Intern. J. Environmental Studies, 1988, Vol. 32, pp. 151–167
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ACID PITS AND BIRTH DEFECTS: A CASE STUDY OF THE STRINGFELLOW ACID PITS DUMP SITE AND CONGENITAL ANOMALIES

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(Received June 16, 1987)

This paper examines the relationship between a toxic waste site and congenital anomalies. The Stringfellow acid pits dump site (SAP) located near the City of Riverside, California, is the focus of this study. Congenital anomalies are examined in relation to various demographic and socioeconomic variables. Our analyses suggest that hydrological and geological proximity to the dump site has a significant relationship to birth defects. An analysis of infant mortality rates showed that the death rate for congenital anomalies was higher in Riverside County than California, while the state's rate was higher than the national average. In order to substantiate a causal nexus, there is a need for longitudinal follow-up studies. Without an adequate longitudinal study, the long term impact of SAP on children born in the SAP area and its impact on subsequent generations will remain a subject of continued speculation.

KEY WORDS: Acid waste, congenital anomalies, birth defects, California.

INTRODUCTION

Over the past few decades, "tens of thousands of man-made chemicals" have been introduced into the environment, usually without being tested.[1] One result of the introduction of these made-made chemicals may be damage to the genetic material in cells—DNA. This damage to cells appears to be the cause of genetic defects, primarily cancer, and may be a causal agent to heart disease and aging as well.[2]

Currently almost one-fourth of the population will develop cancer and a small portion (ca. 1.0%) of children born with birth defects attributable to DNA damage. Not known is what proportion of children in future generations will be born with congenital anomalies as a result of DNA damge. While natural mutagens are present in the environment, there also is an emerging plethora of man-made chemicals used in industry, as well as in pesticides, hair dyes, cosmetics, drugs, in more complex mixtures such as cigarette smoke and vehicle exhausts, and in unanticipated solutions produced as a result of mixing a variety of toxic chemicals in dumps.

Despite the problem of carrying out human epidemiological studies, there is substantial evidence supporting the assumption that man-made chemicals are important causal agents in many birth defects, many cancers, and that man-made chemicals and their emergent properties (e.g. pollution, cigarette smoke tar) are potential mutagens. One example of the possible interrelationship between carcinogens and mutagens is asbestos. Asbestos is an important physical carcinogen but also recently has been shown to be a powerful mutagen since asbestos needles can pierce animal cells and cause chromosomal abnormalities.[3]

Ordinarily it is extremely difficult to establish a linkage between carcinogens and cancer because of the long lag period between exposure and the appearance of most types of human cancer.[4] One such generally accepted lagged relationship is the one between cigarette smoking and lung cancer for both men and women.[5] This relationship is one of the easier ones to demonstrate because of a rather clear cut "control groups," e.g. non-smokers. A similar lag has been shown for exposure to atomic radiation, although leukemia and lymphoma show up earlier than other cancers. Generally, however, it is extremely difficult to show a "cause and effect" relationship even though the number of individuals affected may be quite large. The difficulty lies in the fact that there are seldom clear-cut exposed and non-exposed groups. Thus, millions of people used vinyl chloride in spray cans and/or used the food additive AF-2, but the damage is difficult to assess. The mutagenic linkage is even more difficult to establish because several generations are needed for analysis. The linkage across generations may also go unnoticed if the impact is not severe. Such subtle effects as decreased physical fitness or reduced intelligence may not be noticeable or measured.

An example of such subtle impact that was discovered accidentally was that Dibromo-chloro-propane (DBCP) caused infertility for many exposed workers. It also is possible that DBCP could cause a variety of genetic abnormalities among the offspring of those workers who could still produce children.

