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Mapping Toxin Exposure Risk Due to Children's Play: A Case Study

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During the 1920's and 1930's, a Niagara County, New York residential community, Belden Center, developed in tandem with two adjacent toxic waste disposal sites. During the period that they were in use, both sites were classified as public health hazards. Particularly between 1944 and 1979, as toxins were deposited, neighborhood children swam and played throughout the industrial waste sites. By reference to a large-scale map of the dumps, present residents described locations and types of play during their childhood. Assuming that a child would play away from home between 8 and 19 years of age, this allowed identification of cohorts that used the sites during different periods. An outcome map showing sites, dates, and types of play is the primary product of this investigation. More boys than girls played in the dumpsites, and we identified a subsample that did not use them for play. We conclude that children's play should be considered a major source of risk where communities lie next to toxic waste sites. © 2000 Academic Press

Key Words: **toxins; child behavior risk; map; community study.**

INTRODUCTION

This paper describes an investigation of childhood play as a means of possible toxin exposure. We present a case study employing maps, ethnographic interviews, and archival records as data sources. Results include the history of a residential area and adjacent toxic waste disposal sites and a detailed map of children's play sites within the toxic dumps. While the qualitative picture presented is unique and may never be exactly duplicated, it offers an insight of great importance to future toxin exposure investigations. Children may be exposed to environmental hazards away from their immediate residence, and we should not assume that all children in a neighborhood play in the same areas and share the same risk. That is, risk may be patterned by individual behavior, by temporal cohort, and by geographical clusters. In this case, the New York Department of Environmental Conservation classified the toxic waste disposal sites used for play at "level 2" — significant threats to public health.

We asked adults in a Niagara County, New York neighborhood to describe their childhood use of adjacent toxic waste dumps as a play area. They were shown a map to identify specific sites at which play, such as swimming or building "forts," took place. Their accounts spanned a period between the 1920's when both the neighborhood and the waste sites had just started and 1998 — the time of the field investigation. Neighborhood children continue to play in the dumps.

Project Background

As a result of the deaths of two young men from the same type of brain cancer, members of the Belden Center community became concerned about the threat of toxins to health. Before his death, one of the men helped form C.A.P.E., an action organization dedicated to collecting information on toxins in the dumps and around the community itself and to identifying health problems. A newspaper article initiated by C.A.P.E. led us to begin an investigation.

Literature

A compelling reason to worry about children playing in toxic areas is presented by Bearer (1995). As children grow, those tissues and organs that develop most rapidly are particularly vulnerable to a range of toxins. Specifically, neural tissues, lungs, bones, and reproductive tissues, at different times, are

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easily damaged due to children's higher metabolic rates and lower capacity to detoxify dangerous substances. Further, their behavior brings them into immediate contact with toxins, not tempered by adult caution. Goldman (1995) reviews a number of specific, common endocrine disrupters, neurotoxins, and other substances that are particularly hazardous to the young. She also points out the added risk of multiple exposure, and that is a likely pattern of risk in the dumpsites described in this paper. Rogan (1995) and Lubin and Lewis (1995) sound the same warning and offer additional detail. As a child health hazard, lead is well explored, showing negative effects on both health and cognitive ability (Needleman and Gastonis, 1990; Walkowiak *et al.*, 1998; Wasserman *et al.*, 1998). It is clear that children should not play on industrial properties.

As part of this research, we conducted bibliographic data base searches for studies of children's "natural" play behavior in toxic dumpsites, but found nothing. Assuming that we were simply missing what is there, we contacted several people with acknowledged expertise on toxins and children. They were not aware of a single study on the topic. Elaine Hubal (1999, personal communication) has just completed a major review of factors that affect children's exposure to toxins, including specific age-related behaviors, and kindly sent a prepublication manuscript. She reviewed over 100 sources. None concerned children playing in dumps, although there is a lot of information on other behaviors and toxin exposure (see Pellizzari *et al.*, 1999; McCurdy, 1994; Ott, 1989; Glen *et al.*, 1997). In a study of children's exposure to chromium in New Jersey, Natalie Freeman (1999, personal communication) observed children playing in the dumpsites, but her observations were incidental to the main project. Steegmann remembers many Love Canal residents talking about children playing in the contaminated fill next to the 99th Street School—anecdotal accounts but very unsettling. Clearly this is an area that merits investigation, though an opportunity may not present itself often.

MATERIALS AND METHODS

One advantage of a qualitative ethnographic approach is that the anthropologist gains understanding by spending countless hours in homes and front yards listening to people's concerns and experiences. A great deal of information emerges that the investigator would miss using a structured questionnaire alone. Based on residents' knowledge, the investigator's professional experience, and public records, a synthesis of human–environment interaction emerges. As an example, none of the local environmental agencies were aware of the extent of children's play in toxic waste sites or even that this risky behavior had occurred at all. In Belden Center, the anthropological approach was particularly useful in that the community had never been studied and because the data were amorphous, complex, and hard to quantify. Bernard (1994) discusses anthropological methods in detail.

In the Belden Center case, it is not evident how an investigator could quantify childhood play in toxic waste sites by people who are now adults and no longer play there. However, after we heard repeated accounts of swimming in "green ponds" and visited many of the play sites, it became clear that a map of the neighborhood and adjacent waste disposal sites could be a powerful tool in eliciting accounts of past risk behavior. The map itself interested many of those interviewed, and the consistency of play reports and geographic descriptions support the usefulness of map-based inquiry.

Community Definition

Belden Center has a strong sense of itself as a distinct community and its physical boundaries are unambiguous. Industrial dump sites and buildings lie along the neighborhood's north edge. On the east is a major electric power line right-of-way, and a railroad yard/light industrial park defines the south edge. Whereas there is an adjacent neighborhood to the west, the street between the two is a major road and a clear ethnic boundary. This is a working class community of almost entirely European ancestry, and many of the community adults have lived here since birth. There are approximately 300 dwellings within these borders, most of them single, privately owned homes.

Census

C.A.P.E. conducted two surveys (1995 and 1997) containing demographic, health, and environmental questions. However, the best return rate was 28.6% and we suspected that those with environmental concerns were overrepresented. Consequently, we conducted a census with the intent of contacting as many households as possible and received information from 209 (69% of the 300). Those remaining include a few cases of refusal, but the majority were simply not home when we called. Census data were gathered door-to-door by the senior author and anthropology students Kaci Holt, Gretchen Kardamon,

Craig Hendler, and Pru Aurora. In addition to age, sex, relationship, and length of residence, we asked whether anyone had health problems and whether there were problems with the property, such as basement seepage or odors. Information was recorded by subject number only, to protect confidentiality. The purpose of the census was to determine the size of age cohorts, identify those with lifetime residence, and seek permission for longer interviews. Location within the neighborhood was maintained on a master map for purposes of assessing patterning of problems within the community. One of our first concerns was that toxins could be getting into the area by surface drainage or groundwater movement from the dumps.

Sample and Sampling Strategy

Based on census data, we constructed a sample, tailored for the map-based interview, with the following characteristics.

(1) Both men and women were selected, with ages ranging from the late teens to the mid-80s.
(2) Nearly all were lifetime or long-term residents. Some who were not born in Belden Center were included because of specific knowledge of community history noted during census contact.
(3) Nearly all were selected for their current place of residence, spanning the entire north edge of Belden Center, closest to the industrial waste sites.

It had been clear from our earliest contacts with residents that children might have been exposed to toxins in the dumps. Consequently, this sample was stratified to optimize chances of including those potentially toxin-exposed, to estimate gender-based differences in play, and to span the entire history of the community. Ultimately, 23 men (21 of whom were childhood residents) and 17 women (12 lifetime residents) completed map-based interviews.

General Interview

Following explanation and signed consent, an interview was conducted in the subject's home by Steegmann. It included a kinship diagram to detail household demography, and recorded sex, date of birth, date of community entry, and total years of exposure to the community environment. For each person we also noted apparent occupational exposure to toxins, use of household garden products, and contact with soils. Information was gathered on all household residents and on those considered to be part of the household but living elsewhere (such as adult sons and daughters). The full protocol was reviewed and passed by the Institutional Review Board, D'Youville College.

Map-Based Interview

From a USGS topographic map and extensive ground observations, a detailed 40- by 40-cm map was drawn showing both neighborhood streets and dumpsites to the north and east. On the dumps were shown features identified by locally used terms such "the White Hills" and "the Little Woods." It was similar to Fig. 1. To begin, the subject was oriented to the map until the interviewer felt that its main features were understood, and the map was then covered with tracing paper. The subject pointed out specific sites and features — such as waste disposal ponds — and these were marked in pencil directly on the tracing paper. During this process there was a good bit of probing to locate sites as accurately as possible and to identify exactly what went on there ("swimming," "catching frogs," "riding bikes"). Following the interview, each site and activity was described in field notes and finally recorded permanently on a master copy of the map, along with dates during

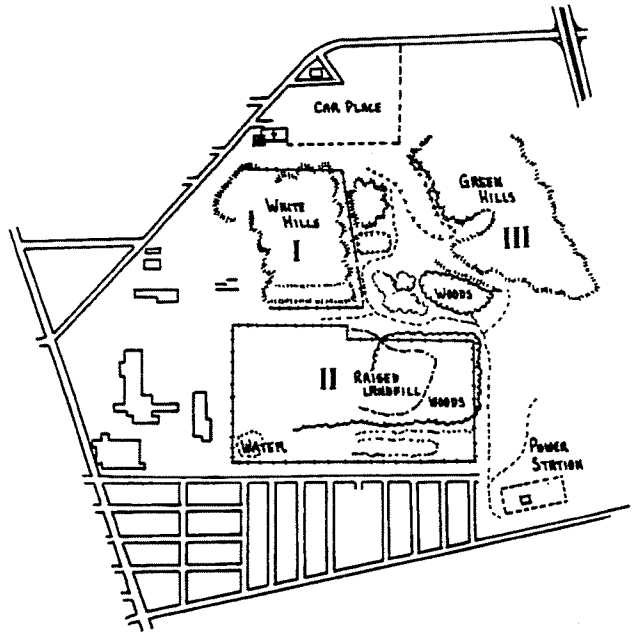

FIG. 1. A map similar to this was used to elicit information from adults on types and locations of childhood play. There were no numerals on the original and more detail such as street names. "I" is the Vanadium dumpsite. Some of the waste forming the "Green Hills" was also apparently deposited by Vanadium or subsequent owners. "III" is mostly owned by Niagara Mohawk and the New York Power Authority. "II" is the Union Carbide site, within the fence and some property west of that. The street grid south of II is Belden Center.

which the person had played there as a child. Consequently, each interview used a fresh, unmarked map, but the master map copy accumulated a rich store of data. This approach also offered a format in which observations could be independently verified by use of multiple reports. For instance, 38% of the swimming sites were identified by more than one person.

