Community Environmental Policing: Assessing New Strategies of Public Participation in Environmental Regulation

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> Impacted communities are ideally located to perform testing due to their proximity and experience. This is similar to community policing. You give people tools and training that are in high crime areas because the cops can't be there all the time. Why not do the same for environmental crimes? The agencies that do respond to complaints often get there too late to take a viable, accurate sample, but the community is already there.... Also it involves and empowers people who would be left out of the process and made bitter, instead you involve them in a meaningful, positive way.
>
> —Denny Larson, Refinery Reform Campaign

Abstract

This paper evaluates a new form of public participation in environmental monitoring and regulation advanced through local "bucket brigades," which allow community members to sample air emissions near industrial facilities. These brigades represent a new form of community environmental policing, in which residents participate in collecting, analyzing, and deploying environmental information, and more importantly, in an array of public policy dialogues. Use of this sampling technology has had marked effects on local residents' perceptions and participation in emergency response and citizens' right-to-know. However, when viewed through the lens of the more developed literature on community policing, the bucket brigades are currently limited in their ability to encourage "co-production" of environmental protection between citizens and the state. Means are examined to strengthen the bucket brigades and to more broadly support community participation in environmental regulation. © 2003 by the Association for Public Policy Analysis and Management.

INTRODUCTION

It is now generally accepted that citizen participation in issues such as public safety, education, and environmental decisionmaking can serve positive institutional functions (Fiorino, 1990; Shepherd and Bowler, 1997), and calls for increased citizen inclusion in regulation and public policy debates are commonplace. Public participation in environmental issues is supported for its potential to provide additional (often low-cost) sources of information to government agencies, increase acceptance of and confidence in government decisions, educate and empower community members on issues that affect them, and advance democratic ideals (Fiorino, 1990; Heiman, 1997;

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Shepherd and Bowler, 1997; Spyke, 1999). At the same time, including community members in technical decisionmaking or environmental enforcement raises a number of concerns. Local residents often lack training, hold "non-scientific" risk perceptions, shift their focus from crisis to crisis, and lack the time, energy, and commitment to participate meaningfully in long-term environmental issues (Chess, 2000).

In spite of questions raised, public participation is now being called upon to address shortcomings in the traditional state-centric, "command-and-control" environmental regulatory apparatus (NAPA, 2000; Rondinelli, 2000). Critics point out the declining returns and increasing costs of environmental monitoring and enforcement strategies developed in the 1970s (Fiorino, 1995, 2000; Kraft and Vig, 2000; Sexton et al., 1999). Budget constraints, limits on the omniscience of the state, and a growing diversity of environmental hazards prompt analysts and practitioners to question the potential of traditional agency strategies to motivate continued pollution reduction (Karkkainen, 2001; Stewart, 2001).

One area of environmental protection that has received heightened scrutiny is air quality monitoring. Contrary to public impressions, surveillance of most sources of toxic air pollutants is extremely low (Russell, 1983, 1990; Russell, Harrington, and Vaughan, 1986; USEPA, 1981). While self-monitored emissions data are reported by industry, the accuracy and coverage of these data are often questioned (Felleman, 1997). State monitoring efforts, which focus on the use of fixed ambient monitors, are also limited in their ability to provide detailed, accurate information to the public. The location, range, and focus of ambient monitors are determined through an inherently political process. Agency resource limitations add to the sporadic placement of monitoring stations that are not optimally suited for assessing the impact of pollutant concentrations across residential areas (NSTC, 1997; Walker, 1997). Critics believe that the limits of current monitoring systems perpetuate an environment in which firms pollute beyond safe levels, and with little threat of punishment. When violations of air permits are discovered, the most common response is for an agency to issue a "notice of violation," ordering a return to compliance without further action (Russell, 1990). Most state agencies issue penalties for fewer than 5 percent of notice of violations issued, with penalties averaging less than $1,000 in some states (Harrington, 1988).

As criticism of the nation's multi-billion dollar monitoring and enforcement system mounts (Kraft, 1999) and civic engagement is evoked as a possible solution, parallels emerge with the crisis of crime prevention of the late 1960s (Crank, 1994). The nation's system for monitoring ambient air quality standards, enacted by the 1970 Clean Air Act Amendments (42 U.S.C.A. §7401 *et seq.*), is based on government inspectors who follow strict criteria spelled out in permits issued to point source polluters. Similarly, policing was built around a paramilitary structure designed to move orders down a chain of command to officers ready to respond to 911 calls (Skogan and Hartnett, 1997). Traditional policing began to suffer a crisis of legitimacy as the 1964 and 1968 presidential elections drew attention to perceptions of sharp crime increases across the country (Walker, 1980). High-profile events and findings of widespread corruption in several major city departments culminated in a series of Supreme Court decisions, such as *Miranda v. Arizona* (1966), and the Kerner Commission report on the contribution of police actions to city riots (Crank, 1994; Greene, 1989). These events spurred reconsideration of the key components of policing, particularly its reliance on rapid response and random preventive patrols. From the criticism emerged alternative approaches to policing based on a decentralization of police bureaucracy, longer-term beat assignments to allow for familiarity with neighborhoods served, and an emphasis on improving the number and quality of police-citizen contacts (Rosenbaum and

Lurigio, 1994). Many of the initial components of what would later be called "community policing" were discredited because of organizational problems and their efficacy in improving resident perceptions more so than actual crime statistics (Rosenbaum, 1987; Skogan, 1990). Yet initial experiments with community policing encouraged a "national infrastructure of organization, literature, and vocabulary.... Not only are there national organizations promoting the technology, but there is a well-developed popular literature that promotes the early successes of previous efforts" (Buerger, 1994, p. 413).

Community groups and non-governmental organizations across the United States have similarly begun to promote citizen participation as a means of improving environmental monitoring. With technological developments and reductions in the costs of communications, computing, and sampling technologies, experiments with new strategies to include community members in environmental monitoring, analysis, and regulatory discussions have begun. These initiatives include new forms of community participation in air, water, and soil monitoring such as through river-watch networks, stream teams, watershed councils, citizen air-monitoring teams, and lead-monitoring programs (e.g., Heiman, 1997; Kerr et al., 1994; USEPA, 2003).[1] Of particular concern for this study are a range of burgeoning initiatives around community participation in air toxics monitoring,[2] the most established of which involves local residents in air monitoring through the organization of "bucket brigades." Bucket brigades are groups of residents who live in industrial zones and are recruited to monitor air, using low-cost grab samplers, near oil refineries, chemical factories, and power plants. They are deployed on the frontlines of efforts to improve environmental monitoring and reinvigorate environmental enforcement. Bucket brigades attempt to meet such objectives by coupling new strategies for air monitoring with sophisticated analysis, cross-referencing of data sources, and deployment of information. The bucket brigades—driven largely by nongovernmental organization (NGO) organizers—involve community members, environmental organizations, and government officials in new and different relationships.

As such, bucket brigades hold the potential to advance a grassroots-driven "community environmental policing" strategy. Early experience with the bucket brigades offers an important empirical opportunity to analyze the effectiveness of participatory strategies for pollution monitoring. A well-documented history of community-based alternatives to traditional policing provides a framework through which early use of the bucket brigades in California and Louisiana can be critiqued. This framework is built upon decades of experience with a similar attempt to encourage co-production between the state and private citizens of a public good (i.e., safety and environmental quality) (Ostrom, 1972; Schneider, 1987).

Based on original field research, this article describes and analyzes the bucket brigades, proposes a framework for understanding their potential, and explores policy strategies for strengthening (and avoiding the pitfalls of) public participation in environmental regulation. This article presents five cases of bucket brigade implementation in two states (Louisiana and California). The case studies were developed through site visits between April and June 2001, involving

[1] A few examples include the River Watch Network based in Vermont, the San Francisco Bay Keepers program, the Chesapeake Bay Citizens Monitoring Program, the Watershed Information Network, and the Dorchester, Massachusetts, Lead Safe Yard Project.

[2] See, for instance, air monitoring initiatives in the Williamsburg-Greenpoint neighborhood of Brooklyn, New York; a continuous particulate monitoring initiative in Roxbury, Massachusetts; and a refinery fenceline monitoring program in Rodeo, California.

semi-structured interviews (n = 25) with citizen groups, local residents, agency officials, and industry representatives. Also analyzed were EPA, Louisiana Department of Environmental Quality (DEQ), and Bay Area Air Quality Management District (BAAQMD) records of complaints, government inspections, and pollution episodes related to the five case study facilities. An evaluation of media reports and citizen group documents regarding the cases complemented this analysis. By combining analysis of quantitative government data with qualitative interview data and public records, evidence on the implementation and impacts of the bucket brigades was effectively "triangulated." Conclusions drawn from interview data were evaluated and cross-referenced with quantitative data and public records. (For a fuller description of methods, see Appendix A.) Obtaining data from different sources allowed evaluation of how processes of gathering and interpreting information by residents in different contexts can alter existing approaches to pollution monitoring and enforcement.

LESSONS FROM COMMUNITY POLICING

"Community environmental policing,"[3] through programs such as the bucket brigades, is similar to community policing in that it seeks to place external community pressure on government officials to change agency practices, consider local issues more seriously, and collaboratively address problems (Bass, 2000). Community environmental policing follows the example of community policing in advancing a new philosophy of enforcement which privileges: shared responsibility for policing (as community members play a role in identifying problems and agencies respond to these community-reported issues); prevention (where the ultimate goal is identifying and eliminating the source of a problem); and increased discretion and flexibility within agency and community stakeholder groups (Rohe, Adams, and Arcury, 2001). As Skogan and Hartnett (1997, p. 5) suggest, the goal of community-oriented policing lies in "reforming decisionmaking processes and creating new cultures... a commitment to broadly focused, problem-oriented policing... responsive to citizens' demands." Similarly, community environmental policing tries to advance both civilian oversight—accountability for government agencies—and community participation in policing (Bass, 2000).

Two decades' worth of experience with community policing provide empirical evidence on the potential and limitations of community participation in policing, and the concomitant roles and responsibilities of state regulators. Community policing carries with it implicit and explicit critiques of traditional policing—many of which can be applied as effectively to state environmental regulation—such as reliance on random preventive patrol, rapid response to emergencies (the "tyranny of 911"), and retrospective investigation (Crank, 1994; Sparrow, Moore, and Kennedy, 1990). Environmental regulation has been similarly critiqued for its dependence on "random" inspections, self-reporting from industry, ambient monitoring, and slow responses to incidents and emergencies.

