proposed incinerator. Like the Skulls map, the Our Town map used graphic displays of death and danger to portray the neighborhood. Skulls and crossbones were used to label toxic storage sites, a large nuclear symbol identified the Radiac facility, and black smoke was shown coming from stacks to identify the proposed incinerator sites around the community. The Our Town map also was filled with descriptive information about the amount of pollution emitted from local facilities.

Over 1,200 residents attended the environmental town meeting, which ended with a commitment from leaders of the Latino, Hasidic, African-American, and Polish communities to form the Community Alliance for the Environment (Greider 1993).[45] The first action CAFE planned was a multiethnic march over the Williamsburg Bridge during rush hour to protest the proposed incinerator (Hevesi 1994).[46] The Toxic Avengers' map helped educate and organize the new multiethnic environmental coalition. The 1992 march has been credited as one of the key turning points that eventually convinced the City to mothball the incinerator proposal (Sullivan 1995).

Both the Skulls and Our Town maps reveal the creativity and awareness young people can bring to an environmental issue. They suggest that, as Mumford noted, the planning process often begins "with a dynamic emotional urge, springing out of a sense of frustration on one hand and a renewed vision of life on the other" (1938, 359). The maps acted as powerful representations of a "dying neighborhood" inundated with hazards. On each map, almost no space was left for viewers to see what else was in the neighborhood besides the polluting facilities. The maps help "pattern attention selectively," or reveal what some residents' value. They publicly express allegiances and prepared residents "to recognize new issues and attend creatively and responsively to particular struggles at hand" (Forester 1999, 139). The maps accomplished their mission of organizing and galvanizing an important multiethnic environmental coalition in the neighborhood.

Students were able to combine local knowledge and professional data into powerful visual information. Visualizing local knowledge, whether



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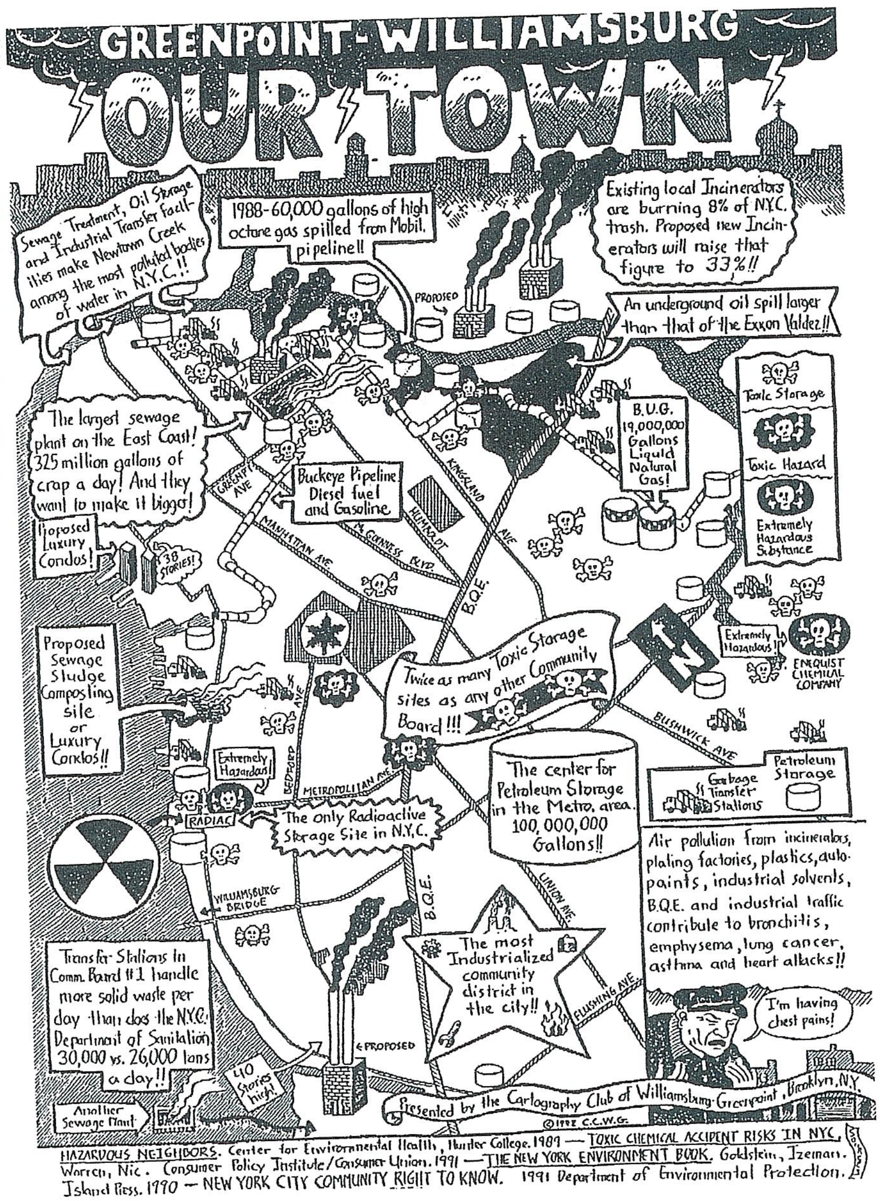