We assumed that a child would have played in the dumps between the ages of 8 and 19 years of age. Based on birth date or other entry date, each set of individual reports was given a time span. That is, if the person was born in 1950, the play period would have been 1958 to 1968, and dumpsite characteristics and types of play usage were dated to that period. Exceptions are specific years identified (usually recalled events witnessed by adults such as "the year they built the berm") or a less than 11-year childhood period of use due to community entry beyond 8 years of age.

Documents

Several maps of the area, from before the neighborhood was built and during its development, were combined with individual recall to construct community and dumpsite histories. Also, New York Department of Environmental Conservation (NYDEC) reports were available because the dumps were registered toxic waste disposal sites, and materials prepared for the NYDEC by private environmental consulting firms provided additional data. The Buffalo office DEC also provided six air photos, taken in 1938, 1951, 1958, 1966, 1977, and 1991, that covered both neighborhood and dumpsites.

Data Quality Issues

Memory and recall. Geographic detail and specific play activity are only as accurate as is memory. We assumed that those who supplied information were not making up the stories and repeated, independent mention of the same play sites suggest that the map-aided method has reasonably strong validity. Geographic landmarks in the dumpsites are quite distinctive, enabling people to pinpoint locations (for example, "an open area just north of the Little Woods and east of the White Hills"). Air photos showed strong general agreement with resident accounts during the different periods over which the dumpsites changed dramatically. However, there were some cases in which people said that they had played in the dumps, but were unable to point to a specific site on the map.

Ability to understand the map. Not everyone is skilled at understanding a two-dimensional drawing of a known piece of geography. This may explain some fuzziness in a few of the reports.

"Dump" is a broad category. Some informants said that they had played in the dump as children. However, they pointed out as the play site, for example, a strawberry-picking area on the map that was a meadow-like extension of the northeastern tier of backyards. There is no evidence that toxins were ever deposited in this area, though they could have migrated by surface or groundwater flow. Getting specific locations does improve reporting quality because "the dumps" in local parlance typically meant anything beyond the north and east property boundaries.

Views on the environmental threat. By the time that our investigation began, there had already been 4 years of publicity on the threat reportedly posed by the toxic waste sites. Awareness was promoted by C.A.P.E. as they distributed information and questionnaires, through a series of anxiety-producing newspaper reports, and from letters and meetings presented by government agencies and corporations owning the dumpsites. All this generated a range of views, from emphatic denial that the sites were unsafe to deep conviction that the neighborhood itself had been severely contaminated. Regardless of where the truth lies, this heightened awareness may have acted to produce both underreporting and over reporting of health conditions and environmental problems.

RESULTS

Based on the accounts of development, we established three periods of neighborhood and waste site history. The first is from before settlement to 1943. Then follows the period of most intensive industrial waste disposal and the most active use of the dumps for play (1944–1979). Starting about 1980, the play pattern became less intense. However, even closing the dumpsites in the late 1980s and early 1990s did not stop their use for play entirely.

Belden Center History

In an area that was once open pastures and woods, the first set of residences appeared between 1920 and 1930 — "about 10 houses toward the west end of the community" according to one older resident. Maps dated 1937 (Portland Place, Sewer District) and 1938 (Portland Place, WPA Subdivision) and a 1938 air photo show lots laid out in their current

configuration. The presence of a school in 1938 suggests rapid development and by 1943 a water service map (Portland Place, Water District) showed 238 dwellings, or 79% of the present number. The community was served by public water from the start and we assume that drinking water is not contaminated.

Older residents agreed that the neighborhood was essentially complete by 1950. The drainage in this flat area was never good, and sewer backup into local drainage ditches led to remedial work on sewers in 1978 and 1998. Some areas were swampy originally, and if toxins migrated into the area, they may have cleared only slowly.

In the east-center of Belden Center, one of the originally planned roads was never developed, leaving an open area (see Fig. 2). Two people noted that during the 1960s, and probably earlier, the land was used as a dump by "Dobie Foundry" and "Wolf's Junk Yard." There was also a town playground there (which later disappeared). The presence of these sites next to a playground and within the neighborhood itself increases the potential for exposure to fuels, solvents, and heavy metals. In the west-center of the community, trucks came up two different north–south roads to deliver drums and other waste to the Union Carbide (U.C.) dump. Air photos show that these roads were open between 1951 and 1977. This may also have increased the risk of toxin exposure in the neighborhood itself. However, most of the residents perceive this to be a good place to live and it remains an island of mostly well-maintained houses along quiet, tree-lined streets.

In 1987, Union Carbide closed the dump, capped their landfill, and fenced the entire 62-acre site. They gave those residents whose lots abutted the site an additional 15 feet of land and even gave them soil from the dump area for gardening. However, many residents began having anxieties about the environment. One now lives on the first tier of lots south of Union Carbide land. He purchased the lot west of his from U.C., which had held it as a possible dumping access route. He is concerned that the corporation may feel that the soil is contaminated by chemical migration from the north, since they told him not to dig in it, and he believes that the surface drains from the dump to the neighborhood (southward) in this area. The deeper (groundwater) beds are thought to drain southwest. As someone extremely well-informed on environmental issues, however, he acknowledges that nobody has actually studied the deeper hydrology and the Department of Environmental Conservation reports concur. He is convinced that the neighborhood soils are contaminated and some of his neighbors agree. One informant dug up industrial materials in his yard (bordering on the old junkyard) and others report black ooze in their basements and in the local ditches. A woman in her 50s learned from the engineer overseeing the water pipe berm construction that the pipe was raised because the ground at the western U.C. boundary was so full of refuse that they could not put a ditch through it. Several residents said that their once fertile gardens would no longer grow vegetables and complained of skin rashes due to yard work. Also, the factories to the northwest of Belden Center still produce noxious fumes. All of these pieces of exchangeable information, regardless of their accuracy, help maintain uncertainty about the environment.

Industrial Site Histories

Vanadium open dump site (1920–1998). We are calling this site "Vanadium" after the original owner, Vanadium Corporation of America (DEC Site No. 932001). The site, purchased in 1920, was originally 62 acres. SKW now owns the western 37 acres and Airco Carbon owns the eastern 25 acres (the "White Hills;" Fig. 1, area I). The eastern parcel was a class 2 open surface dump — that is, a significant threat to public health (NYDEC, 4/2/95). The western (SKW) area has been capped and inactive since 1992 and the eastern (Airco) site is scheduled for remedial work in the summer of 2000 to induce better surface drainage. Whereas Airco's "White Hills" has long been surrounded by a low chain-link fence, it showed old, well-established breaks in at least two places and children were still playing on the refuse mounds in the summer of 1998. Water runoff typically showed a pH of 12.5, considered to be corrosive (AABS Environmental Services, 1993: ES-2).

It may be that wastes were first deposited at Vanadium just after purchase in 1920. However, one man could recall no ponds, streams, or substantial refuse piles in the Vanadium or Union Carbide sites in the middle 1930s and another said the same for the late 1930s and early 1940s. The first informant noted, however, that Vanadium started to bring in "the white stuff" (slag) by rail about 1928; the 1938 air photo shows a road or rail line from the west, buildings, and some low refuse mounds and supports the recollection that there were no ponds. In 1938 the white deposits cover a relatively small area. This was the beginning of the White Hills, and by 1951 the air photo shows extensive white deposits, a large disturbed area, and two large rectangular ponds that were probably also dumps. These are between the "I" and the "III" on Fig. 1. The difficulty is that