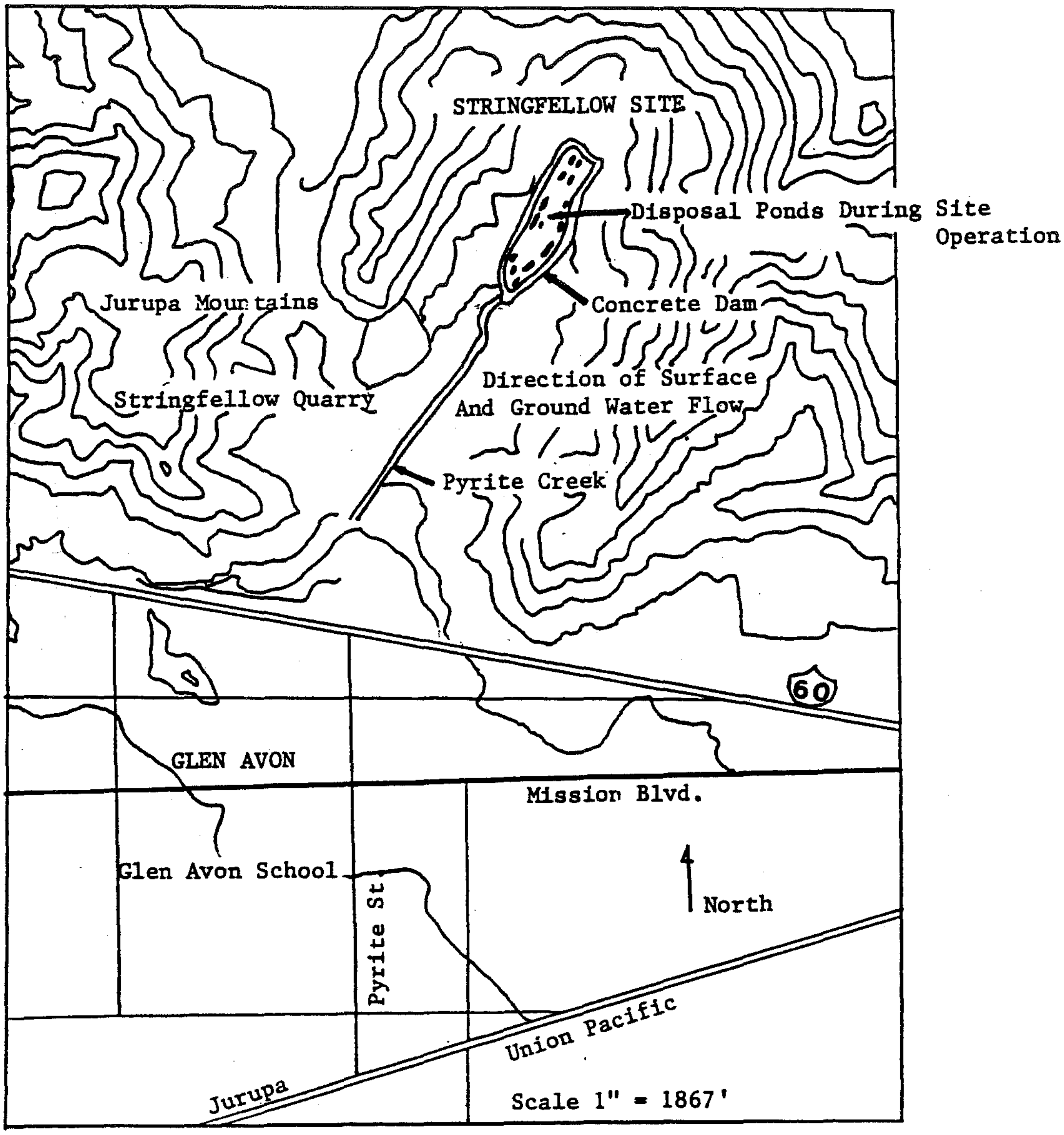
The production of the tens of thousands of man-made chemicals resulted in a need to dispose the waste products developed in their production. It is only during the past several years that chemical waste dumps and their possible effects upon human health have become a national concern. Controversies have emerged involving the extent to which toxic chemical wastes actually pose health hazards, the extent to which the public has the right to know about them which has involved corporate and government secrecy, political favoritism regarding information, and the use of and withholding of public funds committed to toxic waste cleanup.