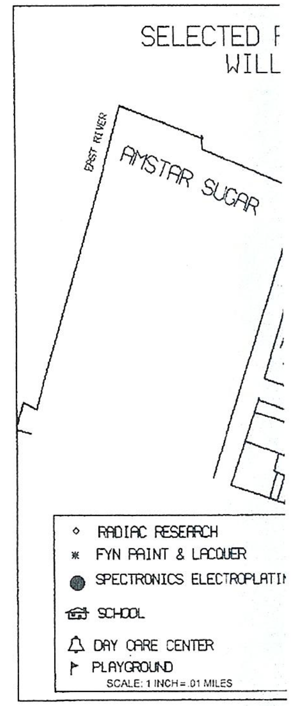
Figure 6.2.
"Our Town" community map. Source: Cartography Club of Williamsburg/Greenpoint.

through community maps, murals, or theater, allows local people to express what they know, share it with other community members in a way that is understandable for all, focus discussion, and propose options for action. As tools for educating community members, sharing experiences, and mobilizing action, maps can be as or more important than local knowledge as text, particularly in communities with disparate levels of formal education, common language, symbols, and traditions. But while the student maps showed that mapping local knowledge can be important for influencing people *within* the community, it is less useful for relating to outside professionals.

The student maps gave "voice" to those previously silent about environmental hazards and showed how residents perceived local pollution and its impacts on different groups within the neighborhood. And while the maps did not help extend professional science, they stimulated community interest in developing other visual portraits of neighborhood pollution.

Contested Images: Community and Professional Maps

The student maps were low-tech images that contained a lot of detail but were cartoonlike. Community groups realized during the incinerator battle that they would have to start generating maps to compete with technical experts in order to make their point of cumulative environmental impacts in the neighborhood (Swanston 1999). Soon after CAFE formed, the Watchperson Project was created. Part of the Watchperson Project's charter included developing GIS and making it accessible for community members (ICLEI 1993; Sweeney et al. 1994). Beginning in 1993, the Watchperson Project partnered with Hunter College to gather electronic data to enter into a community-based GIS. A key goal for the community was to use the GIS for analyzing the proximity of polluters to residents and to develop sophisticated and "official looking" maps (Hanhardt 1999). The Watchperson Project initially used GIS to produce maps displaying the relationship between hazards and residents, schools, and other sensitive receptors. One of the first published maps displayed the proximity of the Radiac facility, an electroplater, and a sugar factory to a school, day care center, and neighborhood playground (figure 6.3). The community first used the GIS to challenge a City-backed project during a



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GIS map depicting selected
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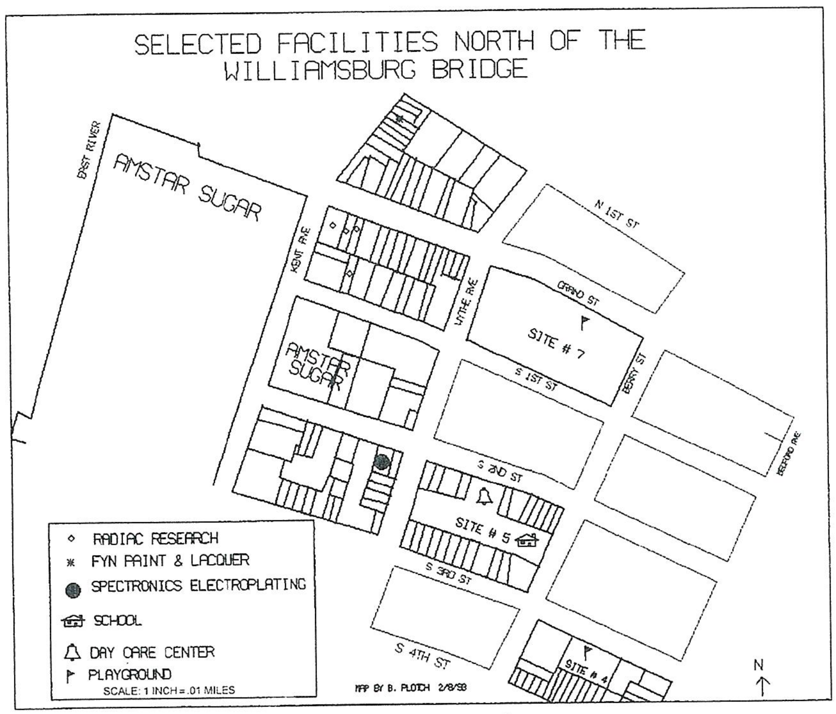

Figure 6.3.
GIS map depicting selected facilities north of the Williamsburg Bridge. Source: Watchperson Project.

public hearing over the permitting of a controversial waste-transfer station in the neighborhood.

In April 1998, the city Department of Sanitation (DOS) and the state Department of Environmental Conservation (DEC) approved the siting of the largest waste-transfer station in the city's history.[47] The transfer station, which was permitted to process up to 5,000 tons of waste per day on the Kent Avenue site known as Eastern District Terminal, would be operated by the USA Waste Services Corporation (Saltonstall 1998).[48] The 60,000-square-foot facility was approved by the DOS and DEC without an assessment of potential environmental, traffic, and public health impacts. The agencies granted the facility a "Neg Dec," declaring that the facility posed no potential significant impact on the community. A coalition of community organizations sued the state claiming that the size of the facility required an environmental impact statement.[49] A public hearing, the required final step in the permitting process, was held in April after the facility's approval.