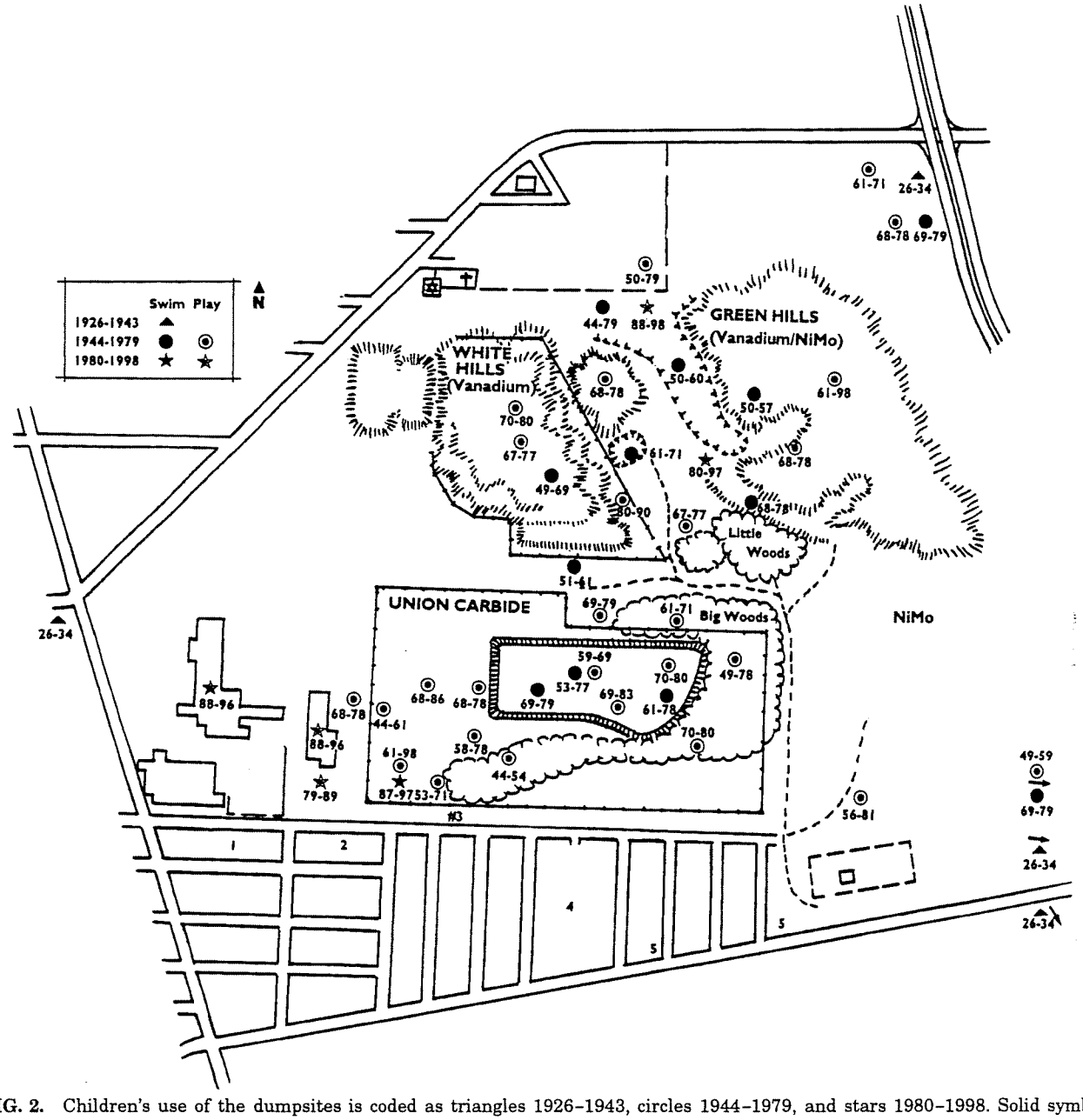

FIG. 2. Children's use of the dumpsites is coded as triangles 1926–1943, circles 1944–1979, and stars 1980–1998. Solid symbols indicate both swimming and play sites, and open symbols show play-only locations. Years during which each site was used are shown adjacent to symbols. If the years amount to a span of more than one cohort (11 years), then the site was used for more than one cohort generation. In the neighborhood, 1 = fumes, 1951 to present; 2 = poorly drained currently; 3 = black ooze in the ditches, 1953 to present; 4 = foundry dump, junkyard, and playground during the 1950s (?) and 1960s; 5 = swampy, 1941–1951.

there is no documentary evidence concerning when hazardous wastes first appeared. However, a NYDEC report (9/1993) found phenol, iron, and hexavalent chromium in surface water and ground water with vinyl chloride, trichloroethane, phenol, hexavalent chromium, chromium, cyanide, magnesium, manganese, sodium, and zinc, all above standards. Ferrochromium silicone dust was dumped here, 1964 to 1981, and mercury has also been reported. While the bioavailability of these substances is not clear, the consultants considered this site to be a significant threat to public health (AABS Environmental Services, 1993: ES-5, ES-6).

Union Carbide site (1934–1998). The U.C. site is 64 acres, 16.5 of which is currently a capped, raised land fill. The first deposits here were in 1934, about the same time that major building was about to

begin in neighboring Belden Center, but the 1938 air photo suggests that the disturbed area was very small and at the far western part of the site, near the buildings. The DEC Site No. is 932035 and it now carries a 2a classification: no apparent threat to public health since it was closed and capped in 1987. Testing will ultimately determine whether it will receive a safer classification, but toxins could be migrating southward into Belden Center with groundwater movement. Further, during the period of most active use as a play site by children (about 1944 to 1979) toxin exposure at the site was more likely than at present. Surface and subsurface soils currently contain moderate to high levels of PAHs, dibenzofuran, carbazole, 1,2,4-trichlorobenzene, and 14 pesticides. Metals include cobalt, lead, and magnesium, also above background levels (Ecology and Environment, 1994; for the NYDEC).

None of the older residents remembered anything distinctive about the U.C. property before 1943. It was wooded on the east and south and the eastern woods extended farther north than they do today. There were no natural or human-built ponds, though there were swampy areas. Nobody remembers U.C. dumping there before 1944 but DEC reports indicate that it was as early as 1934 (Ecology and Environment, 1994). Testimony makes it clear that refuse and carbon bars were being surface-dumped on the western third of the site by the middle 1940s, and the 1951 air photo shows that the disturbed area was pushing eastward. Excavation of deep pits in the present raised land fill area (Fig. 2) is clear on the 1958 air photo, with disturbed surface covering about half of the site, and this is the area most likely to have received toxic wastes. Dumping pits continue moving east until they are shown in the 1977 air photo to be just north of the eastern third of the neighborhood. By 1987, the 16.5-acre landfill area was capped up to about 30 feet above the original surface, and the entire 62-acre site was surrounded by an 8-foot chain-link fence. Informants noted that kids cut holes in the fence and climbed trees over it. However U.C. patrolled the perimeter and mended the holes. Whereas the site was officially closed in 1987, two residents independently said that they continue to see headlights and hear truck tailgates slam at night, and the 1991 air photo shows one area of markedly contrasting appearance to the rest of the grassy cap.

In a large building complex at the southwest corner of the site, and just north of the northwestern-most households in Belden Center there have been accidental spills of volatile organics such as vinyl chloride, 1,2 dichlorethene, trichloroethene, and benzene. The NYDEC classified this site, No. 932036, as a hazard to public health. However, residents had no access to this area and the company, Carborundum-Globar, has taken remedial action.

Niagara Mohawk/Power Authority of the State of New York (ca. 1900–1998). The west part of this site ("NiMo") should be considered to be an eastward extension of Vanadium, already described (see Fig. 1, area III). It is clear that Vanadium dumping intrudes extensively onto to NiMo property, with wide disturbance on the 1958 air photo, but apparently stabilized and grass covered by 1966. Locally known as "the Green Hills," it is today a series of mounds clearly elevated above the original surfaces. The southern part of this area is open meadowland and apparently was never a chemical dumpsite.

We include in area III a now-closed town dump, too far east to show on the maps. One woman remembers that it opened when she was a child (1949–1959). Children used the dump for swimming and play, and the dump and pond appear on the 1966 and 1977 air photos. Whereas this was a general town refuse site, industries could use it as well. Informants mentioned industrial trucks coming and going, but there is no way to recover records of what was deposited there. A creek running along the west dump face drained the area, and may still get lechate from the dump.

Children's Play in the Dump Sites

Our assumption before the start of the research was that toxins might have entered the neighborhood by means of groundwater, surface runoff, or air. Primary human toxin exposure would have been in the neighborhood itself. We were startled during our first meeting with C.A.P.E. when someone mentioned that children from Belden Center played in the dumps. The following, derived from map-assisted interviews with 40 residents, demonstrates that dumpsite play was in fact common during much of the history of the neighborhood. It increases risk to adults who played there as children, but does not exclude the possibility of further exposure of both children and adults in the residential area. Figure 2 shows all sites, between about 1926 and 1998, where those interviewed placed their own activity. Closed symbols indicate play and swimming and open symbols indicate play sites only.

Play between 1926 and 1943. The oldest man interviewed recalled that the area was "clean" when he was a child, and his three swimming holes were far from the Vanadium and U.C. sites that were just

being developed. He recalled that the White Hills started about 1928 to 1930 but as rather minor deposits of slag. This pattern held through the early 1940s. One resident hunted, swam, and played all over the area north of Belden Center but recalls no pits or open refuse piles (1932 to 1942). This implies that swimming sites reported from 1944 onward were mainly runoff swales (Vanadium) or pits excavated as waste disposal sites (Union Carbide). Swimming holes used before the mid-1940s were older than the industrial sites and were not likely to have been contaminated by toxins.

Play between 1944 and 1979. Our sense of the situation, derived from interviews and DEC site reports, is that during this entire period, those who swam and played in the dump sites were at higher toxin exposure risk than children from older or younger cohorts or peers who stayed away from the dumps. Those born in 1936 (when Belden Center was on the verge of rapid expansion) to those born in 1972 define a cohort that played intensively on the industrial waste sites. Of the 14 men whose period of play as boys fell between 1944 and 1979, 9 (64%) indicated in detail where they swam and played in the dumps, and 5 (36%) said that they played there but without swimming. None stayed away, and several volunteered that it was mostly boys who were there. The sample of women was only seven for this period, and none admitted swimming in the dumps, although five of the seven had played there. Of the seven boys who started using the dumps about 1980, only one said he had gone swimming there. It is not clear whether the decline in swimming was due to the old swimming holes being filled or possibly growing environmental concerns.