The community policing literature also offers important benchmarks for evaluating the potential roles of community participation in addressing criminal activity. Recent research argues that community participation can bring new "values" to

[3] Cable and Benson (1993) were the first to compare community crime prevention with corporate environmental crime control. They focused on the emergence of environmental organizations as a function of the perception of corporate crimes, and suggested two strategies that can be used to raise the costs of environmental crimes (encourage enforcement or impose informal sanctions).

policing priorities, shifting focus to "broken windows"[4] and "public order" rather than just emergencies and illegal incidents (Kelling, 1987; Wilson and Kelling, 1982, 1989). This in turn helps shift police strategies from "incident-oriented" to "problem-oriented" policing (Goldstein, 1990; Skogan and Hartnett, 1997). Community participation in neighborhood watch programs can provide new sources of information for identifying problems and their root causes (Crank, 1994; Friedman, 1995; Rosenbaum, 1987) and help to "co-produce" policing through the combined actions of community members and police agencies (Fung, 2001; Schneider, 1987). Finally, some versions of community policing focus explicitly on advancing increased accountability over the police (Fung, 2001, Sparrow, Moore, and Kennedy, 1990).

Community policing has of course taken many forms and achieved varying results (Greene and Mastrofski, 1988). Common characteristics of "successful" community policing initiatives have included: a move toward organizational decentralization, better communication between the police and the public, new kinds of information exchange, increased responsiveness to citizen concerns, increased trust and coordinated actions, efforts to understand the causes of problems, analyzing patterns of problems ("hot spots"), and responding creatively to these problems through multiple means and coordination with other agencies (Lavrakas, 1995; Rosenbaum, 1987; Skogan and Hartnett, 1997; Wilson and Kelling, 1989).

Analysts have also pointed to the challenges and limitations of broader public participation in crime fighting. First, there continues to be extensive police resistance to changing strategies of policing (Sparrow, Moore, and Kennedy, 1990). Some police do not believe that "lay" community members can provide valuable information. Many versions of community policing have thus had a limited substantive role for the community. As Buerger (1994, p. 416) notes, "community policing, by and large, remains a unilateral action on the part of the police." Of the standard community partnership roles advanced by community policing—citizen as "eyes and ears" of the police, cheerleader, provider of monetary resources, and maker of public statements to criminal elements—only the last goes beyond mere legitimization of police actions. Yet, even community-based statements to criminal behavior tend to be directed toward "respectable" actors (such as landlords and local political officials), which are prone to the effects of moral suasion.

In cases where there is a role for the community, residents are often reluctant to spend their time and energy, and to risk retribution, for participating in crime-fighting initiatives (Rosenbaum, 1987). Even organized community members can gradually become demobilized after successes or failures. Research shows that communities most burdened by the lack of a safe environment—the poor and disadvantaged—are often the hardest to keep mobilized (Buerger, 1994). Indeed, early experience with neighborhood watch programs suggests a number of barriers to effective participation in block watch meetings, relating to socioeconomic background and group dynamics (Rosenbaum, 1987). Analysts have thus pointed to an important role for the state in fostering and facilitating community participation in policing activities and targeting disreputable criminals (Friedman, 1995; Rosenbaum, 1987; Schneider, 1987). These concerns are very similar to those raised by environmental justice analysts, who argue that new partnerships are needed to ensure that regulators account for the cumulative and synergistic

[4] Community policing views disorder and crime as inextricably linked phenomenon. The "broken windows" literature began with the social psychological notion that if a window in a building is broken and left unrepaired, it will encourage further neglect and delinquent behavior. Vandalism and crime thrive in areas where sense of community and mutual regard are lowered by behavior that suggests that "no one cares."

effects of industrial activity on low-income communities of color, which receive an inequitable distribution of environmental hazards (Bullard, 1994; Faber, 1998; Hofrichter, 1993; *National Law Journal,* 1992; Thornton, 2000).

In this paper the lens of community policing is used to assess the success and limitations of community participation in environmental monitoring. The literature is used to evaluate whether the bucket brigades meet the goals and practice of community policing. These goals are grouped broadly, evaluating key criteria of performance such as: levels and forms of community participation; state responsiveness and actions; accountability of state agencies and firms; and whether regulation is "co-produced." The essential questions are: Do the bucket brigades support new forms of participation and information gathering? Do they motivate changes in state actions and responses to pollution incidents? Do they increase the transparency and accountability of state and industrial actors? And do they contribute to joint community-state initiatives to regulate difficult pollution problems? Also of interest is whether the bucket brigades avoid or repeat the pitfalls faced by community policing efforts, such as state resistance and skepticism about community participation, and community limitations and reluctance to participate.

BUCKET BRIGADES

The bucket brigades differ in a number of regards from formal public participation as enshrined in environmental statutes. The bucket brigades are instigated by community members; they are facilitated and intermediated by a national nongovernmental organization; and they have been only partially accepted by government agencies. As such, they also differ in fundamental ways from most community policing efforts, which involve either a reorganization or refocusing of agency activities.

The concept for the bucket brigade originated in 1994 after a toxic release from a refinery then owned by Unocal in the Bay Area of California. A 16-day release of Catacarb, a catalyst used to strip sulfur from refined gasoline, rained a sticky liquid on the communities of Rodeo and Crockett, California, and led to a range of community health problems. The failure of local regulatory agencies to identify or regulate the release constituted one of the community's primary motivations for filing a class action suit against Unocal. The community retained several attorneys, including Edward Masry and his research assistant, the now famous Erin Brockovich.[5] Masry's law firm funded the development of the first "bucket" air sampler in 1995 to assist the community in documenting emissions from the Unocal refinery. In 1997, Unocal settled this lawsuit and agreed to pay $80 million to more than 6000 residents whom the original release injured.[6]

After the initial use of the buckets, Denny Larson, the Northern California program director of Communities for a Better Environment (CBE), approached Masry

[5] Ms. Brockovich sustained an eye injury during a subsequent toxic release at Unocal while conducting field research for the case. This incident motivated Masry and Brockovich to build a device to allow community members to capture and record the chemicals from the refinery they were being exposed to.

[6] The release also motivated the development of a "Good Neighbor Agreement" between Unocal and the community, which included a provision for the installation of a fenceline monitoring system, including a Fourier transform infrared monitor, which can measure 30 chemicals in real time; an ultraviolet monitor for the compounds of benzene, ethyl benzene, toluene, xylene, carbon disulfide, and sulfur dioxide; and a tunable laser diode system for monitoring hydrogen sulfide and ammonia (SEA/CBE/CCCHS, 2001, p. 2).

about donating bucket samplers to local residents. Larson then set out to simplify and reduce the cost of the buckets, refining the equipment and developing a manual to show community members how to build their own samplers and deploy them through "bucket brigades." The first brigades were formed in Contra Costa County, California, in 1996 to take grab samples of emissions from oil refineries in the county. The buckets were deployed during non-standard conditions, such as accidents, fires, leaks, and explosions. In 1998, the bucket brigades spread to the "Cancer Alley" region of Louisiana to communities affected by refineries and petrochemical plants in Calcasieu and St. Charles parishes. The bucket brigades have since spread to communities in Texas, North and South Carolina, Illinois, Pennsylvania, Ohio, Oregon, Washington, Wyoming, Montana, Tennessee, Georgia, Minnesota, Alaska, St. Croix, South Africa, Swaziland, and Mozambique. By the fall of 2002, 47 bucket brigades were in operation in the United States and Africa (Denny Larson, Refinery Reform Campaign (RCC), personal communication, October 2002).

The buckets were explicitly designed to be inexpensive, easy to use, and made of materials that could be found at a local hardware store. The buckets represent a populist vision of environmental monitoring, something community members not only operate, but can build themselves. The bucket is made of a 20-liter plastic paint bucket with an air-tight lid and valve drilled through the top. The valve leads to a 5-liter Tedlar bag (a non-reactive plastic bag) inside the bucket. A simple battery-operated pump forces air out of the bucket, creating a vacuum. When the valve is opened, air is drawn into the Tedlar bag inside the bucket over approximately 3 minutes.[7] (For a full description, see CBE, 2003.)

The bucket brigades are of course more than just a grab-sampling technology. They also involve the development of a mini-organization or network of community volunteers who carry out supportive functions:

> "Sniffers" are responsible for recording odors of concern and alerting samplers when they believe there is a serious pollution release. Sniffers are usually located in prime spots in a community for first smelling odors from a plant (such as along the fenceline of a refinery). Using knowledge of prevailing wind directions and chemical releases, the community selects households to receive training in identifying and recording noxious smells (such as a rotten egg smell, gasoline, oil, or various chemical smells), health symptoms (such as nausea, irritated eyes, sore throat, or headache), and unusual sounds (such as explosions or pressure releases). Sniffers are also trained to call the appropriate government authorities to report incidents and complaints.

> "Samplers" are trained to take samples close to the strongest odor (although not to the point of risking personal health), and away from other potential sources of contamination (such as automobiles, sewer openings, large roads, or cigarette smoke). Samplers complete a data sheet with observations regarding smells, smoke or flames, and health conditions, and a chain of custody form to document sample handling.

[7] The buckets cost approximately $125 to construct. The Tedlar bag costs an additional $15 per bag with a nitrogen purge. Currently the bags are analyzed for two sets of chemicals: volatile organic compounds (VOC) (using the TO-14 standard ambient air test) and reduced sulfur-based compounds (using method 16 of ASTM D-5504). The cost of the TO-14 analysis is roughly $250 per bag, while the sulfur compound analysis costs an additional $200. Bags are analyzed for 60 VOC and 20 reduced sulfur compounds at laboratories that follow EPA reference document guidelines.

"Coordinators" are responsible for collecting sampling bags after an incident, checking that the proper sampling protocol was followed (including quality assurance and quality control procedures) and sending the bags (which must be delivered within 24 hours) to a laboratory for analysis. Coordinators are also responsible for recruiting new samplers, maintaining high levels of participation, and organizing occasional meetings and training sessions.

"Spinners," who may also hold one or more of the above positions, are charged with representing the analytical results at press conferences and through interaction with the local media.

Figure 1 presents an overview of the organization of a bucket brigade (CBE, 1999).

CBE, and more recently the RRC, have served as the national organizer, fundraiser, technical assistant, trainer, and proselytizer for the bucket brigade concept. CBE and RRC also assist with the analysis and interpretation of bucket data, disseminate results, and ensure that the media covers the findings and broader community concerns. In addition, these organizations work with local community-based organizations in each of the communities studied. In California these include the West County Toxics Coalition and Shoreline Environmental Alliance. In Louisiana, these include the Concerned Citizens of Norco and Concerned Citizens of New Sarpy. CBE recently spun off its coordinating role in Louisiana to a new NGO called the Louisiana Bucket Brigade. Government agencies have also participated in the development of the brigades. The Contra Costa County (California) Health Services Department has provided technical support, training, and funding for the brigades in their jurisdiction. The U.S. Environmental Protection Agency has also provided funding and assistance with quality assurance for the buckets.