Social scientists have become involved in exploring some of the social aspects of toxic wastes and their potential health impacts. However, not all social scientists approve of such scrutiny. For example, one sociologist has suggested that environmentalists consist of "sun worshippers, macrobiotics, forest druids, and nature freaks generally devoted by course if not yet by fully shared intent to the destruction of capitalism."[6] Notwithstanding this view, it is readily apparent that considerable chemical warfare on US society is now in progress.[7]

THE STRINGFELLOW ACID PITS (SAP)

The SAP are located five miles northwest of City of Riverside, California, and one mile north of the community of Glen Avon. The Stringfellow site was designated by *EPA* in December, 1982 as a top priority site for Superfund cleanup. It was also designated as a priority site for a period of time by the State of California.[8] An original assessment of waste disposal sites in California rates SAP as a number two on the priority list. However, the State periodically revises its list to give priority to sites than can be cleaned up at a low cost to the State independent of potential danger. Thus, the SAP site now is no longer priority number two but became number 81,[9] and then progressively moved downward in priority from 81, 84, and now is 99 primarily because of the projected cleanup expense.[10] Subsequently a bill was approved by a California State Assembly Committee to allocate $6.5 million from a $100 million bond issue for the cleanup of the Stringfellow site.[11] The SAP has become an historically important site because it is one of the first to become involved in political conflict surrounding cleanup.

The site shown on Map 1 covers 22 acres of land; it was originally operated legally



Map 1 The Stringfellow toxic waste disposal site.
Source: Report by the Auditor General of California, October 1983.

as hazardous substance disposal facility between 1956 and 1971.[12] At least 34 million gallons of hazardous wastes were deposited at the site. Over 200 organizations used the site to dump industrial chemicals including many that are suspected of causing birth defects, cancer, and sterility.[13] One aircraft industry, for example, dumped 2,746,173 gallons of pollutants at the site. At least one expert believes that the mix of chemicals at SAP is such that newer and deadlier chemicals with unknown reactions and unknown health hazards are being produced at the site (vide Appendix). "Our understanding of the effects of new chemicals generated by chemical reactions occurring at the site is almost non-existent."[14]

Negotiations for cleanup between various companies and the United States broke down when the government began suing for 100% of the cleanup costs, which originally were estimated to cost between $9.5–$40 million.[15] Subsequent estimates for cleanup costs ranged from $40 to $60 million, with the money coming from the so-called Superfund raised by taxing industrial chemical manufacturers. Originally California was allocated $6.1 million from the Superfund. However, now it appears that the amount will be $9.5 million or $9.9 million.[16] Part of the cleanup costs will have to be borne locally or by the State, c. 10%. Plans for cleanup apparently are now underway with a company, being awarded a $1.4 million contract for planning the cleanup. However, the firm *may* receive more than that for the work according to news reports.[17] The most recent cleanup costs have escalated with estimates now ranging between $50 and $100 million.[18]

While the dump site has been capped, chemicals may be leaking underground through geological formations which are poorly understood. The State of California spent $4.5 million to install clay covers, wells, and culverts in an effort to prevent toxic waste pollution in the area.[19] Despite the clay cap, there was an above ground leak that occurred on May 22, 1983. The leak was discovered on a Tuesday but residents were not notified until Friday the same week. The waste material which leaked above ground was trucked to the BKK toxic dump in West Covina in Los Angeles Country, about 25 miles away in a much more heavily populated area. That site has subsequently been closed and is being studied for cleanup. Other waste leakage from Stringfellow flowed into Pyrite Creek which leads from the pits to the residential area of Glen Avon, and the location of several new housing developments. Pyrite Creek flows into the Santa Ana River which in turn flows through heavily populated Orange County to the Pacific Ocean.[20]

Some Riverside County officials knew at least as early as 1981 that there was a problem at SAP but there was no public announcement of the problem. The Santa Ana River Regional Water Quality Control Board gave the County the results of their tests indicating an underground flow problem from the acid pits.[21] This was considered necessary since some of the people in the Glen Avon area obtain water from their own wells. Others in the area receive drinking water from the Jurupa Community Services District which obtains water some distance from the pits and thus presumably is not contaminated by the acid pits or their overflow. Others in the area now use only state-supplied bottled water since they became aware of the possible pollution. More recently, reports indicate that the toxic wastes are flowing around the underground clay dike built to contain the wastes.

The underground hydrology and geological structure suggest that the plume will move in certain directions and not others. Until recently, the underground poison was estimated to be moving at a rate of 250–400 feet a year; current estimates are that it already may have reached populated areas. The flow is now at least 3,000 yards beyond the site.

One option that for the most part has been discarded is the trucking away of the half-million cubic yards of waste to another location; this alternative has been rejected because of the expected costs of $70 million.[22] The most recent suggestions has been to burn the material either on-shore or off-shore. One area of proposed burning is 15 miles away in the southeast side of Riverside, California, adjacent to one of the fastest growing areas in the United States—the Sunnymead—Moreno Valley area.