Representatives from a number of community groups testified against the proposed facility. From restaurant owners, who said the noise, dust, and smell of the facility would destroy their business, to community leaders such as Rabbi Niederman, who claimed that the trucks and pollution would put all community residents at risk. The testimonials of over 200 residents occupied almost the entire hearing and carried the proceeding well past midnight.[50] An administrative law judge presided over the hearing. Samara Swanston, presented a series of maps showing the areas in the community that would be impacted, such as those along truck routes. The maps also showed the number of existing waste-transfer stations and their proximity to low-income and minority-group populations. According to Swanston:

> We tried to make the case that not only was this mammoth facility going to hurt business, it was also part of a pattern of environmental injustice in the neighborhood. When community folks start talking about environmental justice, regulators tend to cringe, and that is what the DEC did. But, the ALJ [administrative law judge] was more open. I think he hadn't really heard of the issue before. When we put up the map of the cumulative hazards and I asked him if he'd want his kids to live here, he kind of did a double take. (Swanston 1999)

The cumulative hazard map showed the truck routes, the locations of the neighborhood's transfer stations, school and park properties, and sites where toxins were used and released (figure 6.4). The map also plotted the locations where elevated lead levels were found in neighborhood children, an oil plume underneath the neighborhood, and the sewage treatment plant. According to Heather Roslund, an activist with Neighbors Against Garbage (NAG), the map was significant because:

> It gave us legitimacy. We not only gave our testimony, but we showed them [DEC and DOS] that we also did our homework and had technical skills. The community maps showed that we were not just about NIMBY, but that this was a much larger issue about environmental hazards and social justice. We showed that we were prepared and could go head-to-head with the city, state and even a big corporation like USA Waste.

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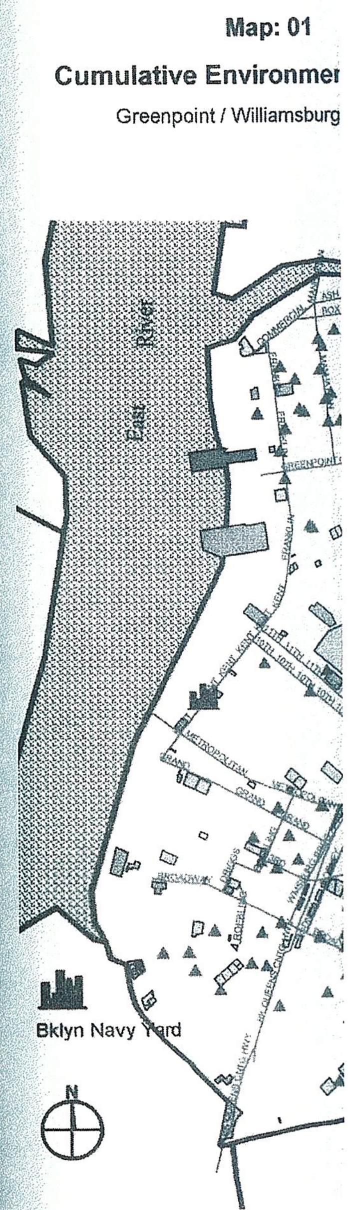