The designers and implementers of the bucket brigades had a range of objectives for the program:

- Raising awareness of community members and the broader public about toxic industrial emissions, and supporting community organizing;
- Finding "proof" of toxic emissions and health effects;
- Using bucket data to support ongoing campaigns and to win specific demands (such as reduced pollution, improved health services, increased monitoring, or residential relocation);

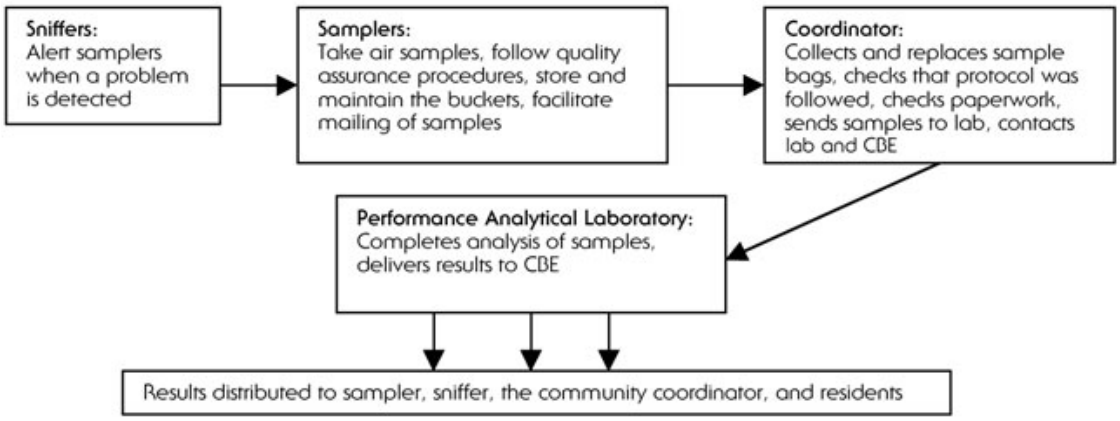


Figure 1. Organization of a bucket brigade.

- Holding agencies and polluting firms accountable for their impacts on communities and pressuring them to monitor and enforce more effectively and to reduce pollution; and
- Forcing a new dialogue among industry, government, and community members on pollution issues.

The Health Services Department in Contra Costa County had its own goals when it assisted with the initial development of the bucket brigades. As the head of the department explained (Walker, 1997, p. 1):

> fixed samplers were insufficient in number, the area they cover, and the range of chemicals they could sample for, the District's staff often does not arrive in time to sample what may be a short-lived event, a general mistrust of the District's and County's capabilities and accountability to the community, and of information from industry about releases.

The county thus viewed the bucket brigades as a means of reestablishing its legitimacy with local communities, a goal very similar to the initial impetus for community policing experiments (Skogan and Hartnett, 1997).

Bucket Brigades in Action

> Shell Norco wishes to apologize for this morning's incident.... At approximately 8:00 a.m. this morning, an over-pressure of a small vessel occurred at the resins unit. There were no chemical releases to the community. An investigation into the cause of the tank over-pressure is underway.
>
> —Notice to Our Neighbors, December 8, 1998 (Shell Norco, 1998)

> On December 8, 1998 a methyl ethyl ketone (MEK) vessel at the Shell Chemical Facility over-pressurized. The highest chemical concentration in the citizens' air sample was MEK.... The chemicals crossed the fenceline and migrated into the community.
>
> —Bucket Brigade Air Sampling Results, Saint Charles Parish (Subra, 2001a)

The events of December 8, 1998, in St. Charles, Louisiana, represent a new dynamic in a long-running interaction between industry and local communities. Industry has an accident that results in a chemical release; government officials arrive too late to inspect or evaluate the release; and industry announces that there is no risk to the community. The community is then left to accept the statements of industry and government. The new twist in this dance involves the introduction of the bucket brigades, which allow community members to gather data and evaluate conditions for themselves during pollution incidents.

Dramatic events are the backdrop for the mobilization of the bucket brigades, and for life more generally in the fenceline communities of St. Charles, Louisiana, and Contra Costa, California. Neighborhoods such as Diamond[8] and New Sarpy[9] in St.

[8] Formerly Diamond Plantation, Diamond is composed of Washington, Cathey, Diamond, and East Streets next to the Shell Chemical facilities in Norco, Louisiana. The neighborhood consists of approximately 630 residents, 89 percent of whom are African-Ameican (McQuaid, 2000). Oil refineries began to supplant the cane and cotton fields of the Diamond Plantation in 1916 when New Orleans Refining Company (subsequently acquired by Shell Petroleum Company) purchased land and constructed the first oil refinery in the area (Bell, 1998).

[9] New Sarpy, the former Prospect Plantation, is adjacent to the Orion Refinery Company. The neighborhood consists of some 250 residents, 87 percent of whom are African-Ameican (Bell, 1998).

Table 1. Case study firms.

Facility	Town	Region
Chevron	Richmond	Contra Costa County, CA
Tosco	Rodeo	Contra Costa County, CA
Shell Chemical	Norco (Diamond community)	St. Charles Parish, LA
Motiva	Norco	St. Charles Parish, LA
Orion	New Sarpy	St. Charles Parish, LA

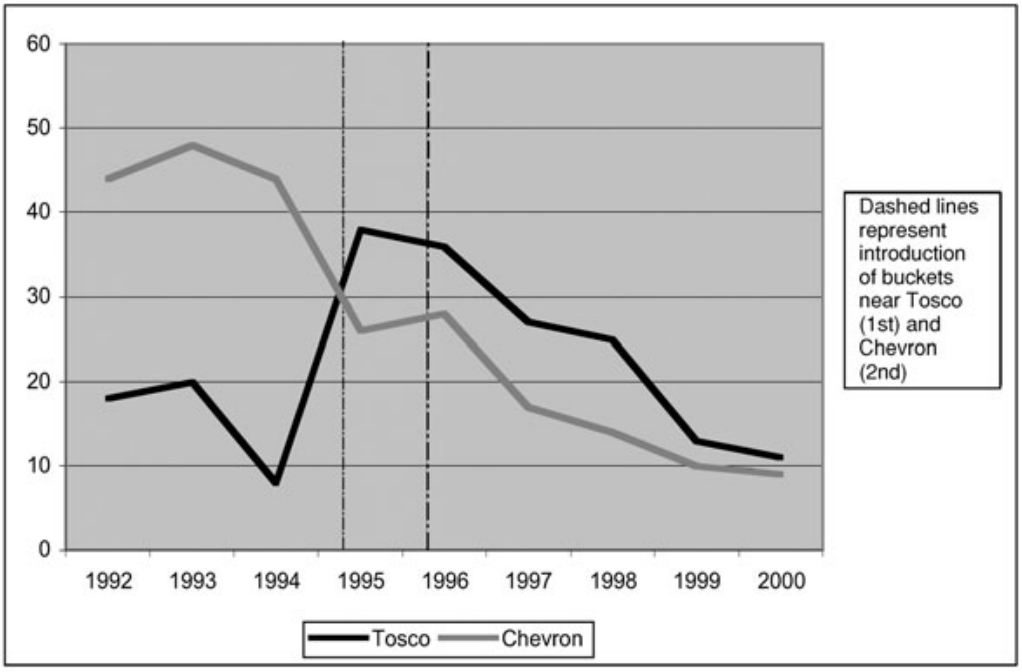
Charles, and Richmond and Rodeo in Contra Costa host hundreds of acres of petrochemical plant operations. People live in areas along the fencelines of these facilities that would have been designated buffer zones under present zoning regulations (Bell, 1995, 1997).[10] The research discussed below focuses on five petrochemical facilities in four towns in two states, as shown in Table 1.

Community members face both major events and ongoing low-level nuisances from these facilities. The California refineries—Chevron and Tosco–Rodeo—have experienced repeated fires, explosions, and releases over the last decade. Also, of any refinery studied nationwide, the Chevron refinery was cited in 1999 for having the highest fugitive emissions from leaks—reportedly, more than 10 percent of its valves leaked (Simon and Anderson, 1999). The communities in Louisiana face similar events and ongoing hazards. Community members recall an explosion of an ethylene pipeline from Shell Chemical in 1973 that killed a young boy and an elderly woman. A second explosion in 1988, of a catalytic cracker[11] at the Shell refinery, resulted in the death of seven workers and the destruction of millions of dollars in property (*Times-Picayune,* 1993, p. A1). In addition to these major events, numerous episodes of flares,[12] leaks, fires, tank car derailments, and other unintended consequences of production have occurred over the last 10 years. Shell Chemical alone has more than 200,000 emission points. Failure to check these points adequately at the Shell Norco complex has been extensively documented (Louisiana DEQ, 2001b, 2001c). Figures 2 and 3 illustrate episodes at facilities in the two counties.

[10] A 1981 parish zoning ordinance in St. Charles prohibits heavy industrial plants from locating within 2000 feet of a residential area. As one local official explained, "Those four streets [next to Shell Chemical] would create a quarter of a mile buffer zone which is not uncommon for industrial facilities...For the grain elevators now in the Parish we've got a 1-mile buffer zone such that you can't build a grain elevator in the Parish anymore because you can't get a 1-mile buffer zone anywhere." Residents of these grandfathered zones live as close as 12 feet to the fenceline of facilities such as Shell Chemical (approximate distance determined during a field visit on April 15, 2001).

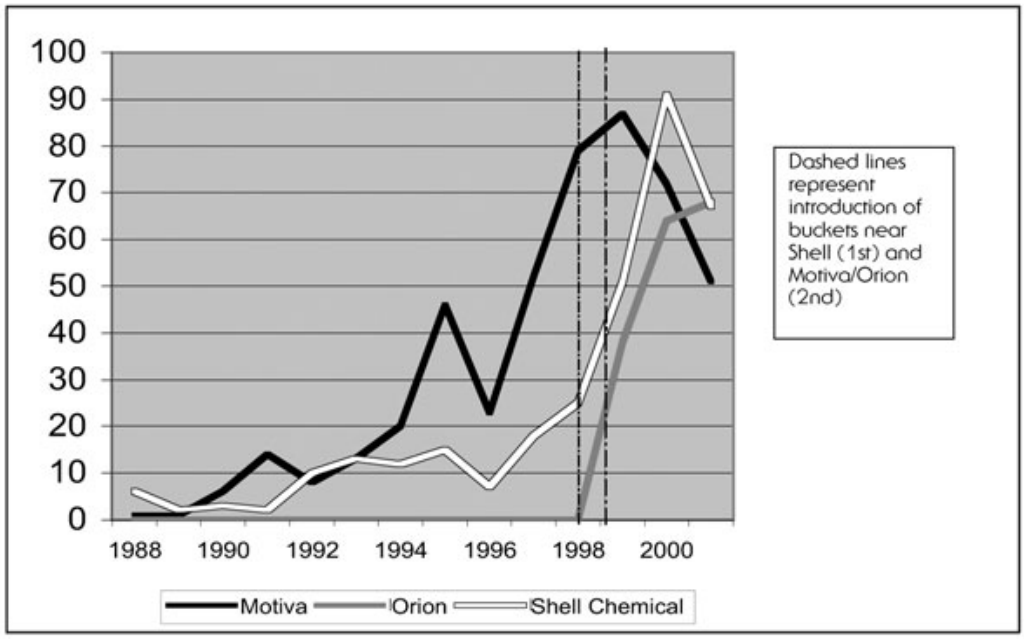
[11] A cracker is a high-pressure and heat unit used to break down molecules to form a variety of chemical products from crude oil.