On Fig. 2, filled circles indicate a specific play/swimming site and open circles with center dots mark play sites for the 1944 to 1979 period. Some people pointed out more than one site, and this raises the question as to whether particularly rich individual reports can inflate the cases of site use. However, 19 of 21 people from this cohort could show specific sites, and from that we conclude that the map is not inflated. Each person was asked to name others who had played in the dumps when they were all children; 12 could give a list of names, for a mean of 14.7 boys and 3.5 girls. Consequently, we assume that our sample of accounts reflects general behavior.

Data on Fig. 2 represent the primary outcome of our investigation. The fences shown were put in late — approximately 1980 around the White Hills and 1987 at Union Carbide. During most of the 1944 to 1979 period, children had free access to the sites. Woods, ponds, grassy hills, and open meadows made them attractive places to play, full of natural interest and fascinating refuse. This is not what "dump" brings to mind but it is a great place to play, even now. The density of symbols on the map speaks for itself, and they reflect only a small portion of the total population who used the dumps for a playground.

Between the Green Hills and the White Hills a series of runoff swales was formed by dump piles and our earliest accounts of swimming in the Vanadium dumps were here (north center of the map). This began about 1944 and continued through 1979. There were ponds actually up in the White Hills, one used for swimming between 1949 and 1969. Just at the south edge of the White Hills, another pond was used for swimming as early as 1951. One man recalled a deep pit in the Green Hills where they swam between 1950 and 1957, but then "the company filled it in with ingots." In addition to swimming, there was intensive play over the entire area by 1950 and probably earlier. A gang "played war" here with WW II surplus helmets and the range of activities is broad. An informant remembers getting in trouble when he came home covered with carbon dust. Swimming, catching frogs, and digging were common to the reports and all expose children to water and soil residues.

Off the southeast corner of the map is a south-running creek, and just east of that, grassy mounds mark a closed town dump. One woman remembered it opening about 1949 or 1950, and others recall seeing government, industrial, and private trucks dumping there. By 1969 a pond had formed in the center, which the children used for swimming. Other than that, the NiMo and Power Authority property seem relatively undisturbed (except for some Vanadium dumping, already noted).

Play unfolded in a parallel fashion in the Union Carbon dump. The western area was visited by one girl when her father collected carbon bars there to be used for fuel (1944) and she also played in the woods. An area now defined by the southwest corner of the 1987 fence has always been swampy, and many reported playing in and around the water throughout a 1949 to 1979 period.

In the north central part of the U.C. property there is presently a landfill raised about 30 feet and covering 16.5 acres. It was closed and capped in 1987. This is the site where numerous large, deep pits were excavated, starting in the early 1950s. Both dumping activity and children's play here were reported by several first hand observers — boys at

the time. The company would excavate the pits and begin to deposit sludge, steel drums, liquid waste, and solid refuse. As soon as they were open, the pits would begin to fill with water. Children would then come in to use the ponds as swimming holes (even though the water "looked funny"). As the pit ponds were filled, new ones were opened and the cycle was repeated. The earliest report of swimming there was 1953 and the latest was 1979.

There was also intensive play on the U.C. land, not only in the southwest area (already noted) but also in the area later capped and especially in the woods surrounding the cap area. Well-established paths reportedly ran from the Little Woods, leading south and from Belden Center, leading north. Several people reported play forts, built by themselves or others, and steel tubes large enough to play in comfortably. Earliest accounts of play in the woods are dated 1949 and they were still playing there in 1979.

Play between 1980 and 1998. Much of what younger residents said could be verified on the ground. Crossing the Green Hills today are numerous dirt-bike trails. We observed children on both powered and nonpowered two wheelers using them, in the summer of 1998, and raising a lot of dust. Remains of sleds and toboggans appeared on the White Hills, and there are at least two campfire sites in the Little Woods and north of there with cans, parts of toys, and other refuse. We were given explicit directions to holes in the U.C. fence along with more than one offer to take us in, advice not to step in the "tooth paste"-lined ditches, to watch for the "suckholes," and so on.

During this period, there was only one report of swimming (in the southwest U.C. area) and this was by a young man who admitted drinking out of one of the nearby ditches. He recalled red water and drums in the swimming pond. However, our reports indicate little swimming after about 1980. Whereas play continues in the Green Hills and White Hills, the U.C. fence (1987) is patrolled and maintained and that has probably decreased use of the area, if not entirely stopped it. In 1988, two buildings west of the U.C. fence were closed, and we have firsthand accounts of children playing in them with "chemicals and equipment." The first floor of one of the buildings was flooded.

DISCUSSION

Uses of Ethnography

The behavior reported in this case study, while distinctive, is certain to be repeated in similar settings. It offers a cautionary insight into assumptions about exposure to toxins. Children's behavior away from home may be a major factor in risk exposure. In situations in which health problems are expected to cluster geographically, we must also consider the possibility that they may instead be stratified by specific behaviors. Further, play-induced risk may not even be homogeneous for age cohorts within the community. In Belden Center, childhood play patterns place those now in their middle years at greater risk than those older or younger. We also determined that fewer girls than boys played in the most toxic areas, and not even all of the boys swam in the waste disposal ponds.

Ethnographic investigation is a method by which we can identify higher- and lower-risk strata within a population. As a hypothetical example, let us say that there are 500 children in a community and there is suspicion that they have been exposed to a neurotoxin. Ten children, or 2% of the sample, show peripheral neuropathies, but this is not significantly higher than expected. The parsimonious conclusion is that there is no indirect (outcome) evidence of toxin damage. However, behavioral investigation demonstrates that only 200 children actually played in the adjacent dumpsite where the neurotoxin was found in surface water. All 10 neuropathy cases are from this smaller cohort, so that the prevalence becomes 5%. This is a high value, particularly when compared to the value for neighborhood children who did not get behavioral exposure. We may now suspect that the 2% community prevalence value is a "false negative" — one of the problems in "small area epidemiology" (Liebow, 1999). Whereas this is an invented example, sample sizes and prevalence values are equivalent to those in the Love Canal studies (see Paigen *et al.*, 1985). For application to environmental health outcomes at Belden Center, watch for Hewner and Steegmann (2000).

The Map

While constructing a map to be used in the interviews, Steegmann walked over much of the area to be represented by the drawing, noting features, elevations, and evidence of play. We recommend that if the site is accessible. One important outcome is improved quality of what the investigator asks in follow-up questions. We are convinced that use of the map with probing questions improved people's recall and sharpened geographic information. Whereas this project used a map to study past behavior, it should work even better with children still engaged in play. At Belden Center, air photos provided by the

New York Department of Environmental Conservation were also of great value in understanding the development and use of the area. They could be used in lieu of maps to elicit information, but are often hard to interpret.

A Well-Defined Community

Belden Center has clear boundaries, visible to outsiders, and recognized by residents. That and the strong sense of community identity may be factors in the high proportion of adult residents who were also here as children. Within the larger survey sample reported by Hewner and Steegmann (2000), 36% of the women and 50% of the men were born in the community and still reside there. Had there been fewer lifetime residents, it would have been difficult to get a sample for the map study. We also suspect that the continued, visible presence of the adjacent dumpsites may have functioned to keep memories clear.

An odd dimension of Belden Center demography is the high level of mobility within the community. Most of the adults do not live in their childhood houses, and many reported living in more than one place as adults. Whereas this flexibility may make it easier to find suitable housing within the same community, it also makes it less likely that environmentally driven health patterns are evident geographically within the area. We still have no environmental sample assays to determine whether neighborhood soil, air, and water are contaminated, but we have demonstrated that a lot of children played in dumps classified as hazardous to public health — 49% of the men and 24% of the women within the larger survey sample ($N = 545$). The changing histories of the dumpsites themselves and play that took place there emerged in a straightforward fashion due to sample stratification by age and lifetime residence.

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Executive Summary of 1998 Study of Behavior and Health Outcomes in a Town of Niagara Neighborhood

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There are a number of specific findings in this study.

1. A door-to-door *census* was completed on 69% of the households in the community (a total of 206 of 300 households). Census data was collected on 613 individuals. Informants for health and exposure interviews were recruited from this sample of the overall population of residents of the neighborhood. 100 interviews about household member's health and exposure patterns were completed resulting in data on 545 individuals.
2. Analysis of the *history of community development and use of the industrial dumpsite* demonstrated that both the neighborhood and the dump began in the 1930's. The first reported play in the dump occurred in 1944, however, prior to that time some residents used carbon bars from the dump to heat their homes in winter. Some dumpsites were capped in 1987.
3. *Demographic patterns* showed strong gender differences. Men who were children in the community were more likely to settle in the community as adults. There are significant differences in gender and play in the dump with men more likely to play regularly in the dump. However, women who played in the dump as children probably have similar exposure patterns to their brothers.
4. *Regular play in the dump* is the only behavior that demonstrated significant differences in health outcomes in either the full community sample (n=545) or the 1936 to 1977 birth year cohort (n=342). Behavioral patterns that were **not** related to any health problems include: being born in the community, being a child in the community, attending a school located in the neighborhood, working outdoors regularly, eating vegetables grown in neighborhood gardens, and occupational exposure to toxins.
5. *Specific health outcomes* occurred significantly more often for the 1936-1977 cohort members who played in the dump regularly. Open-ended health interview data was coded into the following categories by an RN: miscarriage/birth defect, cancer, skin rash, mental health problem, liver disorder, allergy/asthma, skin rash, motor vehicle accident, developmental disorder, and other serious health problem (including specific diagnoses such as arthritis, diabetes, or lupus). The odds ratio of having a liver disorder was 7.70 higher in the cohort who played in the dump ($p<=0.05$) and the odds ratio of having developmental disorders was 3.05 ($p<=0.05$) times higher. The odds ratio of having mental health problems was 2.54 ($p<=0.01$) times higher that for the cohort members who did not report regular play in the dump.
6. No relationship was found between *total years of exposure* in the community and any health outcome for the full community or the cohort.
7. No relationship was found between any *geographic pattern* and health outcomes. Households closest to the dump did not have different health patterns from household's further away

(north/south). Further, households downstream from the dump did not have different health patterns from the rest of the community or the cohort.