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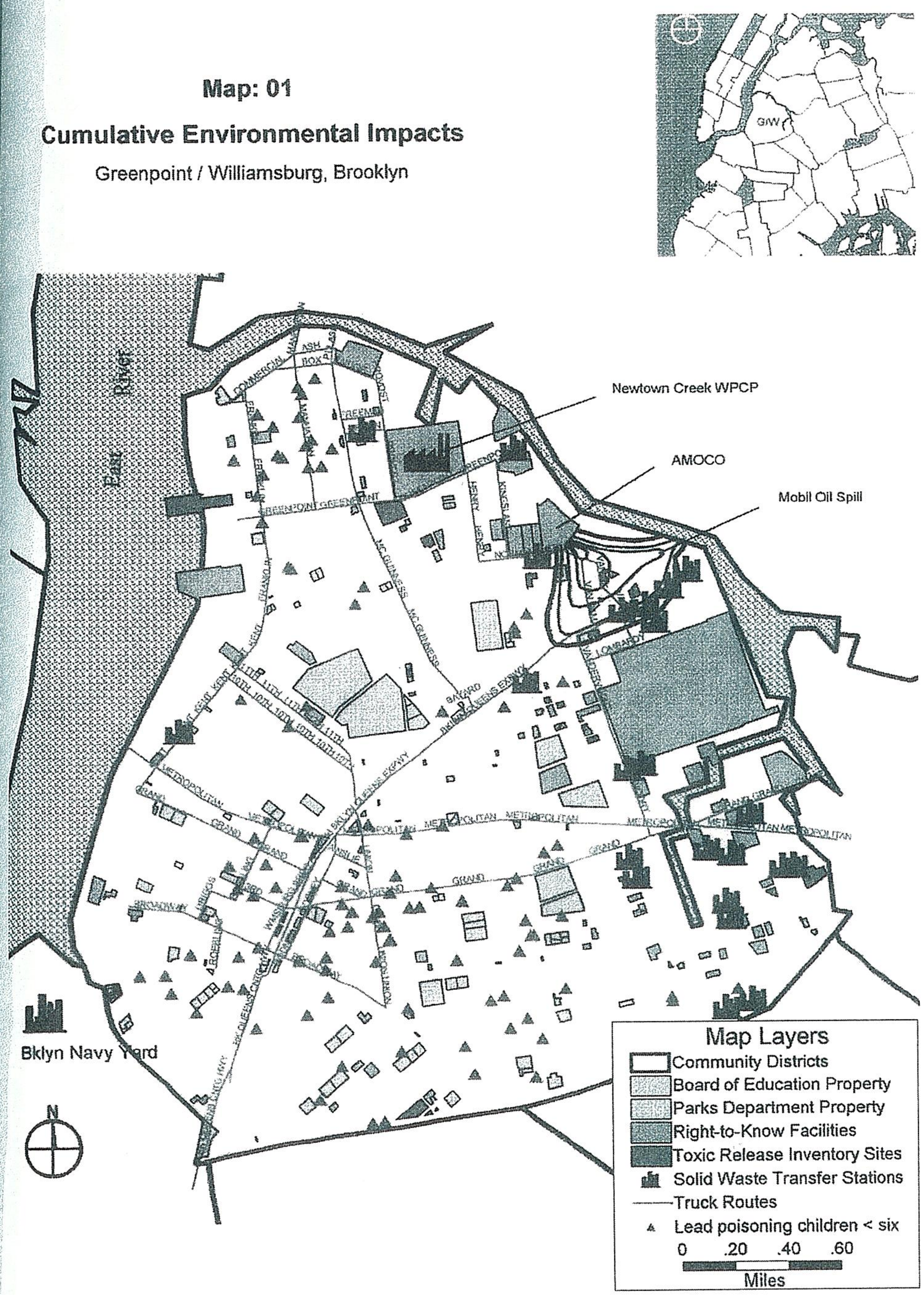

Figure 6.4.
Cumulative-environmental-impact map. Source: Watchperson Project.

were necessary to avoid a garbage-disposal crisis. The issue, according to the DOS, was about available appropriately zoned land. The City displayed a map of the neighborhood's zoning and land use. The only other environmental features on the map were truck routes and the location of existing transfer stations (figure 6.5). The City argued that the only legal location for transfer stations was in areas zoned for heavy manufacturing, labeled "M-zones," and G/W happened to have more of this land than almost any other community district in the city. According to James Doherty, sanitation commissioner at the time:

> The only clustering we might see of transfer stations is because these facilities are limited to industrial areas and these tend to be concentrated in certain parts of the city. In fact, we even exempted the light-industrial, M-1 zones, which tend to be closest to residential areas. We [DOS] have no control over where these things get sited. They go where the zoning allows them to go. (quoted in Martin 1998)

The City's maps were used as a justification for the permitting of the waste-transfer station and were used to deflect concerns about injustice and whether G/W was a community already overburdened with hazards.

In the eyes of most community members, the maps were an indication of the City's refusal to acknowledge the cumulative toxic burden facing the neighborhood. The City's maps became known by residents as the "toxic donut" maps. They showed the oval-shaped community surrounded on all sides by manufacturing land uses and industrial zones, with residents living in the center of the industrial ring.

The administrative law judge overseeing the hearing ruled that the community's case was compelling and required USA Waste to provide more information to show that their facility would not have a significant environmental impact on local residents. The judge ruled that it seemed "unreasonable" for a facility of such a size not to have some impact on the community, and, in light of the background environmental conditions in the community, more information would be necessary before any permits granted (Shin 1999). In June of 1998, both the New York State Assembly and Senate passed bills (S7610/A11084), introduced by Brooklyn representatives, requiring USA Waste to perform an EIS. And, just two months after the hearing, on June 23, 1998, Governor Pataki signed the bill and announced that the State would require USA Waste to prepare the environmental assessment.[51] However, after a year of study,

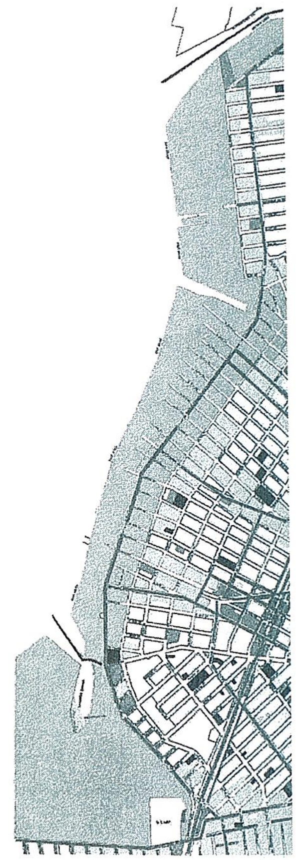

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Figure 6.5.
New York City zoning map and locations of transfer stations in Greenpoint/Williamsburg. Source: New York City Department of City Planning.

the EIS concluded that there would again be "no significant impacts" from the facility but, at the urging of Congresswoman Nydia Velazquez, the White House Council on Environmental Quality and the EPA began an examination into whether G/W had been targeted for garbage-transfer stations because residents were poor and minorities (Shin 1999). According to Brad Campell, a CEQ associate director:

> The problems we see here have a huge influence on policy and legislation. We were very disappointed that the City Housing, Sanitation and Environmental Protection departments are not joining us in this effort. The best chance for solutions is when we have a partnership between federal, state and local governments. (quoted in Shin 1999)

As the federal investigation went ahead, the DOS granted the waste-transfer station its permit. It wasn't until May 2000, after the NY Lawyers for the Public Interest (representing the community) convinced a Manhattan Supreme Court judge to block the permit, that the facility finally stopped operating (Liff 2000).