[12] From 1996 to 1998, 10 documented flares released more than 25 tons of sulfur dioxide (among other pollutants) into the surrounding air (Biers, 2000). These flares focused residents' attention on the potential release of toxic pollutants; the flares are often used when there is too much gas to be burned in boilers and furnaces because of a buildup, a malfunction, or an emergency such as a shutdown or the loss of electricity. Examples of these reported causes of flaring include boiler malfunction, the burning of products that fail to meet specifications, such as ethylene, and mechanical failure causing a unit to be taken off line. "Blazing," or heavy flaring has resulted at the Shell Norco facilities because excess materials have accumulated as a result of mechanical error, or the restarting of olefins units. Shell Norco refers to flaring as a "sign of a productive, industrial community" (Motiva Enterprises LLC, 1999). Flares underscore the tension between industry efforts to avoid cutting back production rates, and concerns that flaring fails to convert all of the chemicals into non-hazardous compounds. An entire Web site, funded by the Sierra Club Legal Defense Fund, has been established to track incidents of flaring in Norco and New Sarpy (Concerned Citizens of Norco et al., 2001).



The trend line labeled "Tosco" represents the Rodeo refinery, which was operated by Unocal until April 1, 1997.
Source: Bay Area Air Quality Management District (personal communication, July 2001).

Figure 2. Annual episodes by facility in Contra Costa, 1992–2000.

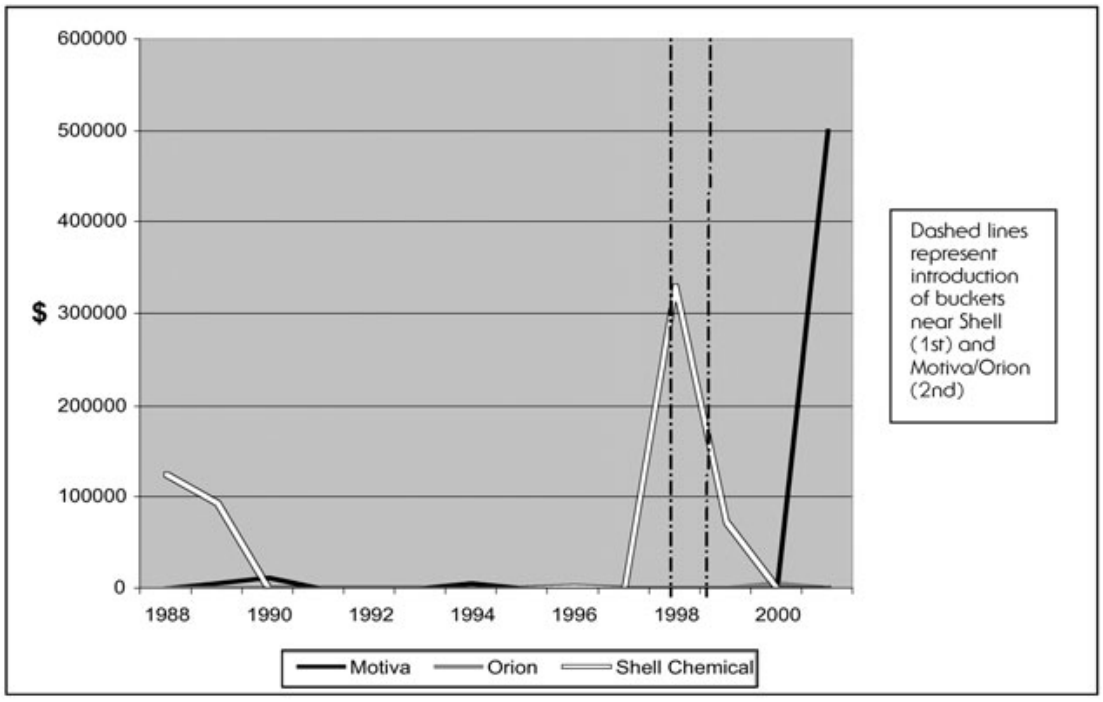


2001 estimate based on episodes through August 22, 2001.
Source: Louisiana Department of Environmental Quality (personal communication, August 2001.

Figure 3. Annual episodes by facility in Saint Charles, 1988–2001.

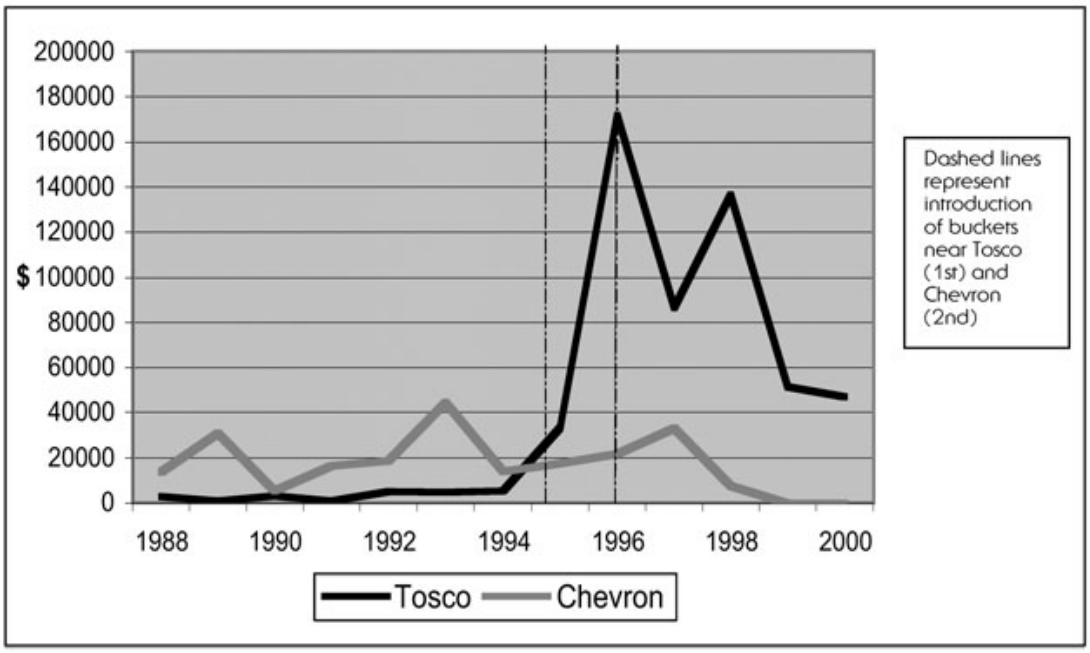
Residents are given a limited role to play during and following incidents. More importantly, they have historically been excluded from decisionmaking concerning production process changes and industry efforts to monitor emissions onsite. In the event of an accident, residents are told to "shelter-in-place," which consists of seeking the nearest building and sealing off potential sources of outside air (Concerned Citizens of Norco, 1999). Until the introduction of the bucket samplers, the residents of both counties relied on the assurances of industry and government officials, whose common refrain was to give an "all-clear" several hours after the start of an incident. Penalties for accidental releases and compliance failure were minimal and gave no incentive to even temporarily reduce production rates (Louisiana DEQ, 2001d). Figure 4 provides an overview of administrative penalties sustained by facilities in Saint Charles before and after the use of bucket samplers.

In contrast to the response of the Louisiana Department of Environmental Quality (DEQ) to facility incidents, the Bay Area Air Quality Management District (BAAQMD) in California has issued a significant number of notices of violation to the Rodeo refinery (owned by Unocal and then Tosco) and to Chevron (BAAQMD, 2001). Figure 5 documents annual penalties assessed for the two facilities, which averaged $1754 and $451 per violation, respectively. While supportive of the frequency of fines, environmental groups have criticized regulators for penalty levels set too low to influence these multi-billion dollar companies (Cuff, 1999).



2001 figures are as of July 25, 2001.
Source: Louisiana Department of Environmental Quality (personal communication, August 2001).

Figure 4. Penalties assessed following LDEQ enforcement actions, 1988–2001.



Source: Bay Area Air Quality Management District (personal communication, July 2001).

Figure 5. Penalties resulting from BAAQMD enforcement actions, 1988–2000.