What have we learned from this study? A number of conclusions can be made based on the results.

1. **There was not a significantly higher prevalence of cancer in any group in the study.** Our results confirm what the Cancer Surveillance Program (1997; 1998) found in its studies of brain cancer and cancer in this neighborhood. Even in the cohort who played in the dump, rates of cancer were not significantly different from the cohort controls. However, cancer may not be the best health marker of low-level toxic exposure.
2. **Analysis of the behaviors allowed identification of a sub-sample for which risk of exposure to toxic chemicals was greatest.** Behavioral patterns of exposure were not readily apparent to outside officials or researchers and community members were often reluctant to admit to activities in the dumpsite. Interpretation of the results is complicated by the fact that many different patterns of regular play exist among current and past groups of children.
3. **Further epidemiological research needs to be done on the health outcomes that were found in the cohort**. Liver disorders are probably the best-documented health outcome and are unlikely to be over-reported since victims are often asymptotic until the problem is noted in a medical exam. The cases of cancer in the cohort should be examined more closely. The two fatal brain cancer cases that triggered the community action were both members of the cohort who played in the dump regularly as adolescents. The mental health and developmental problems are much less clearly defined, but their distribution is strikingly and significantly different in cohort members who reported regular play in the dump. One resident described it as an "epidemic of depression". These problems need further investigation before a potential link to any specific toxin can be made.

Behavioral Influences on Health Outcomes in a Niagara Falls, NY Neighborhood Bordering an Industrial Dump Site

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Introduction

One legacy of Love Canal in western New York is a distrust of government, industry and the university among community residents. Everyone has an opinion, often conflicting, about toxic waste and potential exposure and the impact it may have on health. *Portland Place* (pseudonym), a neighborhood of about 300 households which is directly adjacent to a 64 acre industrial dumpsite that was used by companies in Niagara Falls to dispose of wastes since the site was purchased from in 1934, is a good example. Distrust in *Portland Place* lead to formation of a grassroots citizens group (CaPE: Citizens against Polluting the Environment). CaPE documented health problems among residents and demanded action from the Environmental Protection Agency (EPA), the Department of Environmental Conservation (DEC) and the New York State Department of Health (NYSDH). This response was triggered by two highly publicized cases of brain cancer in young men who resided in the community at the time of their deaths in 1997.

Background

A young man (35 years old) spearheaded political action in the neighborhood after he was diagnosed with glialcytoma and astrocytoma, a fatal brain cancer. A cousin of the man's wife (age 37) had just died of the same type of cancer, and that young man's mother died of liver cancer in the same year. The coincidence seemed too great and the CaPE group conducted a survey of health and environmental problems in the neighborhood. Based on their findings, the group requested that the NYSDH conduct an epidemiological study on the incidence of brain cancer in the community. Their study cautiously indicated a significantly ($p<0.025$) higher than expected rate of brain cancer in the community using 1990 census data (n=949, 465 males and 484 females, Cancer Surveillance Program, 1997). A further study of general malignant tumors

(Cancer Surveillance Program, 1998) found no statistical significance between the number of cases in the community and the expected number of cases given the age and sex distribution of the community. Concurrent with the health survey, the DEC held a series of meetings in the community to discuss possible contamination in the neighborhood. In essence, their report said that the neighborhood was safe for residents.

However, the CaPE organizer died prior to release of the study results. CaPE publicized their fight for information and their frustration at the official response. On the basis of one news report, faculty from area colleges (Hewner & Steegmann) contacted the group organizers and requested a meeting. CaPE leaders presented the volumes of information they had collected: official reports, maps of the area since the community's inception as a low income housing development during the Depression, and all of the original health and environmental surveys. They also reported that children in the community played in the dumpsite regularly until the 1987 when a fence was put up around the worst areas. Based on the Cancer Surveillance Program report supporting unexpectedly high rates of brain cancer and the unanalyzed data the CaPE group had collected, the researchers agreed to review the surveys and try to understand the patterns of health problems reported in them.

The CaPE Survey

Residents were concerned that there had been seepage from the dump into the community, and that this seepage had caused health problems like those in Love Canal (Levine, 1982). The logic used in developing the survey was that residents were exposed to chemicals, and this could be seen in cancer rates, skin rashes, allergies, stomach problems, headaches. The survey provided resident's current address, an estimate of how long the person completing the survey resided at that address, a checklist of environmental and health problems developed by

the CaPE group, and an opportunity to provide information about other individuals in the household, and other people they knew about. The survey had been mailed and hand delivered by CaPE's organizer (the young man with brain cancer) to current residents in the neighborhood. Thus, the surveys could be linked to specific individuals, duplicate surveys were completed in some households, there may have been pressure from CaPE members to participate, and the information on health included reports from individuals, reports on households, and reports on other residents (multiple units of analysis). In addition, the response rate of 86 households out of 300 was only 28.6%.

Rather than attempt a strict quantitative analysis on the survey data, the researchers used CDC EZ-Text software to analyze the responses qualitatively. It was acknowledged that the sample was biased toward believing that their health had been affected by environmental contamination. Responses were coded for themes, and strength and distribution of the responses were mapped geographically. It was expected that neighbors talked to each other about their environmental and health concerns, and that this might create "hot spots" for specific problems. A graduate student in anthropology updated an original map of the lots in the development based on current spacing of households. Response to the survey was plotted, and it was clear that the response rate was higher in the streets bordering the dump than those furthest away. The immediate neighbors of the two afflicted men were often non-respondents.

The research team reported their preliminary analysis to the CaPE group and interested community members. The findings were as follows:

1. The response rate of less than 28.6%, despite repeat mailings and hand delivered surveys, made it impossible to generalize the findings to the overall community.

2. Respondents were clearly polarized about the issues, with many angry responses about the CaPE group and the possible implications to property values.
3. There seemed to be some geographic patterning of serious health problems along the borders of the neighborhood that were directly adjacent to the dumpsite. Serious health problems included cancer, multiple sclerosis, and Bell's palsy.

The qualitative analysis also suggested that some of the community residents played extensively in the dump, and that many of them felt they had no health problems resulting from that exposure. Unfortunately, the data did not permit analysis of whether there was a relationship between exposure time and health outcomes, or if specific exposure was associated with increased risk of health problems.

Methods

The researchers proposed that a two phased ethnographic survey of *Portland Place,* including census of all households in the neighborhood and intensive focused interviews on household health and exposure patterns should be undertaken to resolve these unanswered questions. Specifically, the research sought to answer to following questions:

1. Can specific patterns of exposure be identified and is there a relationship between these patterns and health outcomes?
2. Do patterns of health outcomes differ in specific cohorts between residents who played in the dump and those who did not?
3. Do patterns of exposure and health outcomes differ in geographic regions in the community?

The logic of the study design is based on the assumption that not all neighborhood residents had equal exposure to toxins. It was assumed that during specific times in the

community history, children were exposed to specific types of toxic wastes that may not be present on the current surface of the dump. It was also assumed that exposure in the neighborhoods might be affected by geographic patterns of air and water flow. The design uses residents in the community who did not exhibit certain behavioral patterns as a control population to those who did. The control population for a specific behavior should be similar to the "exposed" group for demographic characteristics of age, sex, ethnicity, socioeconomic status, occupational exposure, and unhealthful behaviors (such as, smoking, alcohol use, and substance abuse). Further, they should also have been exposed to any community seepage from the dump, and any of the airborne contaminants that might released from present day factories in the Niagara Falls area. In addition, various regions in the neighborhood were compared against each other. If there is a greater rate of any health problem in the exposed cohort or region compared to the control, it should be related to exposure to wastes in the dump since that is the only known difference between the groups.

The census used a saturation sample of the community. Students in anthropology at SUNY Buffalo who served as research assistants for the study visited each household. No names were recorded on the census forms, but information was collected on sex and dates of birth, death, entry, and exit for each household member. The individual responding to the census questionnaire was asked three questions about their household. Did they believe that they had any health problems related to exposure to wastes, did they have seepage or standing water on their property, and would they volunteer to participate in the second phase of the study? The census was anonymous and no individual names or identifying information were collected.

The census usually took less than five minutes, and if a household member refused on the initial contact to participate in the study, they were not visited again. A household where no one

was home was contacted again at a different time of day. Households were canvassed for the purpose of census during the first three weeks of July, and it is possible that some households were eliminated from the sample because they were out of town during the census.

Residents who volunteered during the census were contacted to arrange a longer interview about health and exposure. The principal researchers and an advanced graduate student in anthropology did all interviews. Most interviews were completed during the daylight hours, and this may have created a bias toward retired residents as primary informants. However, working households were selectively recruited, and interviews were conducted whenever informants were available. This included weekends, evenings, and holidays. All interviews were conducted during July and August 1998.

Individual data was coded for household geographic location and position in the household. Four geographic regions were identified: north, southwest, south central, and southeast. The dump was located to the north of the neighborhood. No names or identifying information were used in the study, and after completion of the analysis all coding information was destroyed as part of the research protocol.

The health and exposure interview utilized a semi-structured interview format that facilitated rapid recording of data, but allowed the informant to respond flexibly as they told of their experiences in the community. Exposure interviews generally took between 30 and 60 minutes to complete. Initially a kinship diagram was drawn to orient the interviewer to household members. A grid was used to record individual health data, and this included a self-rating of health and a listing of health problems in the words of the informant. Occasionally interviewers probed to clarify details about health problems. Next structured queries were made about specific types of exposure for each household member. Open-ended questions allowed the

informant to expand on topics previously discussed, and allowed them to ask questions of the researchers.