By combining agency data with residents' experience of hazards, the community hazard map was attempting to extend the work of professional science. The community map also tried to shift the debate from facility siting and zoning to cumulative impacts and environmental injustice. However, the City perceived the map as a threat and countered that it was "irrelevant" for siting decisions that were based on zoning. The map did help residents gain attention from the environmental justice movement, and this visibility played a significant role in getting the federal government and eventually the administrative law judge to pay attention to the community's claims. Community mapping played a key role organizing attention but ultimately only supplemented the legal arguments that influenced professional action.

Mapping Small-Source Air Polluters

As environmental justice claims continued to surface in the neighborhood,[52] community groups continued expanding the capabilities of their own GIS. The Watchperson Project used its mapping technology to influence the EPA's Cumulative Exposure Project (CEP), the same project that assessed risks from subsistence fish diets discussed in chapter 3. This time, the community mapped polluters that an EPA exposure model in the community would have overlooked.

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While the relationship between air pollution and public hea has been studied (ATS 1996; Holgate et al. 1999), definitive conclusions about air pollution's effects on urban residents are limited. In addition to gaps in understanding regarding the biologic mechanisms responsible for the morbidity and mortality associated with increased air pollution, a lack of consistent ambient monitoring in urban areas has prevented scientists from capturing pollution at the local or microenvironment level. Yet, high concentrations of air pollutants are suspected of being common in many poor urban neighborhoods. The lack of microenvironment air monitoring also has prevented study of intra-urban or neighborhood differences that also might help better understand distributions of health effects associated with urban air pollutants. Additionally, combining point, area, and mobile sources to characterize pollution in microenvironments has proved difficult. Thus, dispersion models are used to estimate micro-scale urban pollution.

The CEP's first task of the air toxic exposure assessment involved gathering data inputs for the hazardous-air-pollutant (HAP) dispersion model called, Assessment System for Population Exposure Nationwide (ASPEN). The ASPEN model estimates long-term outdoor concentrations of 148 of the 188 HAPs listed in the Clean Air Act of 1970 for every census tract in the contiguous United States, based on 1990 data (totaling 60,803 census tracts) (EPA 1999a; Rosenbaum et al. 1999; Woodruff et al. 1998). ASPEN is a Gaussian dispersion model that estimates outdoor concentrations of HAPs on the basis of their emission rates, frequency of various meteorologic conditions, and the effects of atmospheric processes such as decay, secondary formation, and deposition.

The EPA planned on using the ASPEN model in G/W and adding any relevant local emission sources. However, the agency was content on basing the model on pollution data from the one NYS DEC air monitor in the neighborhood and the roughly fifty Toxic Release Inventory (TRI) sites registered with the EPA that were known to emit some hazardous air pollutants (EPA 1999a). During meetings presenting the project to the community, EPA heard from residents that their proposed methodology, particularly the census-tract aggregation and the reliance solely on state and federal data, was going to miss some potentially hazardous exposures. According to a local resident attending one of the meetings:

> If you just walk around here you can see that we've got polluters mixed in with residents; some small and other large factories. To tell us that everyone in the census tract was exposed more or less the same missed the variations on the street.

More specifically, representatives from the Watchperson Project noted that the air-dispersion model was going to miss hundreds of potential polluters because they did not show up in any state or federal air-quality database. These polluters were registered, since they had to file for permits with the NYC DEP, but their emissions were not monitored. According to community members commenting on the EPA analysis, the census-tract aggregation of the ASPEN model was going to "wash out" the block-to-block pollution differences that existed in the neighborhood. The Watchperson Project noted that the air toxic model made no mention of indoor air pollution, specifically perchloroethylene ("perc"), a known carcinogen suspected of affecting residents living above dry cleaners (Swanston 2000).

In making their case to the EPA, community residents once again developed their own set of maps. The Watchperson Project used their GIS to develop maps comparing the state hazardous sites the EPA used as data inputs for the model to the DEP-regulated air polluters that the model was slated to ignore (figure 6.6). The Watchperson Project had spent over two years trying to obtain environmental information from the City, including air-permit information, environmental complaints records, and parcel-by-parcel tax information from the City's Department of Finance. The DEP data was from the Bureau of Air Resources Administration Management Information System and included permit data on over 3,000 facilities in the neighborhood that were required to file for an air-emission permit but were not regulated, such as apartment-building boilers, auto-body paint shops, and printers. The Department of Finance data set included details about the history of every land parcel in the neighborhood for tax assessment purposes, and included information such as building type, property value, fire department inspections, and property owner. After a lengthy battle with the City, including numerous Freedom of Information Act requests, the community group obtained the electronic data (Swanston 1999). The Watchperson Project was the only community organization in the City that obtained these disparate data sets

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and, since these data were not housed at any one agency, no agency had compiled this information into one computer system capable of graphically displaying the information (Hanhardt 1999). With the help of computer specialists from Hunter College, the group began manipulating the data in their own GIS.