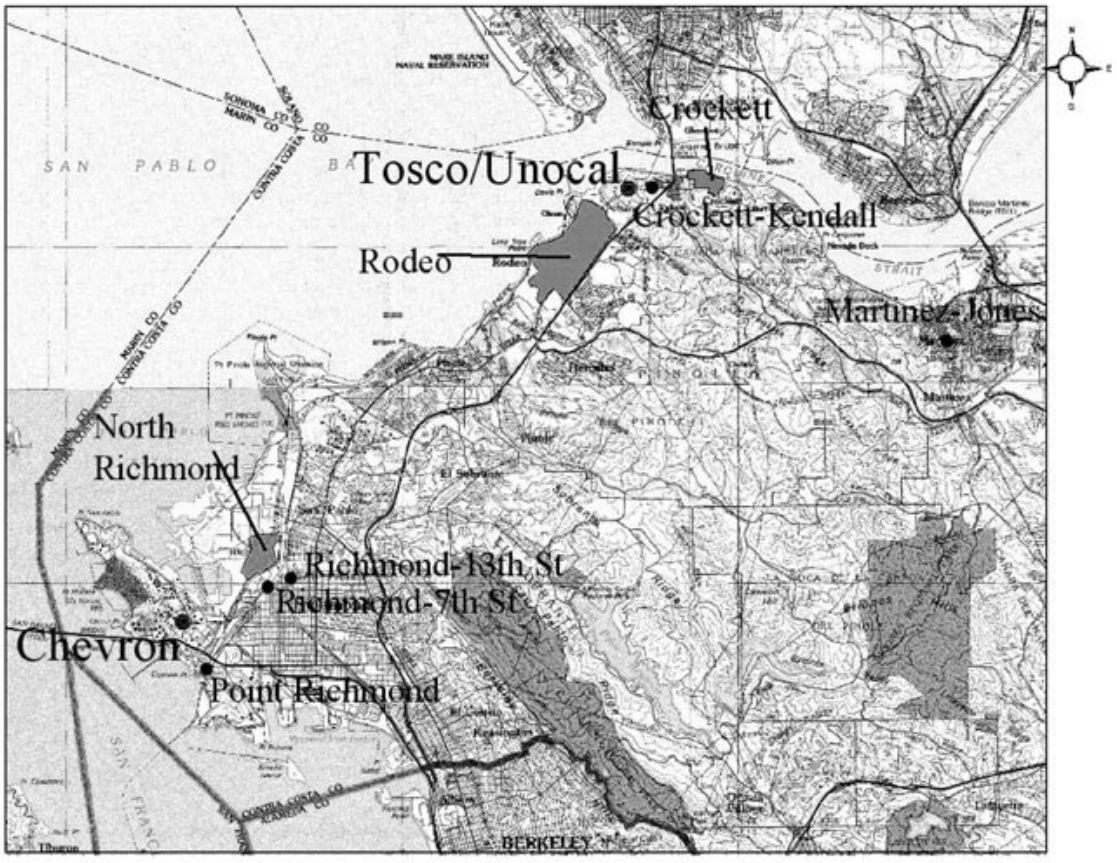
A key concern of community members is that government agencies are not monitoring the full range of chemicals they are exposed to. Existing ambient monitors measure only a handful of criteria air pollutants (those in relative proximity to the case study facilities measure sulfur dioxide [SO_2], carbon monoxide [CO], nitrous dioxide [NO_2], ozone [O_3], particulate matter of 10 microns [PM10], and lead [Pb]) (California Air Resources Board, 2001). Ground-level air monitors required by the District add only a few other compounds, such as hydrogen sulfide (H_2S). By 1997, Saint Charles Parish had established three ambient-air monitoring sites to measure air pollutant concentrations (Louisiana DEQ, 2001a). These monitors were located significant distances (over 30 kilometers in one case) from the facilities of concern to community members and measured a limited range of pollutants (particulate matter, total suspended particulates, and ozone)—not the hundreds of toxic chemicals released every year from petrochemical facilities. Hence, after an incident, community representatives are referred to a monitoring station often kilometers away where monitors almost always record acceptable concentrations of air pollutants. See Figures 6 and 7 for the relative location of industrial sources of pollution, residents, and air monitoring stations. Note that no fixed air monitoring capacity currently exists in the fenceline communities of North Richmond and Rodeo, California, or Diamond, Louisiana.

Impacts of the Bucket Brigades

Following their introduction, the bucket samplers directly and indirectly influenced a variety of citizen, agency, and firm responses. A survey of administrative, industry, and community-level dynamics after the initial use of bucket samplers shows

the following broad trends, attesting to the complexity of evaluating the effects of monitoring with this novel technology:

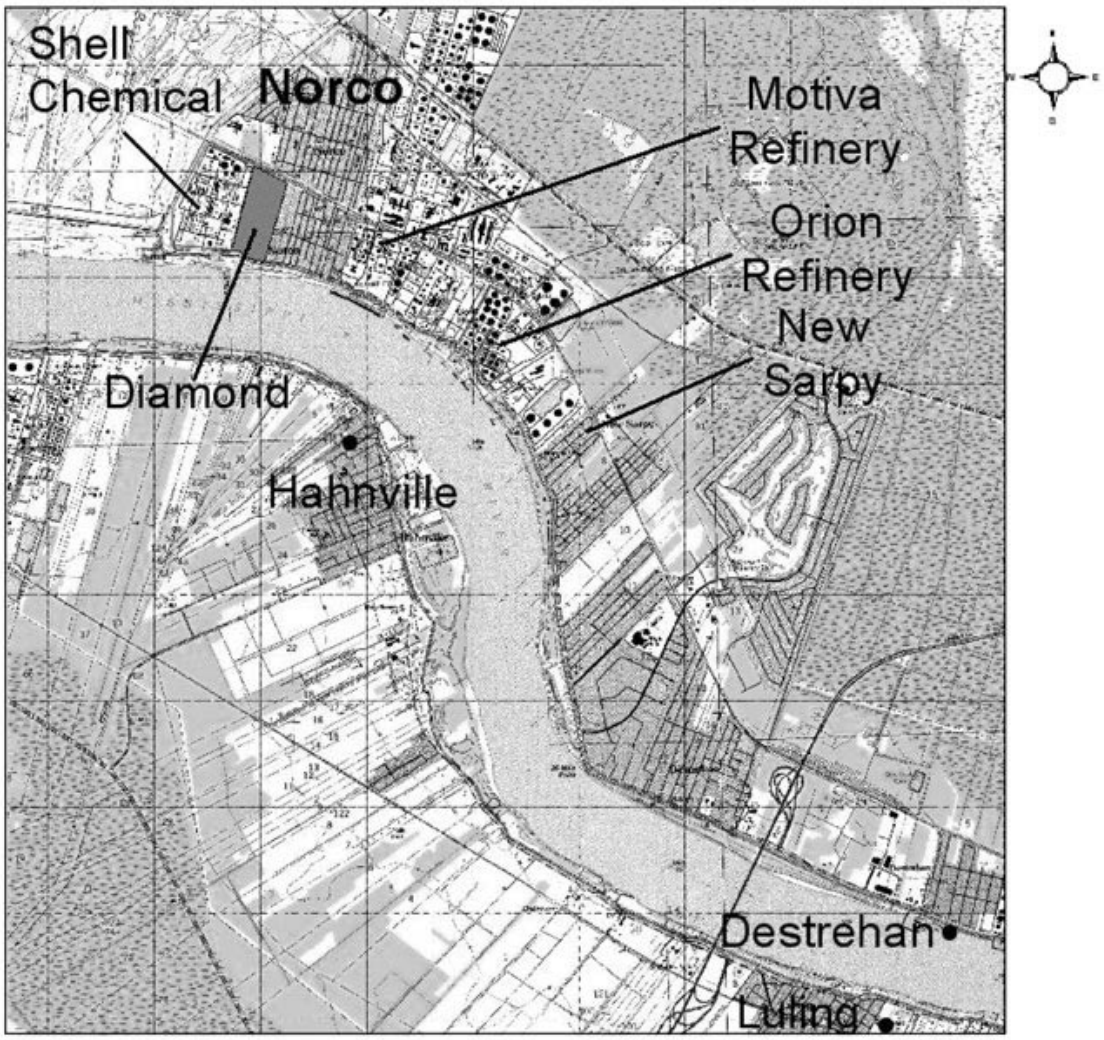
1. The most universal effects of the use of bucket samplers were changes in residents' understandings and perceptions of pollution, and in community responses at the local level;
2. Administrative actions, some arguably influenced by the use of bucket samplers, were carried out beyond the scope of local decisionmaking;
3. Industrial process changes were implemented, mostly in Contra Costa County, although without direct citizen participation or input;
4. The number of episodes of fire, explosion, or other accidental release remained high or increased at four of the five facilities for the first 12-month period following initial use of bucket samplers. (Chevron, with a significant



Centroid locations for each facility are represented by circles. Air monitors include Crockett–Kendall, Martinez–Jones Street, Point Richmond, Richmond–7th Street, and Richmond–13th Street.

Source: United States Geological Survey Aerial and Topographic Data (Terraserver, 2002; BAAQMD, 2002; Jim Tomich, BAAQMD Supervising Engineer, personal communication, December 20, 2001).

Figure 6. Relative location of facilities, affected communities, and air monitors in Contra Costa communities.



Air monitors include Destrehan, Hahnville, and Luling.

Source: Louisiana DEQ (2001a); U.S. Geological Survey Aerial and Topographic Data (Terraserver, 2002).

Figure 7. Relative location of facilities, affected communities, and air monitors in Norco communities.

immediate reduction, is the exception.) Thereafter, reductions in the number of episodes were noted at both Contra Costa facilities, while episodes decreased at Motiva and increased at Shell Chemical and Orion in St. Charles;

5. Increased industry monitoring on-site was identified for three of the five facilities;
6. The modal response of petrochemical firms to accidental releases changed little;
7. Agencies operating in Contra Costa County have begun to alter their monitoring strategies, while in St. Charles the bucket samplers are regarded as little more than a unique citizens' complaint; and

8. Each bucket brigade has relied on a regional infusion of resources and the use of intermediaries to reframe the sampling results and link them to local concerns.

Community Participation

The most wide-ranging effect of the bucket samplers on local residents can be inferred from how they collectively represent their transition from victims to agents of change. Residents agree that the use of the buckets yielded clear results that had proven unobtainable through litigation and earlier attempts to meet with industry officials:

> The plant manager of Shell Chemical started to change. He started the "good neighbor" policy. Before then, we were just here, we didn't exist. They didn't think anything of us. We started the bucket and started getting on TV, the newspapers, and that's when the plant people started coming in and really discussing things with us. We didn't have any idea of what kind of chemicals; we didn't know, because we're not scientists or anyone who would know what we were smelling or what's coming out. And they knew we didn't know. But once we got the bucket, and the bucket was proof that there were chemicals coming out of there that could hurt us, well, I think that kind of put, I don't want to say put fear or anything in them, but I think it kind of made them move a little faster. (Concerned Citizens of Norco, personal communication, April 13, 2001)

Residents of St. Charles and Contra Costa agree that the buckets have provided important information regarding "who is releasing what" so they can ascertain whether officials are misrepresenting the effects of an accidental release. Beyond these accountability uses of the data, residents in St. Charles have used sampling data as the centerpiece of a reinvigorated campaign for relocation. Armed with analytical results, residents successfully filed complaints with neighboring facilities, which resulted in a series of official meetings between Norco residents and Shell Chemical, the creation of a Norco–New Sarpy Community Industrial Panel, and the expansion of a 30-year-old relocation policy. As the Norco bucket brigade expands, it is considering a shift from nearly exclusive reliance on samples taken during episodes to purposive samples to show that similar concentrations of toxic pollutants can be found across the community. Such data have been used to bolster claims that Diamond neighborhood residents should be relocated *en masse*. Bucket data have also been critical in convincing community members who work for local industry that the companies they depend on are doing harm. Having analytic data was regarded as critical to convincing a skeptical public. The bucket data also afford impacted communities the opportunity to speak directly with firms and regulators, giving community members a seat at a different kind of negotiating table (bucket brigade participants, personal communication, May 22, 2001).