Census data were entered into a spreadsheet for analysis. A census analysis program allowed a population pyramid to be created for each year in the community's history. Geographic Information System software was used to map the responses to the census questions. Exposure and health data were entered into CDC EZ-Text (Carey, Wenzel, Reilly, Sheridan, & Steinberg, 1998) so that open-ended responses (qualitative data) could be compared with quantitative responses. This allowed the researcher to check coding decisions after all the data had been entered. SPSS statistical analysis software was used to describe the sample and sub-samples, and test hypotheses using chi square statistical analysis, as well as correlation and ANOVA when measurement scales were interval level data.

A weakness of the study is the use of self-reported health problems. It was not possible to attempt verification of diagnoses. However, every attempt was made to allow informants to describe health problems in their own words (unlike the checklist used in the CaPE survey). It is possible that community residents were sensitized about specific types of problems because of the original survey. Because of the polarization of the community, we expected to find both over-reporting and under-reporting of problems. Over-reporting was probably most prevalent for common problems such as allergy, skin rash, or headaches.

Data were coded into the following categories: miscarriage/birth defect, cancer, allergy/asthma, skin rash, mental health problem, liver disorder, motor vehicle accident, developmental disorder, and other serious health problems. Decisions about categorizing certain descriptions into specific codes were made by a registered nurse with extensive experience in conducting health interviewers in the community (Hewner, 1998). After completion of data

entry, coded responses were checked against the individual's verbal description of their health problems. An additional code of developmentally delayed was added to distinguish between learning disability and depression, both previously categorized as mental health problems.

Based on ethnographic interviewing prior to development of the interview tool, a number of specific behaviors that put some individuals at increased risk for exposure were identified by residents. These included: being born in the community, being a child in the community, attending a school located close to the dump site, playing in the dump itself, working outdoors regularly, eating vegetables grown in the neighborhood, and occupational exposure to toxins. These were specific questions on the interview. In addition, the total years of exposure in the community were calculated. Finally, based on experiences conducting research at Love Canal (Paigan, Goldman, Magnant, Highland, & Steegmann, 1987; Steegmann, 1998), Steegmann conducted extensive ethnographic interviews on activity in the dumpsite among specific age cohorts in the community. This was analyzed against known toxic waste dumping at the site. Based on this work, it should be possible to narrow the search for causative toxins in the dump.

Results

Census. A door-to-door census was conducted in the community using boundaries identified by community residents. The community boundaries are slightly smaller than those used by the US Census block groups 2 & 3 census tract 226.01. Census data from these block groups was used by the Health Department in their study of brain cancer and cancer in general (Cancer Surveillance Program, 1997; 1998). The 1990 US Census data identifies a total population of 933 men and women.

Figure 1 shows the results of the door-to-door census collected by the research team in 1998. The total population is 613 individuals. Data was collected on 206 households out of 300

households in the neighborhood (69%).

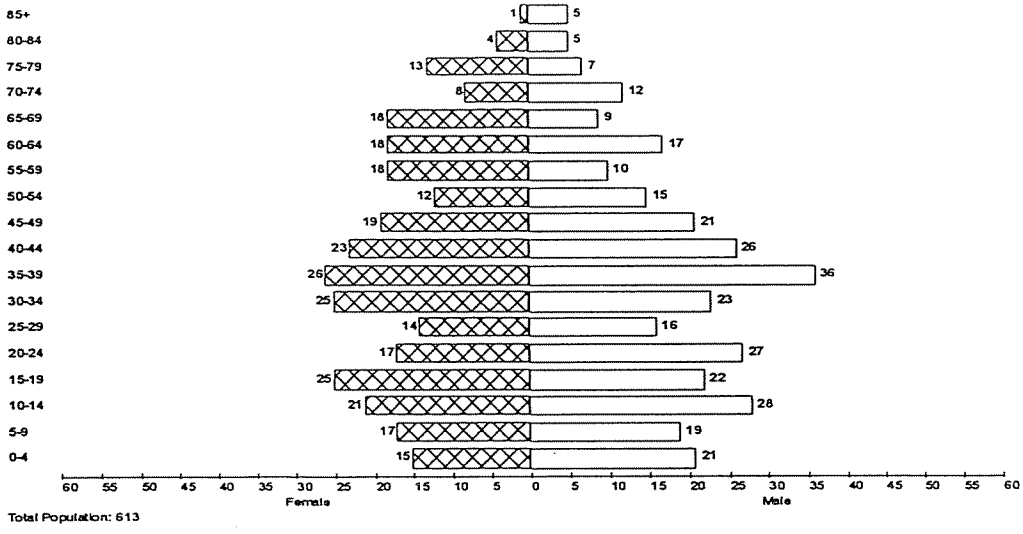

Figure 1. 1998 *Portland Place* Census.

Geographic information systems (GIS) software was used to map the households responding to the door-to-door census. Response rates for geographic regions ranged from 60% (region 2), to 78% (region 3), with regions 1 and 4 responding in 74% and 73% of households respectively. Region 2 was the most polarized region in the neighborhood.

History of Community and Dumpsite. A Niagara County map dated 1908 shows only two houses in the area now occupied by *Portland Place*, and only two roads appear. They are not laid out in the present pattern. One resident, born here in 1924, noted that there were a few houses in the West End of the community, but most building was in the 1930's and 1940's. Sub-division plots dated 1938 show the community layout in present configuration and by 1943 there

are 238 houses shown on a water district map. Since there are only about 300 houses today, the population of the 1940's was nearing modern size.

Vanadium Corporation (1920) and Union Carbide (1934) purchased adjacent industrial dumpsites. Ethnographic data from current interviews indicate that children were swimming and playing at both sites as early as 1944. Despite a low fence surrounding the "White Hills" of the Vanadium dump, both sites were readily available to children. It is not clear when toxin dumping began here, but we are assuming that disposal began shortly after the properties were purchased. Toxins identified on the surface and in groundwater include PAH's, trichlorobenzene, hexavalent chromium, benzene, trichloroethene, lead and others, all above background levels. Both sites were closed to dumping in 1988 (NYDEC, reports on site 932001 and site 932035, both 4/1/1995).

Over 100 health and exposure interviews were conducted in community households resulting in 545 individual cases with complete data on health problems and exposure patterns. Household members reported on health and exposure of all household members. Based on census data, ethnographic interviews, and official reports of dumping at the site, it was determined that playing in the dump was much more common than was initially reported by the CaPE group, that this was the most direct route of exposure. A cohort of residents who were born between 1936-1979 was used to partition out residents currently over age 63 who are more likely to have health problems related to age, and children under the age of 20 who might not show long-term health outcomes to exposure. The cohort is the group currently between age 20 and 63 and this population is most likely to show the long-term effects of exposure to toxins. The results compare two sub-samples of the overall community: community respondents with and without dump exposure (n=545), and the subset cohort of community respondents with and without

dump exposure between ages 20 and 63 (n=342). Differences in behaviors and health patterns by gender were explored for both the community and cohort samples.

The relationship between household location and health outcomes was analyzed using non-parametric statistics (chi-square) comparing northern households to southern and western to eastern. It was hypothesized that residents who lived directly adjacent to the dump (north) or residents who lived downstream of the dump based on groundwater flow (the West End) might receive direct contamination from the dump.

Demographic Characteristics. A unique characteristic of *Portland Place* is the unexpected number of children from the community who decided to reside there as adults. The community has a history of being "on the other side of the tracks" both figuratively and literally and is generally considered a rough neighborhood. This is especially true for boys who grew up here. The neighborhood is almost entirely "white" and social economic status is working class. In fact, many of older men worked at the chemical companies that dumped wastes in the adjacent dumpsite. Most describe it as a good place to live and they prove this by settling in the community as adults. Table 1 presents exposure patterns of the overall community and Table 2 presents the same data for the cohort born from 1936 to 1979.

A number of interesting differences are noted between men and women in the community and the cohort. Men are significantly more likely to have been born in, have been children in, and have attended the local school than women in both samples. The significance level of these differences is even greater in the 1936-1979-birth cohort. This is an unexpected finding, and supports the notion that the sense of community cohesion was greater among men than women. The fact that men in both the overall community and the cohort were more likely to have played in the dump as children can be attributed to two factors. First, our ethnographic data demonstrate

significant differences in patterns of exposure to wastes in the dumpsite. Girls were, and still are, less likely to play as extensively in the dump as boys of the same age, and many report that even though they were children in the community, they never played in the dump. The second factor is the fact that men were more likely to settle in the neighborhood as adults (patrilocal), while many of their sisters, who grew up in the community, left. Many women in the adult cohort are "transplants", that is, a woman who moved into the community as an adult after marriage. They are very unlikely to go into the dumps as adults.

Health Patterns. Given these differing patterns of exposure between men and women, it might be expected that self-ratings of health status would reflect increased health problems among men. In the 1936-1979 cohort, 3.1% of women have died, 4.4% report very poor health, 5% report poor health, 17% report average health, 18.9% report good health, and over half (51.6%) report excellent health. The majority of men also report excellent health (50.3%), with 20.8% reporting good health, 12% average health, 5.5% poor and 2.2% very poor health. However, 77% of the deaths in the cohort were men. In the cohort group there is no significant difference in self-rated health between the group with dump exposure and those without.

However, this is not the case for the full community (Table 3). There is a statistically significant difference in self-rated health between those who played in the dump and their control group who didn't play in the dump. The exposed group is more likely to rate their health as poor or average, while 67% of the controls rate their health as good or excellent. Using a two-tailed test for Pearson chi-square, the significance level is 0.006. There is also a significant negative relationship between self-report of health and the number of serious health problems reported for both the cohort (r=-. 473, p=0.000, n=342) and for the full community (r=-. 347, p=0.000, n=545). In the full community self-rated health is inversely related to the number of serious

health problems and with self-rated health worse in the exposed group than in controls who did not play in the dump.