The Watchperson Project's map showing the block-by-block variation of air polluters was aimed at convincing the EPA that their model's aggregation was not fine-grained enough to accurately characterize air pollution in the neighborhood. According to Robert Lewis, director of the Watchperson's Office GIS project:

> To capture data only by census tract or block group averaged-out significant localized emissions. A data-set that aggregated by census-tract or even block would miss important distinctions between city blocks and even within one block. We had the data to show this. So we produced maps of the entire neighborhood and presented them to EPA showing just how many small-sources there are in the neighborhood and how the state and federal databases missed all these. (Lewis 2000)

The Watchperson Project mapped 15,167 distinct land parcels in the community and produced maps comparing the facilities used in the EPA model with facilities regulated by the DEP but which the dispersion model was not going to include (e.g. figure 6.6). The group found over 1,000 potentially toxic air polluters that the EPA would miss in its census-tract level assessment (Swanston 2000).

The Watchperson Project's maps were convincing to EPA scientists, but the agency struggled with how to treat the information in their dispersion model. According to one EPA scientist:

> The community maps made sense, especially after some of us had toured the neighborhood with some residents. We had a sense there were lots of small sources, but we didn't realize the full extent until we saw the community's maps. We struggled for a long time considering what to do with their data set. We tweaked the model some but we just couldn't aggregate all those sources at a block-by-block level without loosing accuracy in the dispersion model. What we did do, however, was take the area sources we could get enough data for, plot them, and model them as point sources.[53]

The community-generated map forced EPA to rethink whether its dispersion model was an accurate characterization of on-the-ground exposures, but it ultimately did not significantly alter the agency's dispersion model.

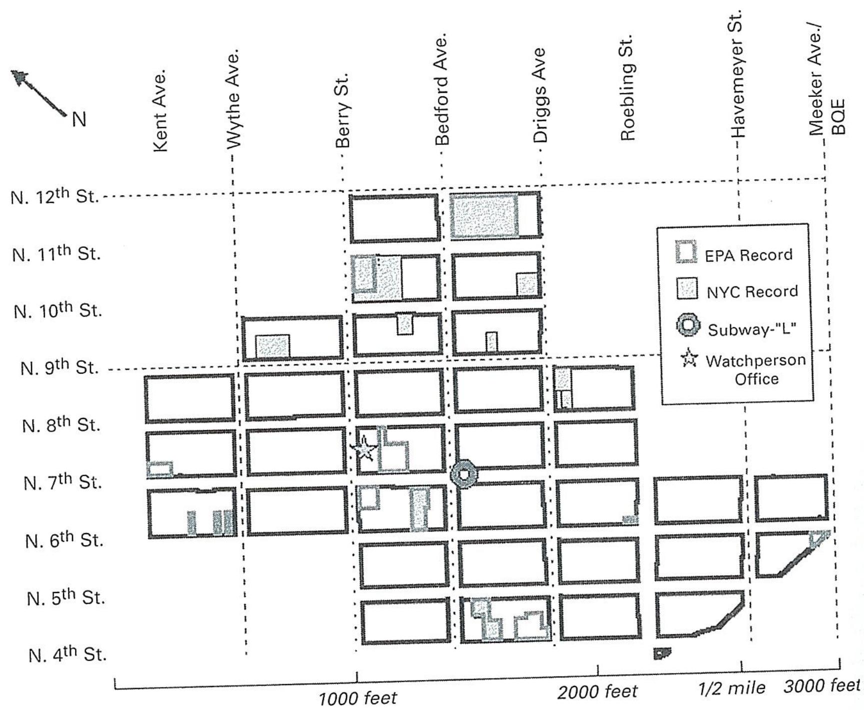

Figure 6.6.
Community-generated block-by-block map comparing EPA and DEP modeling sites. Source: Watchperson Project.

A second map produced by the Watchperson Project's GIS was also used to try to influence the EPA modelers. As part of their GIS program, the community group used volunteer high-school students to canvass the neighborhood in teams to follow up on community complaints of air, noise, and odor pollution registered by residents with the DEP. The community group plotted the location of the complaints on GIS-generated maps and students "investigated" the areas near the complaints to look for any obvious sources of pollution that might need attention. One finding from the student's "street survey" was that a large number of complaints were coming from residents living in buildings with dry cleaning establishments (Swanston 2000).