Controversy of various sorts has emerged over the acid pits. For example, Rita Lavelle, of the *EPA*, was fired over political use of Superfund dollars and their release. She denied that she participated in decisions related to a former employer and dumper at SAP, and she denied that she had a conflict of interest. She was found guilty of perjuring herself before a Senate committee regarding some of these matters.[23] Interestingly, *EPA* could not account for 89% of the Superfund money allocated to California, e.g. only $118,000 remained out of $1 million plus.[24]

Over the years several accidents have occurred that may have affected local residents. Winds blew chemical fumes before the dump was capped. Further, in 1978, water from the pits was released so that the northern dikes holding the chemicals would not burst as a result of an extensive rainfall. The local population was not immediately notified of this toxic waste release. In fact children were playing in the creek so the National Guard was called out to keep people out of the water.[25] The County reportedly developed a "hotline" that was supposed to keep local residents informed. However, the local newspaper reported that no one answered the hotline when it was called.[26]

There has been controversy over the variety and amounts of toxic wastes in the pits. In fact this information was available in official records but it took residents years to obtain it. Generally, information has not been released to local residents at all or only on a much delayed time schedule. Thus, local residents argue that they have not been adequately informed or represented on decisions regarding the dump. Residents of the local communities have argued that they have the right to know what risks they sustain by living near the dump site. They believe that they deserve to know when problems arise concerning the site so that they can act accordingly.[27]

The remainder of this paper examines birth defects and infant mortality in Riverside County, with special emphasis on the Stringfellow Acid Pits site.

BIRTH DEFECTS IN RIVERSIDE COUNTY: 1980–1982

Generally there is some question as to the ability of birth certificates to reflect accurately the number of birth defects (congenital anomalies), e.g. a validity question. Birth defects reported, however, are assumed to actually exist; there are no false-positives. A remaining question is to what degree there are birth defects occurring that are not reported. Obviously, those not reported cannot be included in an analysis. Another consideration relevant to this research is whether or not the underreporting of congenital anomalies is random or systematic. Unfortunately, while this is a legitimate question to ask, no answer is available. Also some birth defects may not be immediately recognizable and may not have an apparent effect until a later time. For this analysis, the data on hand are accepted as being reliable and valid.

There has been a dispute over whether or not there has been an abnormal number of congenital anomalies in the SAP area. An analysis by the Riverside County Health Department showed that the rate of birth defects among babies born to residents of the area near the acid pits was higher than the County average, e.g., by census tracts. Particularly, the area where SAP is located had a statistically significant higher birth defect rate during 1980–82 periods. Yet, none of the birth defect children purportedly were born within the *immediate* SAP "exposed area."[28] The same analysis also indicated that while adjacent areas had high rates, they did not have the highest rates in the County.[29] The County rate of birth defects for the period of 1980–1982 was 0.88. This was somewhat higher than the State's rate in 1980 of 0.76%.

Basically the analysis presented above is accurate, but perhaps misleading because of the lack of comparison with the entire County. Table I presents the basic data used in this analysis which includes all of the areas (census tracts) in Riverside County.

Table I Congenital anomalies—births by census tracts 1980–82, Riverside County.