It is interesting to contrast these self-rated health results with the report of any serious health problem (cancer, miscarriage, motor vehicle accident, liver problem, mental health problem, developmental disability, or other serious) by gender. Thirty-nine percent (39%) of women in the cohort report at least one of these, while only 26.8% of men report one serious health problem. The difference between men and women is statistically significant ($p=0.011$). There are not significant differences between men and women in frequency of cancer, mental health problems, liver problems, motor vehicle accidents, developmental disabilities and other health problems for either the full community or the cohort. However, women are more likely to report more serious health problems in both samples (full community chi-square=11.01, $p=0.012$; cohort chi-square =9.100, $p=0.028$).

Exposure Patterns. The greatest exposure to toxic waste is likely to have occurred among those children who played regularly in the dump. However, there were different patterns of play at differing times in the community history. Further, there were very different patterns of dumping at differing points in the dumpsite history. The points where exposure patterns and dumping patterns overlap are the most dangerous times. Boys often went to the dump to play when they were as young as 8 years old and many continued until their late teens. Our question about play in the dump did not specify what the play consisted of, who companions were, or where in the dump. There is undoubtedly a wide range of variation in the amount and type of exposure among residents who reported regular play in the dump.

There is not a significant relationship between total years of exposure in the community and the number of serious health problems in either the full community

(r=. 060) or the cohort (r=.027). To restate this, the number of serious health problems an individual reported is not related to how long they lived in the community. Years of exposure ranged from 0-85 years in the full community and 0-60 in the cohort. Those who lived in the community longer did not report more health problems. However, even though length of time in the community is not related to health outcomes, it does not mean that there is no contamination in the neighborhood; that conclusion is beyond the scope of this study.

Health Risks. This research asked does playing in the dump lead to specific health problems and to increased rates of health problems? For the full community, the results indicate that there are very few significant differences in frequency of health problems between the group who played in the dumps and their control neighbors (Table 3). Outside of gender differences, and poorer self-rated health in the control group, the only health problem that is significantly increased in the group exposed to dump is mental health problems. For the most part, this code was used for undiagnosed illnesses. In a working class neighborhood it is expected that mental health problems such as depression, alcohol abuse, drug abuse, domestic violence would go undiagnosed. It is very surprising that there is a difference in the reporting of these problems based on a childhood pattern of play.

The differences in health outcomes become much more dramatic in the cohort who was born between 1936 and 1979 (which eliminates residents over age 63 and under age 20 – see Table 4). In this cohort, rates of cancer, mental health problems, liver problems, developmental disability, and any serious health problem are increased over the controls that were not exposed to the dumpsite directly. Although the difference is not statistically significant, the odds ratio (attributable risk) of getting cancer is 1.38 times higher in the exposed group (Page, Cole, & Timmreck, 1995). This is not statistically significant. The odds ratio of having a mental health

problem as an adult or a developmental disability as a child is 2.54 times higher and 3.05 times higher respectively in the exposed group. But most striking of all, the attributable risk of have a life threatening liver disorder is 7.70 times higher in the group who were exposed directly to the dump. For mental health problems the difference between exposed and control is significant at $p <= 0.01$. For liver problems, developmentally delayed, and presence of any serious health problem the difference between exposed and controls is significant at $p<=0.05$. Thus, for the exposed cohort (those who played regularly in the dump), some health outcomes (liver and mental health problems) are significantly different from controls of the same age taken from an otherwise identical environment.

Geographic Patterns. Did living closer to the dump or ground water drainage from the dump have an impact on the same health outcomes? Tables 5 and 6 report the results of two-tailed chi-square analysis on behaviors and geographic region. Table 5 shows that residents living adjacent to the dump were more likely to play in the dump ($p<0.01$). The only significant difference in health outcomes was that people who lived further away from the dump were more likely to report a serious health problem. That is, those living adjacent to the dump were healthier in regards to other serious health problems and otherwise not significantly different from their southern neighbors.

The differences is health and exposure based on living downstream to the ground water draining of the dump is reported in Table 6. There are no significant differences in the West End in patterns of playing in the dump or health outcomes.

Summary of Findings. To review, there were a number of specific findings in this study.

1. A door-to-door *census* was completed on 69% of the households in the community (a total of 206 of 300 households). Census data was collected on 613 individuals.

Differences between the door-to-door and the US 1990 census used by the Cancer Surveillance Program (1997; 1998) may be attributed to the use of census block groups rather than a community definition of the neighborhood. Further apartment dwellers were not included in the door-to-door census. Migration out of the community has certainly occurred since the time of the US Census.

2. *History of community development and use of the industrial dumpsite* demonstrated that both the neighborhood and the dump began in the 1930's. The first reported play in the dump occurred in 1944, however, prior to that time some residents used carbon bars from the dump to heat their homes in winter. Some dumpsites were capped in 1987.
3. *Demographic patterns* showed strong gender differences (see Tables 1 & 2). Men who were children in the community were much more likely to settle in the community as adults (partilocal). This is especially true in the cohort. There are significant differences in gender and play in the dump with men much lore likely to play. However, the group of women who played in the dump as children probably has similar exposure patterns to their brothers.
4. *Health outcomes* were significantly different for the exposed cohort (1936-77) of individuals (see Tables 3 & 4). But that is the only behavior that demonstrated significant differences in health outcomes. The risk of liver problems was 7.70 higher in the cohort who played in the dump ($p<=0.05$), mental health problems were 2.54 ($p<=0.01$) times higher, and developmental disorders were 3.05 ($p<=0.05$) times higher for the exposed cohort.

5. No relationship was found between *total years of exposure* in the community and any health outcome for the full community or the cohort.
6. No relationship was found between any *geographic pattern* and health outcomes (see Tables 5 & 6). Households closest to the dump did not have more individual health problems than households further away (north/south). Further, households which were downstream from the dump did not have different health patterns than their neighbors further west.

Discussion

How could a neighborhood so close to Love Canal ignore the warning about dangers of exposure to wastes from chemical companies? How could they allow and continue to allow children to play regularly in the dump? How could they laugh when the children cut the fence so they could play in dangerous areas of the dump? These questions will surface again and again over the next few decades as young men and women develop health problems at a higher rate than expected for their age. For this cohort, it is a matter of not-so-great expectations. As one 39 year old man with liver disease put it, "I always looked forward to retirement after working all my life, and now I realize that I'll never get there".

Of course, there are a number of lessons for government epidemiologists as well. It is too easy to ignore the details of behaviors that put individual's at unusual risk for health problems, it is often too time consuming to sort out who lived 2 blocks away and who biked every day into the dumps. However, this behavioral information may be the key to understanding why a community reports unusual health problems. It is too difficult to spend the time taking to residents about their perception of health problems and too easy to rely on existing documents

like the cancer registry to calculate rates of disease. It is easier to identify flaws in a grassroots survey, than to look for the patterns in what residents have found in their own back yard.

There are lessons for industry and government agencies to protect the environment as well. It is not a good use of their time to discredit the efforts of private citizens to understand why health outcomes are unusual in their neighborhood and to bring in experts to "prove" them wrong. If they have determined that a dumpsite is unsafe, how can they allow the fence to be cut and not repair it? If Love Canal taught us anything, it should be to abandon the partisan biases we have, and to unite in our efforts to make people's homes and neighborhoods safe.

What have we learned from this study? A number of conclusions can be made based on the results.

1. **There was not a significantly higher prevalence of cancer in any group in the study.** When epidemiological research considers all residents of the neighborhood to have equal risk of exposure, then our results confirm what the Cancer Surveillance Program (1997; 1998) found in its studies of brain cancer and cancer in this neighborhood.
2. **Cancer is not the best marker of low-level toxic exposure.** In fact, even in the exposed cohort, rates of cancer were not significantly different from the cohort controls. That is, the CaPE group was looking for a too narrowly defined health outcome.
3. **Ethnographic interviews uncovered routes of direct exposure to chemical wastes in the dumpsite**. Behavioral patterns of exposure were not readily apparent to outside officials or researchers. Community members were often reluctant to admit to activities in the dumpsite. Family members had difficulty admitting that direct

exposure may have occurred to their children as they played out back. Confirmation of this behavioral pattern was revealed in face-to-face open-ended interviews in people's homes.

4. **Analysis of the behaviors allowed identification of a cohort for whom risk of exposure to toxic chemicals was greatest.** Interpretation of the unexpected health outcomes was complicated by the fact that not all play in the dump the same.
5. **Further research should be done on possible relationships between exposure and specific health outcomes**. The search for cancer as the most important health outcome has obscured the real differences in the exposed and control cohort. Given the fact that the researchers had no knowledge of a specific chemical exposure, it was impossible to determine in advance what health outcomes might be significant.
6. **Further epidemiological research needs to be done on the health outcomes that were found in the exposed cohort**. The liver disease is probably best documented health outcome, and is unlikely to be over-reported since most of the victims are asymptomatic until the problem is noted in a medical exam. The nine cases of cancer should be examined more closely. The two brain cancer cases that triggered the community action were both members of the exposed cohort who played in the dump regularly as adolescents. The mental health and developmental problems are much less clearly defined, but their distribution is strikingly and significantly different in the exposed cohort. One wife described it as an "epidemic of depression". The striking feature to an outside observer was a lack of impulse control and tendency toward substance abuse. These problems need further investigation before a potential link to any specific exposure can be made.