Opportunities for dialogue have differed across the two locales. In Contra Costa, members of the Shoreline Environmental Alliance (SEA) attend meetings with local and regional officials to discuss pollution data and monitoring techniques. Chevron and local residents have begun to discuss chemical emissions and production processes at its community advisory panel. Sampling data are used to support the Good Neighbor Agreement between Tosco, the towns of Rodeo and Crockett, SEA, and CBE. The County's Health Services Department continues to collaborate with local groups to improve the sampling technology and to further reduce costs (Jim Gallagher, county official, personal communication, May 24, 2001).

In St. Charles, a more focused campaign for relocation and limited agency cooperation have reduced opportunities for changing the relationship between residents and industry representatives. When Shell Chemical and Motiva Enterprises met with residents of the Diamond community for the first time (November 29, 1999), it was to discuss a Voluntary Fenceline Property Purchase Program for residents of the two streets directly adjacent to each plant (Swerczek, 1999). In May 2001, 30 meetings later, only two properties had been sold, while 11 others had agreed to sell (Swerczek, 2001a).[13] Other communications efforts were begun at the suggestion of a report to the National Petrochemical and Refiners Association following the December 8, 1998, incident. A Community Industrial Panel was formed in August 1999 to address community concerns (Thomas, Baker, and Menard, 1999). Shell Chemical, Motiva, and Orion are represented on the panel that also includes area residents, ministers, and other facility managers. A Good Neighbor Initiative, introduced by Shell Chemical and Motiva in September 2000, promises: to reduce emissions by 30 percent and flaring by 50 percent over 3 years; to provide job training to local residents; to establish an air quality monitoring system; and to establish an endowment for community improvements (Swerczek, 2000, 2001b, 2001c). To date, only the endowment has been implemented.

Nonetheless, participation has led to significantly increased awareness about chemicals, health hazards, and monitoring procedures in communities surrounding each facility. Over and over, bucket brigade members explained in technical detail their concerns about industrial practices and emissions of chemical compounds.

State Responsiveness

The factors driving federal and state environmental agency actions regarding St. Charles and Contra Costa facilities are difficult to discern given lack of information on the linkages among citizen complaints, inspections, outside events, and internal discretionary acts within the agencies. Here we focus on St. Charles, where more detailed information is available. Use of bucket samplers in St. Charles may have contributed to the degree and scope of agency actions following their introduction on December 8, 1998, but it would be premature to declare that they were a driving force behind these efforts. The first significant enforcement action taken against Shell Chemical since 1990 included a penalty assessment on November 24, 1998, before the bucket brigade began (Louisiana DEQ, 1998, 2001d).

Motiva also underwent heightened scrutiny starting on July 19, 1999, when DEQ inspected the site and reviewed documents, in conjunction with the EPA Region VI's Multimedia Inspection Team (Louisiana DEQ, 2001e). A compliance order in March 2000 based on the 1999 inspection did not indicate any violations of air quality standards, but focused rather on operation and maintenance deficiencies that resulted in improper handling and treatment of wastewater (Louisiana DEQ, 2000). By the time of their issuance of a Notice of Potential Penalty to Motiva on June 2, 2000, the DEQ and EPA had discovered hundreds of violations, mostly pertaining to open-ended valves and other fugitive emissions, which had been a major focus of

[13] Residents of the Diamond community remained steadfast in their opposition to any relocation plan that did not include the entire four-street community. The Purchase Program has been criticized as using "invitation only" meetings, not adhering to deadlines, directly communicating with only a few residents, and failing to recognize associates of Concerned Citizens of Norco throughout the negotiation process (Concerned Citizens of Norco, 2000).

the citizen campaign. Possibly the citizen campaign, centered on the use of bucket samplers and their ability to detect concentrations stemming from fugitive emissions, encouraged such a focus. However, information required of Motiva in the Notice of Potential Penalty focused on volatile organic compound emission changes from the rebuilding of the catalytic cracker in 1995 as well as modeling results for 1,3-butadiene emissions from the facility from 1997 to 1999, which was never found in a bucket sample.

Nevertheless, a settlement reached in March 2001 among the EPA, the states of Delaware and Louisiana, and Motiva Enterprises speaks directly to the focus of citizen complaints as well as the need for more effective monitoring mechanisms (Louisiana DEQ, 2001e). In it, Motiva agrees to perform beneficial environmental projects through an expenditure of $4,030,000 above and beyond the $500,000 penalty DEQ assessed and a $1,000,000 penalty the EPA assessed. These projects include working with community representatives to develop an ambient air monitoring network, including "the installation of air monitors at various locations in and around the Norco area" (Louisiana DEQ, 2001e, p. 16). A flaring reduction program will include the installation of a flare gas compressor to reduce the total emissions resulting from flaring episodes.

The bucket brigade surrounding the Orion refinery took three samples between July 12, 1999 and August 27, 1999 (Subra, 2001b) in which they discovered benzene concentrations that exceeded the Louisiana Ambient Air Criteria (25 ppb vs. 3.76 ppb) (Subra, 2001a). New Sarpy Concerned Citizens, in conjunction with the Louisiana Bucket Brigade, have succeeded in directing the attention of the media and the state DEQ toward Orion's lack of compliance with regulations governing flaring, fugitive emissions, and other practices. DEQ officials credit the complex citizen complaints with spurring a comprehensive probe of the facility, which continues in conjunction with the EPA (Biers, 2001; EPA official, personal communication, July 3, 2001).[14] This investigation is likely to result in a dramatic increase in penalties similar to those handed down to Shell Chemical and Motiva.

As shown in Table 2, enforcement activities increased sharply at Unocal–Tosco following the initial use of bucket samplers. And while reported episodes actually decreased, community complaints increased dramatically, encouraging a greater number of inspections and fines. It should be remembered, however, that litigation following the Catacarb incident was ongoing during this period. Similar deployment of bucket brigades around Chevron, without the requisite use of litigation or enforcement of a good neighbor agreement, did not significantly raise enforcement activity, although monthly episodes did decline.

It would be inaccurate to claim that the bucket samplers were solely responsible for increases in enforcement actions. Dramatic increases in pollution episodes, coupled with historic trends in agency enforcement and, in the case of Motiva Enterprises, the cooperation of a whistleblower who played an important part in the state investigation, were all critical to motivating increased enforcement activity (Biers, 2000; Louisiana DEQ, 2001d). As indicated in the enforcement data presented for Louisiana, state and federal agencies appear to direct their attention to clusters of facilities in cycles (EPA Region VI official, personal communication, July 3, 2001; Louisiana DEQ official, personal communication, June 28, 2001). In an interview (June 28, 2001), a Louisiana DEQ official explained

[14] EPA and state agency officials requested anonymity in their responses to our queries.

Table 2. Trends following introduction of bucket samplers near targeted facilities.

Facility	Bucket Intro	Ave. Penalties Assessed ($)	Ave. Episodes	Industry Actions	Impacts on Residents/Citizen Groups
Unocal-Tosco	Aug. 1995	8,775 12,467 27,513 82,047 123,374 105,397	na 17 25 47 42.5 38.7	Increased self-monitoring Adjusted operation of plant aerators Installed fenceline monitoring system	Complaints increased and then dropped sharply Supported good neighbor agreement with Unocal Increased awareness and knowledge of emissions Attend pollution monitoring meetings with local, regional officials
Chevron	Nov. 1996	25,639 18,629 28,825 34,180 31,461 53 PFD	38 36.3 31 18 15.5 13.7	Increased self-monitoring Reduced flaring Installed new coker Improved community siren system Shut down fertilizer plant within facility	Complaints stagnant Improve position on community advisory panel Increased awareness and knowledge of emissions Attend pollution monitoring meetings with local, regional officials
Shell Chemical	Dec. 1998	66,500 110,833 330,000 73,458 36,729 24,486	15.4 16.7 25 51 71 69.7	Community/Industrial Panel Good Neighbor Initiative Voluntary Fenceline Purchase Program	Renewed calls for buyout and use of data to support relocation campaign; Diamond Options Program agreed to after facilitated negotiations in June 2002; includes a Property Purchase Component available to all residents of Diamond Increased awareness and knowledge of emissions Challenge industry explanations of recurrent episodes

(Continued on next page)

Table 2. Continued.

Facility	Bucket Intro	Ave. Penalties Assessed ($)	Ave. Episodes	Industry Actions	Impacts on Residents/Citizen Groups
Motiva	June	1000	50.6	Community/Industrial	Calls for buyout and use
	1999	0	62.3	Panel	of data to support
		0	84		campaign
		0	80	Good Neighbor	
		250,000	71	Initiative	Influenced kinds of
		na	na		Beneficial
				Voluntary Fenceline	Environmental Projects
				Purchase Program	required
					Increased awareness and
					knowledge of emissions
Orion	July	closed	closed	Agreed to conduct	Calls for buyout and use
	1999	closed	closed	canister air sampling	of data to support
		0	21	on property	campaign
		5050	39		
		2025	63.5		Expanded scope of
		pending	na		DEQ/EPA investigation
					to include Orion site
					Increased awareness and
					knowledge of emissions

Annual penalty and episode averages are: 5 years prior/3 years prior/12 months prior/12 months after/2 years after/3 years after the initial use of bucket samplers.
PFD = number of violations pending final disposition.
NA = sufficient data not available.
Pending = investigation ongoing.

that this cycle of attention can be attributed to finding a "critical mass" of violations through annual inspections of major facilities:

> We can take a look and say right now we've got some critical mass down in this area, let's go ahead and concentrate on that. We have a number of ways that we look at things. You can't focus on everything, but we do annual inspections of the major facilities. If we find a pattern of something going on, one of the things that came into play down in that part of Louisiana was looking at ambient air models or looking at water discharges into the Mississippi. We have certain things that we have prioritized for that period of time, and as soon as we get that under control, we have another item to go after.

These cycles of activity can either be influenced by or supercede the operation of bucket brigades around facilities of interest.

While EPA Region IX has supported the buckets through grant money and hopes to begin comparative studies of their reliability vis-à-vis approved monitoring techniques, both state and federal agencies assert that the buckets cannot serve as a direct enforcement mechanism (EPA official, personal communication, July 3, 2001; Louisiana DEQ

official, personal communication, June 28, 2001). Problems with meeting chain-of-custody requirements, divergence from approved sampling methods, use of a Tedlar bag (which neither agency has approved), and uncertainties regarding the interpretation of results from limited sampling frames (3-minute versus 8- or 24-hour standards) are given as primary obstacles to the use of bucket samplers in enforcement activities. Nonetheless, government agencies in California have gradually begun to recognize and even support the bucket brigades. EPA Region IX and Contra Costa County have provided funding, assisted in the development of a quality control program, and brought different actors to the table to discuss these new strategies (Contra Costa County, 1997; Walker, 1997; EPA official, personal communication, May 24, 2001).