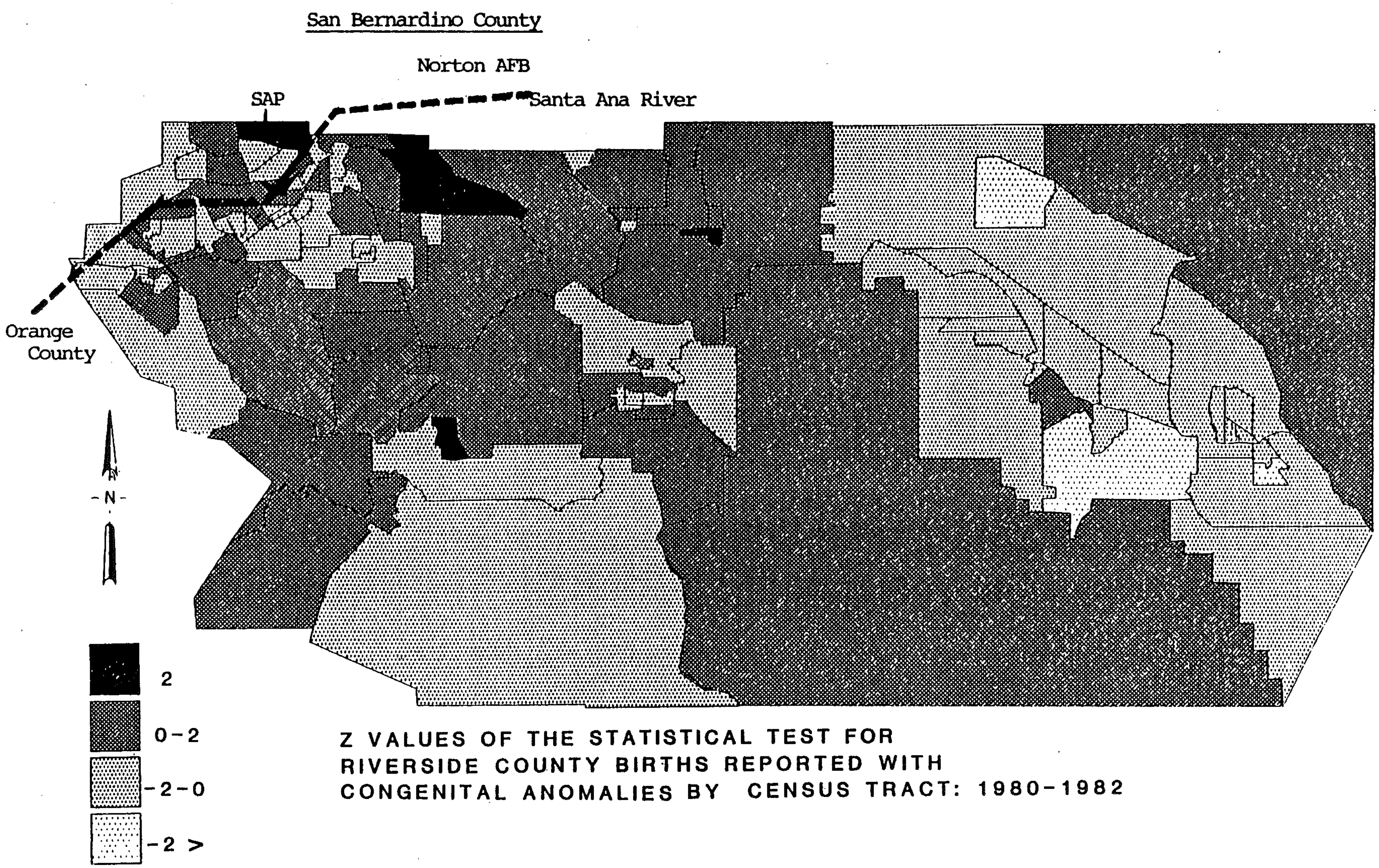
Variables	Z score greater than 2.0	Z score between 0.0 and 2.0	Z score between 0.0 and −2.0	Z score less than −2.0
RACE				
Non-Hispanic whites	74.3%	76.0%	73.9%	58.2%
Blacks	6.6	5.9	3.3	1.5
Indians	1.1	1.3	1.0	0.6
Asians	0.5	1.1	1.8	0.6
Hispanics	17.5	15.7	20.0	39.1
INCOME[a]				
Family	$32,392	$31,357	$28,749	$70,702
Median	14,309	13,875	11,205	25,449
EDUCATION[b]				
High school graduates	68.2%	67.9%	70.6%	60.5%
OTHERS				
Poverty[c]	16.4%	20.6%	20.0%	22.2%
Unemployed[d]	10.6	13.4	13.6	15.1
Unoccupied housings[e]	8.6	11.6	20.2	34.6
	(N = 7)†	(N = 45)	(N = 57)	(N = 3)

[a] Mean of 1979 income.
[b] Number of high school graduates divided by the total number of persons 18 years and over.
[c] Families with income in 1979 below poverty level divided by the total number of families.
[d] Unemployed persons divided by the total number of persons 18 years old and over.
[e] Vacant housing units divided by the total year-round housing units.
† Number of census tracts below and above zero are not equal due to rounding errors.