The results support the addition of anthropological methods to epidemiological case finding. Researchers must not assume that they know more about important health problems than the community members who are affected by them. Epidemiological research needs to consider more contextual and behavioral variables in their efforts to understand the patterns of health in a specific community. This research has demonstrated that two aspects are critical in small area epidemiological research – careful identification of exposure patterns and a broad definition of what will be described as a "case". Application of these anthropological methods of defining the community and understanding community perception of cases is relatively inexpensive, especially when compared to medical research, and can narrow the search for possible causative toxins. It may be an effective type of triage for a community who suspects they have toxic waste exposure. The focus on historical exposure and long term outcomes can help to identify diseases with a long latency period, and this may be the most important type of problem related to toxic waste exposure. Anthropological methods may bridge the gulf between communities and the agencies whose mission is to protect them from dangerous exposure to wastes.

Table 1

Gender Differences in Exposure Patterns in the Full Community Sample (N=545)

Variable	Full Community # / %	Men # / %	Women # / %	Statistical significance
Sex	545 / 100	288 / 52.5	257 / 47.2	____
Years of exposure, interval level data	0-85, mean 24.5 years	25.4 yrs.	23.6 yrs.	NS, ANOVA
Occupational exposure	96 / 17.2	75 / 26	21 / 8	$p <= 0.01$**
Seepage in household	133 / 24.4	65 / 23	68 / 27	NS
Born in *Portland Place*	238 / 43.7	145 / 50	93 / 36	$p <= 0.01$**
Attended local school	161 / 29.5	98 / 34	63 / 26	$p <= 0.05$*
Child in *Portland Place*	361 / 66.2	204 / 71	157 / 60	NS
Grew and consumed vegetables	180 / 33	100 / 35	80 / 31	NS
Played in dump	202 / 37	141 / 49	61 / 24	$p <= 0.01$**
Regular outdoor labor	17 9 / 3.1	15 / 5	2 / 1	$p <= 0.01$**

Note: NS means the difference between men and women is not statistically significant. ** Means statistically significant difference between men and women using chi square analysis with $p <= 0.01$. * Means statistically significant difference between men and women using chi square analysis with $p <= 0.05$.

Table 2

Gender Differences in Exposure Patterns in the 1936-1979 Cohort (n=342)

Variable	Full Community # / %	Men # / %	Women # / %	Statistical significance
Sex	342 / 100	183 / 53.3	159 / 46.5	____
Years of exposure, interval level data	0-60, mean 24 years	25.5 yrs.	22.1 yrs.	$p<= 0.05$*
Occupational exposure	59 / 17.3	43 / 24	16 / 10	$p<= 0.01$**
Seepage in household	94 / 27.5	45 / 25	49 / 31	NS
Born in *Portland Place*	176 / 51.5	110 / 60	66 / 42	$p<= 0.01$**
Attended local school	147 / 43.0	90 / 49	57 / 36	$p<= 0.05$*
Child in *Portland Place*	261 / 76.3	153 / 84	108 / 68	$p<= 0.01$**
Grew and consumed vegetables	125 / 36.5	71 / 34	54 / 159	NS
Played in dump	166 / 48.5	119 / 65	47 / 30	$p<= 0.01$**
Regular outdoor labor	9 / 2.6	8 / 4	1 / 1	NS

Note: NS means the difference between men and women was not statistically significant. ** Means statistically significant difference between men and women using chi square analysis with $p<= 0.01$. * Means statistically significant difference between men and women using chi square analysis (ANOVA for years of exposure only) with $p<= 0.05$.

Table 3

Frequency of Health Outcomes in the Full Community and Among Residents Who Played in the Dump Regularly as Children (N=545)

Variable	Attributes	No play in the dump as child n=343 # (%)	Regular play in the dump as child n=202 # (%)	statistical significance (one-sided *p* value)
Sex	Male (n=288)	147	141	
	Female (n=257)	196	61	.000 **
Self-rated health	Very poor	11 (3.2%)	6 (3%)	
	Poor	16 (4.7%)	14 (6.9%)	
	Average	30 (8.7%)	34 (16.8%)	
	Good	59 (17.2%)	37 (18.3%)	(two-tailed)
	Excellent	166 (48.4%)	94 (46.5%)	.006 **
Miscarriage/birth defect	Yes (n=44)	31	13	
	No	312	189	.181 NS
Cancer	Yes (n=40)	28	12	
	No	315	190	.216 NS
Mental health problem	Yes (n=43)	21	22	
	No	322	180	.035 *
Liver problem	Yes (n=12)	5	7	
	No	338	195	.109 NS
MVA	Yes (n=9)	5	4	
	No	338	198	.443 NS
Developmental disorder	Yes (n=31)	18	13	
	No	325	189	.345 NS
Other serious	Yes (n=46)	24	22	
	No	319	180	.079 NS
Any serious health problem	Yes (n=172)	103	69	
	No	240	133	.182 NS

Note: NS means that the result of the Chi square analysis was not statistically significant. * Means statistically significant difference between dump exposed group and control using chi square analysis with $p <= 0.05$. ** Means statistically significant difference between dump exposed group and control using chi square analysis with $p <= 0.01$.

Table 4

Frequency of Health Outcomes in the 1936 – 1979 Cohort and Among Residents Who Played in the Dump Regularly as Children (N=342)

Variable	Attributes	No play in the dump n=176 # (%)	Regular play in the dump as child n=166 # (%)	statistical significance (one-sided *p* value)
Sex	Male (n=183)	64	119	
	Female (n=159)	112	47	.000 **
Self-rated health	Very poor	5 (2.8%)	6 (3.6%)	
	Poor	7 (4.0%)	11 (6.6%)	
	Average	18 (10.2%)	31 (18.7%)	
	Good	36 (20.5%)	32 (19.3%)	(two-tailed)
	Excellent	99 (56.3%)	74 (45.2%)	.174 NS
Miscarriage/birth defect	Yes (n=33)	20	13	
	No	156	153	.178 NS
Cancer	Yes (n=16)	7	9	
	No	169	157	.353 NS
Mental health problem	Yes (n=32)	10	22	
	No	166	144	.013 **
Liver problem	Yes (n=8)	1	7	
	No	175	159	.028 *
MVA	Yes (n=7)	4	3	
	No	172	163	.532 NS
Developmental disorder	Yes (n=15)	4	11	
	No	172	155	.043 *
Other serious	Yes (n=38)	18	20	
	No	158	146	.358 NS
Any serious health problem	Yes (n=111)	49	62	
	No	127	104	.039 *

Note: NS means that the result of the Chi square analysis was not statistically significant. * Means statistically significant difference between dump exposed group and control using chi square analysis with $p <= 0.05$. ** Means statistically significant difference between dump exposed group and control using chi square analysis with $p <= 0.01$.

Table 5

Frequency of Health Outcomes in Among Residents Who Lived Closest to the Dump (Region 1 versus Regions 2-4, N=545)

Variable	Attributes	Lived adjacent to dump n=165 # (%)	Lived further from dump n=380 # (%)	statistical significance (two-sided *p* value)
Played in dump	Yes (n=202)	80 (48.5)	122 (32.1)	
	No	85	258	.000 **
Miscarriage/birth defect	Yes (n=44)	13 (7.9)	31 (8.2)	
	No	152	342	.921 NS
Cancer	Yes (n=40)	8 (4.8)	32 (8.4)	
	No	157	348	.142 NS
Mental health problem	Yes (n=43)	15 (9.1)	28 (7.4)	
	No	150	352	.493 NS
Liver problem	Yes (n=12)	6 (3.6)	6 (1.6)	
	No	159	374	.133 NS
MVA	Yes (n=9)	2 (1.2)	7 (1.8)	
	No	163	373	.596 NS
Developmental disorder	Yes (n=31)	6 (3.6)	25 (6.6)	
	No	159	355	.173 NS
Other serious	Yes (n=46)	8 (4.8)	38 (10.0)	
	No	157	342	.047 *
Any serious health problem	Yes (n=172)	45 (27.3)	127 (33.4)	
	No	120	253	.156 NS

Note: NS means that the result of the Chi square analysis was not statistically significant.
* Means statistically significant difference using chi square analysis with $p <= 0.05$.
** Means statistically significant difference using chi square analysis with $p <= 0.01$.

Table 6

Frequency of Health Outcomes in Among Residents Who Lived Downstream to the Dump (Region 2 + western portion of region 1 and 3 versus Region 4 + eastern portion of 1 and 3, N=545)

Variable	Attributes	Lived downstream to dump n=210 # (%)	Lived outside ground water drainage from dump n=335 # (%)	statistical significance (two-sided *p* value)
Played in dump	Yes (n=202)	73 (34.8)	129 (38.5)	
	No	137	206	.378 NS
Miscarriage/birth defect	Yes (n=44)	14 (6.7)	30 (9.0)	
	No	196	305	.340 NS
Cancer	Yes (n=40)	18 (8.6)	22 (6.6)	
	No	192	313	.383 NS
Mental health problem	Yes (n=43)	21 (10.0)	22 (6.6)	
	No	189	313	.148 NS
Liver problem	Yes (n=12)	5 (2.4)	7 (2.1)	
	No	205	328	.822 NS
MVA	Yes (n=9)	3 (1.4)	6 (1.8)	
	No	207	329	.747 NS
Developmental disorder	Yes (n=31)	8 (3.8)	23 (6.9)	
	No	202	312	.134 NS
Other serious	Yes (n=46)	16 (7.6)	30 (9.0)	
	No	194	305	.585 NS
Any serious health problem	Yes (n=172)	63 (30.0)	109 (32.5)	
	No	147	226	.535 NS

Note: NS means that the result of the Chi square analysis was not statistically significant.
* Means statistically significant difference using chi square analysis with $p <= 0.05$.
** Means statistically significant difference l using chi square analysis with $p <= 0.01$.

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