After learning about the findings of the student canvass, the Watchperson Project organized a special project focused on documenting

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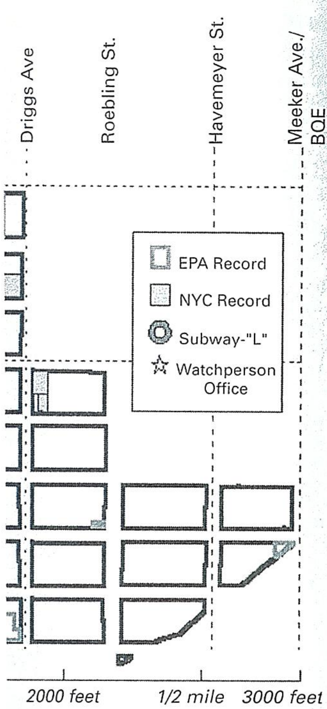

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the location of all neighborhood dry-cleaning establishments and the specific type of buildings in which they were located. The survey found 54 dry cleaners in the neighborhood, with 23 of the 54 performing dry-cleaning in a residential building (EPA 1999a). Using the GIS and census data, the community group estimated that as many as 183 apartments and approximately 550 residents were living above dry-cleaning establishments (EPA 1999a). Again the group mapped these findings and presented them to the EPA modelers (figure 6.7).

The Watchperson Project's dry-cleaning survey raised a particular concern to EPA since a number of recent studies in New York City had found concentrations of perc inside apartments, at up to three floors above a dry cleaner in the same building, averaging 150 ppm (parts per million), with some measurements exceeding 1,000 ppm (Wallace et al. 1995; NYS DOH 1993).[54] In one study by the NYS DOH, 39 of 40 apartments above dry cleaners tested had concentrations of perc in the air exceeding the 100 ppm state guideline for noncancer effects. One measurement in this study found perc levels at 197,000 ppm. Another study by the Consumers Union found that 24 of 29 apartments above dry cleaners had four-day average concentrations of perc above the DOH guideline and 8 had average concentrations above 1,000 ppm (Wallace et al. 1995).

The EPA ASPEN model estimated the expected *outdoor* concentration of perc at less than 2 ppb (part per billion), with a maximum-modeled census-tract outdoor concentration of 39 ppb (EPA 1999a). According to Fred Talcott, Project Director of the CEP at EPA:

> The average concentration found in apartments above dry cleaning establishments was on the order of 1,000 times higher than the outdoor concentration of "perc" as predicted by the ASPEN model in G/W. That to me is an illustration of a micro-level problem that would be completely obscured if you only looked at daily walking around concentration. Without the community group data set, we would have missed this. (Talcott 1999)

EPA considered performing a separate assessment for this subpopulation, but eventually decided to document the findings only in the CEP report (EPA 1999a, 6–24).

These two examples of community mapping reveal that local knowledge can bring important insights to sophisticated technological assessments. The community GIS organized information that no other agency

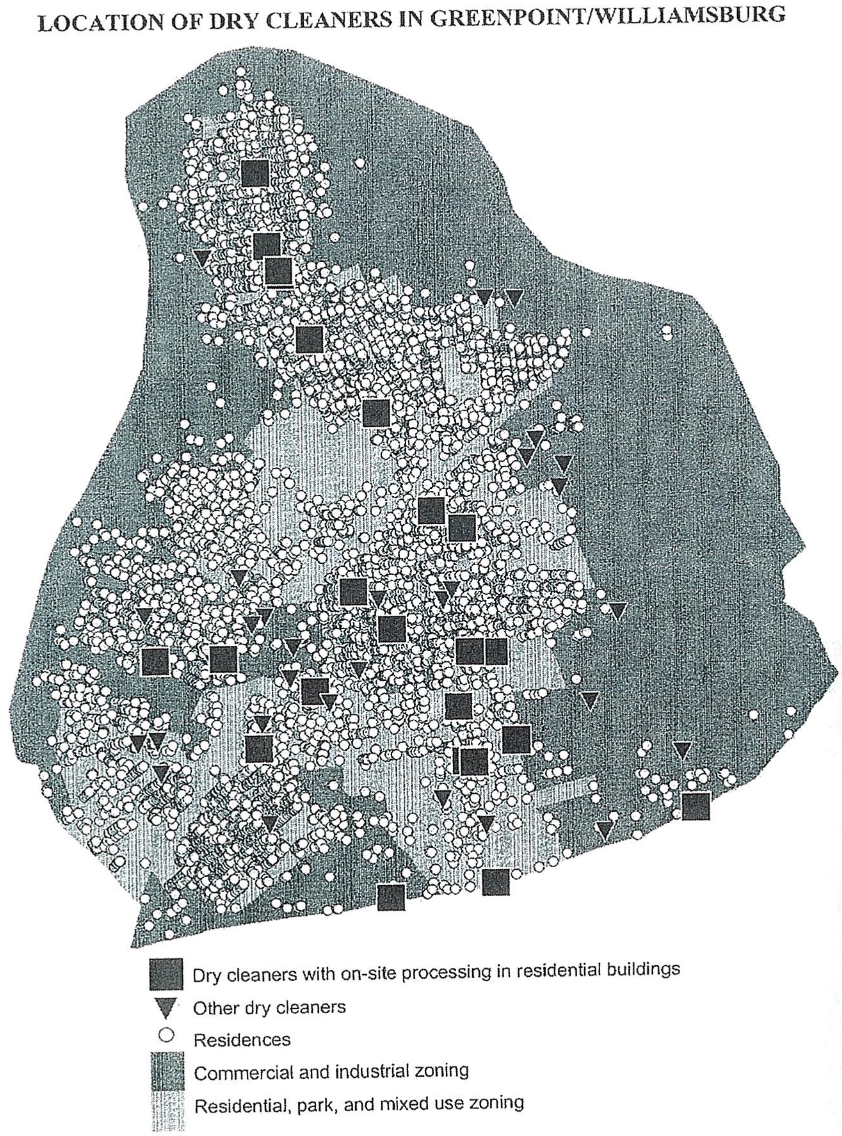

Figure 6.7.
Community plots of neighborhood dry cleaners. Source: US EPA 1999a, chapter 6, p. 23.