Map 2 shows most of Riverside County and Z scores for birth defects (1980–1982). In fact, several areas with the highest scores are located near the Stringfellow site. Yet several other areas in the nearby City of Riverside also have as high or higher rates. Similarly, several areas adjacent to the City of Riverside in an easterly direction but not adjacent to the SAP have high rates (Rubidoux, Pedley, and North Sunnymead). Other areas relatively far removed have high rates (Banning and Sun City). Finally, an area nearly 200 miles away which is not shown on Map 2 also has a high rate of birth defects. It thus becomes important to determine what factors may be associated with high rates of birth defects in addition to or instead of the acid pits since there were high rate areas elsewhere in the County, not only near the acid pits.

As perhaps might be anticipated, primary factors emerging from the demographic and socioeconomic analysis are race/ethnicity and income. However, the statistical analysis results present a complex picture that must be tempered with knowledge gained from a perusal of birth defect rates by year, e.g. 1980, 1981, and 1982, and by a detailed analysis of areas with higher rates of congenital anomalies.

The regression analysis shown in Table II combining the three-year birth defect data indicate a complex relationship between race/ethnicity and birth defect rates, that would not necessarily be predicted by previous sociological research. When other factors are controlled, both the Asian and Spanish origin populations are associated with lower rates of congenital anomalies; there is no difference for anglos, and a positive association exists for the black population. In contrast to what might be expected, some areas with high incomes have high rates of birth defects.



Map 2 Z values of the statistical test for Riverside County births reported with congenital anomalies by census tract: 1980–1982.

Table II Congenital anomalies—births regression analysis 1980–1982, Riverside County.

Dependent variables	Income[b] Family	Income[b] Median	High school graduate	Poverty	Unemployed	Unoccupied housings	Race[c] Non-Hispanic whites	Race[c] Blacks	Race[c] Indians	Race[c] Asians	Race[c] Hispanics
	Independent variables[a]										
Z score in 1980	−0.04	0.19	−0.11	0.06	0.05	−0.28†	0.17	0.17‡	−0.06	−0.09	−0.22‡
Z score in 1981	−0.27	0.39†	0.02	−0.04	−0.07	−0.08	−0.20	0.09	0.25†	0.07	−0.20
Z score in 1982	−0.21	0.19	−0.09	0.14	0.07	−0.17‡	0.10	0.11	−0.09	−0.28†	−0.28†
Z score, 1980–1982	−0.27	0.39†	−0.12	0.04	−0.02	−0.28†	0.03	0.22‡	0.05	−0.18‡	−0.36†

[a] Standardized regression coefficients.
[b] 1979 income.
[c] Absolute numbers.
† Significant at 0.05 probability level.
‡ Significant at 0.10 probability level.

The association between the black population and higher rates appears to be in contrast with the income dimension. A detailed examination of the areas with the highest rates suggests a complex relationship between ethnicity and income that is obscured by the regression analysis. Two of the highest areas have a substantial black population (28.3 and 31.2%, respectively) *and* have incomes above the County average. One of these two areas is adjacent to the acid pits while the other one is approximately 200 miles away on the California–Arizona border. On the other hand, two of the highest areas have no black population. These areas are far removed from the SAP. Thus, some of the highest rates are in areas characterized by a black population with higher than average incomes but high rates also exist in anglo areas with relatively low incomes.

These results suggested a revisit to the component years of 1980, 1981, and 1982 to determine if there was similar variation for each of these years. Also there was an increase each year in the rate of birth defects reported in Riverside County; 0.86% in 1980, to 0.91% in 1981, and 1.20% in 1982. An examination of birth defects by year showed a somewhat varied spatial distribution.

The next question, of course, was whether or not the same factors were related to birth defects for the three years. Despite somewhat different spatial distributions, the main conclusions shown in Table II for the three-year period holds for each of the individual years. That is, higher level income areas with a black population were associated with higher rates whereas Asians and Spanish origin populations meant lower rates of birth defects. Yet, several areas with no black population had high rates.

Rates of congenital anomalies are higher in the SAP area and in areas in a *southwestern* direction, which is consistent with the currently accepted hydrological and geological structure of the area.[30] Yet there are indications that other factors may be involved in areas with high rates in addition to the acid pits. For example, areas adjacent to the SAP in a *northeastern* direction also have high rates of congenital anomalies. Similarly, as already noted, other areas in the County far removed from the SAP have high rates. In fact, since the relationship betwen congenital anomalies and environmental conditions exist even in areas in addition to the SAP indicates that the relationships are complex. More case studies of individual areas may be necessary to explain fully higher rates of birth defects. Further, other areas within the County have now been reported as having toxic waste problems.[31] What impact these, and perhaps other as yet unidentified sites, have is unclear and have not been analyzed by anyone so far.