Accountability

The participants in the bucket brigades are fairly frank about not knowing how much influence they are having on industry. When industry accountability is discussed, it is characterized in general terms. As one participant asserted, "We are changing the companies because they know we're here" (May 21, 2001). And another noted, "Tosco knows I have this stuff. Tosco knows that I've taken samples. Tosco—their odor science and engineering people have come by and watched me take the bucket samples" (May 23, 2001). Community members believe that the knowledge that they are being monitored makes industry "sit up a little straighter." Public records support this perception.

The Tosco refinery, subject to litigation as residents began to address its emissions, has been hailed as an example of what can happen when citizens begin to police such facilities. Ed Masry (September 22, 2001) argues that the

> amounts of emissions coming from that plant dropped dramatically.... Emissions really stopped because they started patrolling their own perimeter and they started really closing up their loopholes. Before they could [pollute] with impunity because nobody could prove what they were doing. Now we have them surrounded, and they couldn't do that anymore.

The fact that community members were "surrounding" this facility certainly seems to have had some influence on the firm's performance. One government official noted that there has not been one "major incident" at Tosco since the beginning of the bucket brigades and the development of a fenceline monitoring system (BAAQMD official, personal communication, September 24, 2001). A longer-term trend of decreased episodes at Chevron, while positive, is more difficult to connect directly to the introduction of the bucket brigades.

The presence of bucket samplers in neighboring communities has also motivated industry to carry out additional monitoring of its own. As one county official (May 24, 2001) explained,

> They used to rely entirely on their on-site fixed monitors. It was very rare they would ever go off site. And now they have a mutual aid agreement through the industry group that would provide off site monitoring with an industrial hygienist, industrial hygienists from various industries have equipment in the trunks of their cars...they take home and they provide 24/7 assistance to industries who are having problems, and they do off site monitoring. If you're an industry, and you have various agencies and various groups out there taking air samples with valid samples, and they don't have anything to confirm or to contest, do you think that their management would be unhappy about that?"

This increase in monitoring is important because one of the key concerns of community members and environmental groups is the overall lack of monitoring of emissions from these facilities. Motivating firms to carry out their own monitoring has the potential of producing more information for the public and public agencies to use, and providing refinery managers with information on problems stemming from their production processes. Indeed, the bucket brigades—and associated community pressures—have motivated a range of production changes to reduce pollution. One bucket brigade participant (May 23, 2001) argued that bucket sample data has forced Tosco to adjust the operation of plant aerators. Another (May 21, 2001) noted that Chevron had reduced its flaring, installed a new coker, improved a community siren system, and shut down a fertilizer plant within their facility. The mere presence of a bucket brigade is believed to create an incentive for firms to avoid further incidents.

Residents of Norco and New Sarpy in St. Charles are unaware of any internal production process changes at neighboring facilities, although they have observed shifts in flaring cycles, an increase in nighttime emissions, and a reduction in odors during the day. Efforts are being made to adjust the bucket brigade organizations to accommodate these changes and maintain their citizen policing capabilities. As noted in Table 2, episodes have increased dramatically at Shell Chemical since the first sample was taken in December 1998 (with similar increases at the Orion facility), while limited reductions were noted at the Motiva refinery. The growing number of episodes at Orion can be attributed to the refinery's approaching full production after reopening in April 1999, while episode reductions at Motiva coincide with heightened EPA scrutiny that led to a site inspection in July 1999. The only clear link between bucket sampler use and episode trends in St. Charles can be found at Shell Chemical, where a dramatic rise in episodes can be attributed to increased industry reporting encouraged by penalty assessments in November 1998, citizen monitoring, or a combination of the two. Estimates for 2001 suggest that for the first time, episodes declined at each facility.

Data generated from the bucket brigades also appear to have motivated additional monitoring on the part of local agencies and firms (Denny Larson, personal communication, May 21, 2001).

> Agencies like the Bay Area Air District, and the state agencies that are hostile have been forced to take more samples during accidental releases and events, to do more monitoring around facilities.... In the past, there was almost never any air sampling during or after a chemical accident or release. Now, you have community people taking samples, you have Contra Costa County using glass-lined canisters and buckets. You have the Air District out there, taking hand-held and glass-lined canister samples, you've got people tripping all over each other taking samples.... So, it's increased the level of monitoring that's done.

Government agencies appear to feel pressure to be more accountable to affected communities now that data on industrial emissions are public. The BAAQMD, for instance, is developing and expanding its own mobile monitoring program, having retrofitted a van with new mobile monitoring technologies. As one county official (May 24, 2001) admitted, "The fact is that outside groups were implying that they weren't getting their money's worth with the government agency or agencies. It's a democracy. It's a watchdog. Why not? Why not keep government agencies on as well as industry?"

Assessing the Bucket Brigades

How do the bucket brigades perform along key dimensions of public participation and the more specific goals of community policing, such as increasing community

involvement, providing new information, increasing the accountability of state agencies and firms, and co-producing regulation? On broad measures of public participation (Chess, 2000; Rowe and Frewer, 2000; Shephard and Bowler, 1997), the bucket brigades have performed quite impressively. The bucket brigades are inclusive, bringing previously excluded groups and technical "amateurs" into dialogues about pollution and health issues. In both St. Charles and Contra Costa, participants come from lower-income communities and communities of color living next to polluting industries. The bucket brigades support place-based organizing, creating new mechanisms for mobilizing around local environmental improvements. The brigades introduce community members into environmental disputes very early—almost immediately as a pollution event is occurring and often before regulatory agencies have arrived on the scene. The brigades help to increase knowledge of emissions and potential health risks, raising awareness and strengthening the technical skills of local community members.

At the same time, a shift from initial resident empowerment to a broader set of shared responsibilities and increased discretionary roles needed to address the root causes of pollution within fenceline communities has not occurred in the cases analyzed. The gap between initial progress and a genuine form of community environmental policing remains significant. And while community environmental policing has not fully taken hold, members of citizens' groups and their intermediaries are calling for the inclusion of bucket brigades in a broad array of enforcement activities.

Turning to the framework of community policing, the bucket brigades represent "incident-oriented" policing that encourages problem definition by residents in cooperation with regional NGOs. The buckets create a kind of community 911 system, in which designated persons pull an alarm, and community members investigate and gather data on a specific incident. But the bucket brigades also represent a broader organizational process that mobilizes the community to demand improvements in the overall operation of local industry. The bucket brigades support community values of order and cleanliness and reduction of nuisances such as chemical leaks, flaring, and accidents, the environmental equivalents of fixing broken windows. The bucket brigades also advance a system of accountability over state agencies and firms. The buckets function like a sophisticated neighborhood watch program, tracking local "crimes" and nuisances, and then monitoring police responses while working to encourage the state to investigate incidents. Members of the bucket brigades want a say in defining the underlying problems of industrial process design, and they want state agencies to work to prevent future episodes.

The buckets differ from community crime policing, first, in that there has been little state role or support for community environmental policing. The Louisiana DEQ has not embraced the concept of the bucket brigades the way many police forces initially encouraged community policing, through unilateral moves to improve police responsiveness and resources by setting up neighborhood watch and block clubs. Nor have state officials begun to experiment with decentralized inspection teams, and any efforts to reorient "patrols" have been made in accordance with agency-wide shifts in attention from one industry to another. Reactions to the buckets within environmental agencies working in Contra Costa and Louisiana range from the view that bucket brigades constitute just another form of citizen complaint to open hostility to community participation in environmental monitoring.[15] This hostility mirrors the early

[15] As one regulator in Louisiana (June 28, 2001) told us, "I look at bucket samples as kind of like a minimal thing. It provides some information but don't expect me to take a bucket sample and say that this is real. There are just too many qualifiers that I would have to put on any of that. So I'm not for or against. It is a tool that somebody could use, but they have to understand the limits that we would place on those buckets."

years of community policing, when there was significant pressure on police departments to strip layers from their rank structures and devolve discretion to patrol officers. This led to resistance from supervisors, who sought to maintain an illusion of control even as beat officers were called upon to exercise a growing amount of discretion while making their daily patrols. To date, the majority of state agencies and federal regulators operating in the case study regions—the police for environmental issues—remain unsupportive of community environmental policing.

Reacting partly to these state responses, different bucket brigade organizations are moving forward in different ways. As with community policing, there are both partnership- and accountability-focused versions of community participation. For instance, the BAAQMD, one of the most stringent command-and-control agencies in the country, levied a significant number of violations for a range of facility-specific problems throughout the life of the bucket brigades. Their recognition of problems relating to fugitive emissions, monitoring maintenance problems, flaring, and excess VOCs at the plants provided justification for resident efforts to link their analytic data to proposed problem solutions. Agency actions as well as various court cases resulted in sharp reductions in the number of episodes per year following the introduction of the buckets. In St. Charles, the parish government had minimal discretion in meeting the challenges posed by its refineries. Episodes increased, further legitimating calls for relocation as residents saw little government sanctioning of efforts to link root causes of facility incidents to additional uses of bucket data or other solutions (see Figure 3). Community groups have applied the bucket brigades differently in response to these varied contexts.

Thus, while even some of the earlier, unilateral efforts of police departments to involve the public have not yet occurred in the arena of environmental monitoring, the bucket brigades hold the potential to involve a more expansive and direct form of citizen action than community policing. Bucket brigades focus directly on tracking and changing "criminal" behavior. They seek processes through which to negotiate directly with those causing local nuisances or emissions (a strategy specifically discouraged in community policing). And they have pushed strategies that provide direct access to the courts in order to speed remediation. The bucket brigades also show that "weak" communities can respond to environmental problems and effectively participate in complex policing debates. Interestingly, these debates have occurred among the public and a limited number of comparatively "respectable" targets (i.e., Shell, Chevron) that issue emissions data yearly to the state, are subject to operational permit conditions, and under certain circumstances are prone to the moral suasion inherent in the publicity surrounding bucket sampling results (smaller, more numerous, and often unregulated point source polluters have not been targeted by the bucket brigades). Direct contact between local residents and the state has been limited to either the state's attempts to study and critique the new sampling technology, or efforts by citizen groups to influence the state's attention regarding facilities targeted by the bucket brigades.