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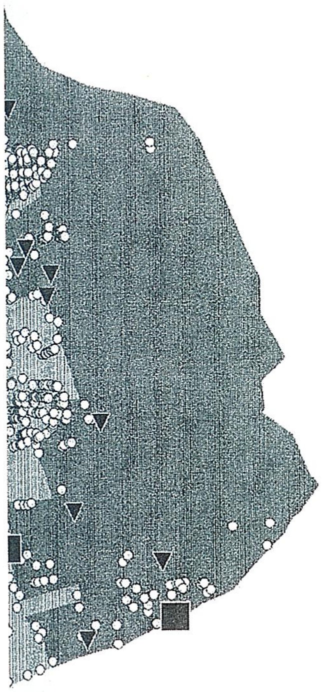

esidential buildings

Source: US EPA 1999a, chapter

had compiled and then mapped these data to reveal what daily experience already told most residents: that pollution exposures differ from block-to-block and even along the same block. The community group also combined their computer-mapping capabilities with a student survey to find a hazard unanticipated by the EPA: potential toxic exposures from dry cleaners in residential buildings. In both instances, the community-mapping technology helped validate what residents already were experiencing (e.g., following up on air and odor complaints) and helped bring this knowledge to the attention of the EPA. While the community maps failed in the end to significantly alter the EPA air-dispersion model, the maps did challenge the EPA to address new questions, new sources of data, new exposures, and new groups claiming access to the assessment process—all of which had a significant impact on the way professionals viewed their role, if not their final decisions.

How Community Maps Influence Professionals

Maps are an important tool for organizing and making publicly visible the *street science* performed in communities. The mapping of local knowledge in G/W ranged from student drawings on photocopied street maps to sophisticated computer-generated GIS outputs. In each instance, maps were used as counter expertise, opposing a noxious facility or challenging professional assumptions about how to assess the neighborhood's environment. In each case, residents eventually changed the way professionals viewed the environmental issue at stake, although the extent to which the community maps were responsible for these changes was mixed.

The Toxic Avenger's maps did not directly influence professionals but, by helping organize the community around environmental issues, the student maps helped build an important coalition that played a role influencing professional decisions. The community's cumulative burdens map was a key piece of a series of influential testimony that convinced the administrative law judge and other politicians to eventually demand that USA Waste perform an EIS. However, the community's hazard map was not convincing to the City, as they continued to permit the transfer station even after the federal government intervened. For the City, the issue was appropriate zoning, not cumulative environmental impacts or unfair siting practices. It took successful litigation two years after the initial public hearing to convince the City to revoke the transfer station's permit. Finally, the GIS maps that the Watchperson Project offered to the EPA modelers were compelling, even mapping information that no other agency could combine, but did not significantly alter the air dispersion model.

In this case, the student maps were explicitly aimed at building a community coalition, but the other maps were not. The student maps combined understandings from agency databases, environmental pollution information, and local experiences with pollution. However, the maps were more expressions of how a group of local people saw the conditions under which they lived and the cartoonlike use of symbols might have contributed to professionals not taking these maps seriously. The community's GIS-generated maps combined electronic information that agencies and scientists were themselves using with local knowledge of problems and experiences with hazards. These *street science* maps both extended the understanding of scientists and also radically challenged professional analyses. For example, the GIS maps identified small-source air polluters that the EPA model was going to miss and helped fill gaps in the agency's modeling inputs. The cumulative environmental impacts map radically challenged the fairness of the City's transfer-station-siting practices and attempted to shift the discourse from zoning to environmental justice.

The influence of expert intermediaries was less significant in these episodes because visual images tend to "speak for themselves." The community did use intermediaries to help them obtain some electronic data and build their GIS, however. In some ways, the GIS technology itself acted as the surrogate intermediary, since the technology was something both professionals and locals accepted as a legitimate means for displaying environmental information. The more the street scientists were able to make their knowledge resemble professional renditions, the more professionals took their work seriously.

As these episodes reveal, community-generated maps can challenge radically the way professionals are normally prepared to address envi-

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ronmental health problems. When community groups reframed the waste-transfer-station issue as one about fairness and justice by using their cumulative-hazard map, the City could not respond. Even when the federal government intervened to investigate whether waste-transfer stations were being targeted for poor and minority neighborhoods, the City refused to participate in this probe. Similarly, the EPA modelers could find no easy solution to the inadequacy of the census-tract-level aggregation of their air dispersion model, or for keeping the model from missing hundreds of small pollution sources, such as dry cleaners. The EPA was committed to the ASPEN model even when compelling community-generated information suggested that it might not accurately characterize local air toxics exposures. As street scientists generate maps that reframe and reorient definitions of "problems," and as these same scientists develop the sophisticated skills of computer-aided mapping, they will continue to blur the line between professional and local knowledge and whose evidence counts as credible in environmental health decision making.