One example of unanticipated results was the high rates of congenital anomalies found in the area on the California–Arizona border. After our original analysis was completed, it was reported by the *Arizona Republic* newspaper that large amounts of paraquat, methyl parathion, and aldicarb, the most poisonous and toxic of all pesticides, had been illegally sold by pesticide companies and illegally used by farmers in that area.[32] Another interesting phenomenon that emerges as a result of the mapping were the high rates along the Santa Ana River (see Map 2) that reportedly are upstream from the SAP plumes. However, Norton Air Force Base in San Barnardino County is located next to the river bottom and 20 different sites were recently identified on the base as containing some form of hazardous wastes, including TCE, PCBs, solvents and fuel sludge, and low level radioactive wastes. Some of these sites are near wells that serve Riverside and all of them are adjacent to the Santa Ana River which then flows into Riverside County. Virtually all of the areas along the Santa Ana River in Riverside County have high rates of congenital anomalies. Incidentally, none of the Norton AFB sites are listed by *EPA* or the State of California among their priority sites.

Finally, birth defect rates are higher in areas surrounding the SAP but are not necessarily statistically significant. The mapping of congenital anomalies shows that in fact the SAP area and areas directly south all have rates higher than the County average which is higher than the state average. The higher rates in south of the SAP are consistent with the reported hydrological and geological structure of the area. However, several aras to the west and east of the SAP have birth defect rates lower than the County. Finally, emerging data on the SAP imply that in contrast to earlier reports actually relatively little is known about the underlying hydrological and geological structures of the area and that most of the assumptions regarding them in the pasts were at best not well understood or at worst completely wrong.[33] The only other dimension included in the statistical analysis so far that is consistently associated with congenital anomalies is the vacancy rate, suggesting that areas with stable populations are more likely to have higher rates of birth defects than more mobile areas.

CONGENITAL ANOMALIES AND INFANT MORTALITY RATES

Another health question is the possible relationship between the SAP and infant mortality. The analysis of the relationship between congenital anomalies and infant mortality is of great significance, since birth certificate data have several known deficiences. One problem is that while a birth defect may be noted, at times no classification of the defect is given. Further, some children may be born with observable birth defects but this is not indicated on the certificate. Also there is an apparent lack of ability to ascertain other than physical anomalies. There may be more subtle influences that will appear only later in the life cycle and only if analyzed. Thus, birth defect data from birth certificates generally can be assumed to indicate accurately that a defect exists, but there may be some question as to the coverage and accuracy of birth defect classification. While there are probably no false-positives, there undoubtedly are babies born with birth defects that are not recorded. Analysis of infant mortality in relation to congenital anomalies, however, does provide additional information obtained from birth certificates. In the remainder of this section, the relationship between congenital anomalies and infant mortality rates is examined.

Table III shows infant mortality rates for California during the three year period of

Table III Infant mortality rates: congenital anomalies 1980–1982, California.

		Total deaths		California deaths (1–11 months)	
Year	Total live births	No.	Rate[a]	No.	Rate[a]
1980	398,222	4,451	11.2	1,024	2.6
1981	415,853	4,276	10.3	1,070	2.6
1982	429,632	4,218	9.8	1,039	2.4

[a] Rates are per 1,000 live births.
Source: State of California, Department of Health Service, Health and Welfare Agency, Death Records, 1983 and 1985.

Table IV Infant deaths from selected causes: congenital anomalies California, 1980–1982.