This peculiar relationship between the "policed" and the broader community begs the question: To what extent can or should the state be involved in co-production of environmental monitoring in highly polluted communities? The answer to this question will depend on whether citizens and government can agree to a common definition of the "order" that they are seeking to maintain and on methods that can be applied to reduce the perception that overburdened communities are constantly "under siege" by toxic emissions. Co-production also requires that the two groups pay close attention to the potentially politicizing, polarizing, and inequitable results of community involvement that have been unearthed through research on

community policing. Indeed, our research identified a number of community organizing challenges experienced by the bucket brigades, which can be easily overlooked in reports of early successes. These included problems with sampling protocols, training of local samplers, mobilizing community members to participate in sampling and technical debates, and strengthening community capacity to analyze and interpret sample results.

The progression from pilot projects to broader implementation in some ways mirrors the development of community policing infrastructure. In the case of air quality monitoring, this requires adequate attention to how co-production of environmental protection can occur between the state and the public, given the limitations and opportunities posed by the bucket brigades.

TOWARD COMMUNITY ENVIRONMENTAL POLICING

A number of participants in the bucket brigades, including some of the original leaders, believe that bucket data should support litigation efforts against targeted facilities. The original idea for the buckets was to gather data for lawsuits and to support legal remedies for emissions violations. Despite the development of legally oriented protocols for tracking the chain of custody of monitoring samples and laboratory handling, the bucket data have still not been admitted into evidence or used to adjudicate a court case. From agency staff to activists, a number of people were skeptical that the bucket data could ever withstand the court's scrutiny. Advocates, however, believe that with the right quality assurance, training, and sampling procedures, bucket data could gain the status of legal evidence.

Others see the future of the buckets as an advanced and more technical form of citizen complaints. Bucket data in this model would be used more extensively in motivating enforcement actions. Community participation would serve primarily to provide information and incentives for the state to enforce environmental regulations more stringently, akin to the "eyes and ears" function of early neighborhood watch programs. In this view, the bucket brigades offer an additional weapon in traditional lobbying and pressure group arsenals. Community monitoring generates information to focus attention on polluting industries and to encourage the state to monitor more effectively. Bucket data can be used to pressure for increased government regulation, in particular for the installation and operation of additional fixed monitoring stations at more appropriate geographical locations. This pressure can also help support capacity building initiatives of local agencies.

To significantly move forward community participation in environmental regulation, it will be necessary to do more than simply use the buckets within the limits of available strategies. Currently, bucket brigades perform well in the community policing roles of providing new types of information, encouraging industry's accountability, and in reorienting resultant policy debates to community-defined, health and quality of life values, and away from technical, risk-based approaches to monitoring. Where the bucket brigades have yet to succeed is in promoting a division of roles between residents and the state that can form a basis for the co-production of environmental protection.

Because of the lack of state–citizen interaction, communities also lack new problem-solving strategies to form and maintain an organization that takes adequate, frequent samples. Deployment of bucket brigades centers on responding to incidents of air toxics emissions in a defined area in an attempt to counter the inefficiencies of government responses to industrial accidents. Bucket samples are of short duration. Buckets are donated to citizen groups in limited supply. Bucket

brigades are reliant on human capital for setup, maintenance, and usage. This system has not encouraged more specific avenues for exploring the sources contributing to accidental releases, excessive flaring of refinery catalysts or impurities, or other symptoms of disorder that plague fenceline communities. Similarly, early efforts to improve the efficiency of 911 call response ignored the discovery of situations that produce calls for police assistance in the first place. This kind of joint exploration of root causes and new methods for addressing them has not occurred, in large part due to the inability of the bucket brigades to encourage co-production with state and federal agencies.

To get a sense of the possibilities for community involvement in environmental monitoring, we must tease apart the avenues of co-production that can result in communities helping to resolve crimes on their own, and the kinds of problem-solving that co-production can encourage. Two forms of co-production, joint and parallel, are discussed in the community policing literature (Percy, 1984). The former involves a collaborative effort where citizens work with a specific government program to produce a desired good. The latter is carried out by citizens on a parallel yet unconnected track with government. Problem-oriented policing varies from place to place, but shares some common traits: knowledge of community needs and the public's definition of its problems, focus on threatening and fear-provoking conditions instead of legally defined incidents, search for patterns of incidents rather than responding to isolated events, and creative response or referral of citizens to other agencies that can help resolve certain aspects of community-defined concerns.

With regard to the direction of co-production, bucket brigades in California and Louisiana have operated on tracks often unconnected to government. The exception is Contra Costa (CA) and EPA Region IX's attempt to verify the accuracy and reliability of bucket sample results. Otherwise, co-production has been limited to voluntary organizations, with an infusion of resources from regional NGOs, supplementing government monitoring and enforcement. This parallel production is limited by the lack of problem-oriented policing encouraged by disconnected efforts of citizens and the state. It also heightens the constraints on problem definition by encouraging citizen reliance on a simple technology with limits in terms of how often it can be used, what it can test for, and what the results can tell a community about underlying causes of the conditions they face. Coordination between simple and complex technologies and the data which they generate has not occurred. When isolated from a partnership role with the state, the design and implementation of the bucket samplers encourages continued focus on the symptoms of disorder, as buckets are deployed to respond to "irregular" incidents and accidents. High-profile episodes galvanize communities and public support for their objectives, which are framed in terms of the effects of isolated events.

In Diamond, Louisiana, a shift from parallel improvements in data gathering after plant episodes, to calls for a community buyout recently succeeded. Yet, this move from incident-driven data gathering to a clearly defined campaign was the exception among our case studies. Weaving bucket sample results into a limited number of campaigns does not necessarily improve the long-term ability of residents, NGOs, and enforcement agencies to better understand patterns of accidents and their underlying causes, or the ability of enforcement officers to refer communities to other agencies that can better deal with other aspects of living in fenceline communities. Integrating emergency response capabilities of local fire and police departments, improving housing stock so that it can better protect residents during

"shelter-in-place" periods, notifying sensitive receptors in a timely fashion, ensuring that facilities such as schools, nursing homes, and medical centers are adequately protected and made available to those who lack mobility, and a host of other activities have yet to materialize in the communities that use the buckets, which arguably need them most. Both emergency response and facility environmental management stand to gain from data gathered by bucket samplers, but only if these data are linked to a growing network of data than can be shared, cross-referenced, and applied in making decisions by regulators working closely with the broader community. Such an approach would require coordination between simple and complex technologies (from bucket samplers and odor logs to fenceline laser monitoring systems) and the data which they generate, as well as the development of appropriate structures and relationships between residents, non-governmental organizations, regulatory agencies, and private firms. Otherwise, bucket brigades will remain constrained by the capabilities of the sampling technology that they employ, which encourage reactive responses to incidents and a focus on noticeable symptoms of industrial neglect.

Leveraging initial changes encouraged by bucket brigades and moving toward a more comprehensive form of community environmental policing will require increased government support, funding, and technical assistance, and the inclusion of local non-governmental organizations and previously excluded community members. The Environmental Protection Agency could play a pivotal role in addressing some of the pitfalls community environmental policing currently faces—both from state agency skepticism and resistance, and from community limitations of time, energy, coordination, and capacity. In addition, the EPA could better support initiatives such as the bucket brigades by providing funding, training, quality assurance, and legitimacy to community participation efforts, and by acknowledging the potential of joint government–community strategies. Yet recent programmatic shifts at EPA, including the cancellation of its Environmental Monitoring for Public Access and Community Tracking (EMPACT) program, suggest that it is unlikely that it will support bucket sampling or other community monitoring initiatives in the foreseeable future. Thus, efforts to overcome some of the inherent weaknesses of the bucket brigades, which mirror the shortcomings of community policing (state resistance, difficulty forming or maintaining block-level organizations, etc.), will continue to stem from NGOs operating with foundational support and targeting state and local governments.

Our case studies, carried out in two regulatory environments, suggest a strong diversity of factors that mitigate how a state or local agency might respond to NGO-driven demands for expanding community environmental policing. While a lack of co-production limits the corruption or capture of community policing efforts, it also limits the deployment of the sampling technology itself and reduces its potential to be integrated into broader public disclosure systems and public education programs on industrial pollution. One could imagine a national network of community monitors connected to a larger, integrated system of citizen complaints, government monitoring efforts, toxics release data, and corporate accountability dialogues and mechanisms. Early experience with the buckets suggests that fenceline communities are adept at cross-referencing data (i.e., TRI, fugitive emission, and sampling results), isolating culpable parties, and formulating agendas and broad campaigns. And new efforts to recruit samplers from local emergency planning boards and to move from reactive to purposive sampling reveal that some of the above connections are already within the realm of possibility. What local residents lack, as did early neighborhood watch programs, is meaningful two-way

communication with policing agencies, access to resources that will ensure continued community participation in setting priorities and policing tactics, and legitimacy as co-producers of environmental protection.

From our analysis of initiatives in Louisiana and California, it appears that the bucket brigades have promoted community awareness and empowerment, provided new sources of information on air emissions, pointed out gaps in existing monitoring and enforcement systems, and helped to increase regulatory and industry accountability. Through a process of NGO-intermediated participation, communities are advancing new forms of participation and strategies of environmental protection. While limited in a number of regards, the bucket brigades offer a vision of community environmental policing that can be expanded and deepened.

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APPENDIX A: RESEARCH METHODS

Case studies were developed through site visits between April and June 2001, semi-structured interviews (n = 25) with citizen group members, local residents, agency officials, and industry representatives, and a review of EPA, Louisiana Department of Environmental Quality, Bay Area Air Quality Management District, citizen group, and media records. Each interview averaged 1.5 hours in duration with the interviews ranging from 45 minutes to 4 hours. Nearly all interviews were conducted on-site. Interviews were transcribed and coded.

Topics that were probed in depth included sampling methodology, real and perceived actions taken by each major stakeholder over time, interpretations of analytical results and their application to local campaigns and monitoring objectives, and historical accounts of lived experiences by residents of communities bordering the fencelines of the facilities in question. Newspaper accounts of the events surrounding each facility were gathered from 1991 to 2001 and coded. Where accessible, citizen group records were also gathered and subjected to analytic coding. Finally, public records requests were mailed to relevant enforcement agencies at the state and federal level, yielding a wealth of data regarding citizen complaints, pollution episodes and accidental releases, and enforcement actions.

Triangulation of these data, where possible, allowed us to reconstruct a common set of responses to citizen complaints and a lack of confidence in corporate and agency information that existed in each geographic area prior to the use of the bucket samplers. Reconstruction of the events preceding and following the use of bucket samplers allowed us to test to what extent the bucket brigades influenced the responses of citizens, agencies, and polluting firms. A comparison between the introduction of bucket brigades in Saint Charles Parish, Louisiana, and Contra Costa County, California, allowed us to make sense of the ability of this sampling technology to influence public policy responses in different contexts.