Ninth revision ICD number	Cause of death	1980 No.	1980 Percent	1981 No.	1981 Percent	1982 No.	1982 Percent
05–999	Total, all causes	4,451	100.00	4,276	100.0	4,218	100.0
740–759	Congenital anomalies	1,024	23.0	1,070	25.0	1,039	24.0
740–742	Anencephalus, spine, bilida and other nervous system	211	4.7	219	5.1	201	4.8
745–747	Heart/circulatory system	387	8.7	383	9.0	412	9.8
748	Respiratory system	62	1.4	101	2.4	90	2.1
750–751	Upper alimentary tract/digestive system	23	0.5	25	0.6	32	0.8
713	Urinary system	46	1.0	47	1.1	42	1.0
758	Chromosomal	81	1.8	100	2.3	95	2.3
759.8	Other specific	13	0.3	11	0.3	13	0.3
759 (except 759.8)	Other and unspecific	114	2.6	90	2.1	74	1.8
Residual	Other congenital anomalies	87	2.0	94	2.2	80	1.9

Source: State of California, Department of Health Service, Health and Welfare Agency, Death Records, 1983, 1985.

1980, 1981, and 1982. The overall infant mortality rate declined slightly over the three year period, while infant mortality rate for those with birth defects remained almost constant over that three year period and accounted for about 25% of infant deaths each year.

Table IV presents a refined categorization of infant deaths from selected causes of congenital anomalies for 1980–1982. The death rate due to congenital anomalies in California remained stable during the period (23–25%).

Table V compares Riverside County with the State of California for 1982. The major differences between the County and California are a lower rate for heart/circulatory system deaths and a higher rate for respiratory system deaths in Riverside County.

Table VI presents data on infant mortality for Riverside County in 1982. It shows that the death rate for congenital anomalies was higher in Riverside County than for California and that the state's rates were higher than the national average.

Table V Infant mortality rates: congenital anomalies Riverside and California, 1982.

Ninth revision ICD number	Cause of death	Riverside[a]	California[b]
740–742	Anencephalus, spine, bilida, and other nervous system	18.7	19.3
745–747	Heart/circulatory system	25.0	39.7
748	Respiratory system	18.7	8.7
753	Urinary system	6.3	4.0
759	Other CA affecting multiple systems	6.3	8.4
Total		100.00 (N = 16)	100.00 (N = 1,039)

[a] *Source:* Death data stored on tape with individual records. From Department of Health, Sacramento.
[b] *Source:* State of California, Department of Health Services, Health and Welfare Agency, Death Records, 1985.

Table VI Infant mortality rates: Riverside, 1982.

ICD number	Cause of death	No.	Percent	Percent	California percent	US percent
740–759	Congenital anomalies	16	23.9	28.6	24.6	21.2
765	Disorders to short gestation	9	13.4	16.1	—	8.8
768	Intrauterine hypoxia	2	3.0	3.6	—	3.6
760–764, 766, 770–779	Other conditions originating in the perenatal period	18	26.9	32.0	—	26.4
798	Sudden infant death syndrome	2	3.0	3.6	—	10.9
All other causes	(Residual)	9	13.4	16.1	—	29.1
Unknown		11	16.4	—	—	—
Total		67	100.0	100.0		100.0

Source: State of California, Department of Health Service, Health and Welfare Agency, Death Records, 1983 and 1985.

The data shown in Table VII vary from some previous tables because several different sources of data were available. Published sources reported different numbers of death and causes than the mortality computer tape for the State of California which includes all reported deaths from 1963 to 1985. When different sources varied, the computer tape was accepted as being more accurate than published sources; it invariably contained a greater number of congenital anomalies and deaths than published sources.

Table VII Infant mortality rates; congenital anomalies 1980–1982, Riverside.

				Z score	
Year	No. of births[a]	No. of CA[a]	No. of deaths (CA)[b]	CA†	CA death‡
1980	11,969	96	43	0.50	2.15
1981	12,740	102	56	0.52	4.29
1982	12,955	135	47	3.70	2.79

[a] *Source:* County of Riverside, Department of Health, 1983.
[b] *Source:* State of California, Department of Health Services, Health and Welfare Agency, Death Records, 1983 and 1985.
† Calculations are based on California State's rate in 1980 of 0.76%.
‡ Calculations are based on California State rates in respective years.

The analysis shows that for 1980 and 1981 the County had a rate of congenital anomalies similar to California's, but the county had a rate significantly higher than the state in 1982. In all three years the infant mortality rate for children born with congenital anomalies was greater in Riverside County than California. There is a substantial relationship between infants born with congenital anomalies and the infant mortality rate. Of the deaths that occur in the first eleven months of life, approximately 25% are children with birth defects.

DISCUSSION

The defects analyzed in this research are known abnormalities, observable at birth, and recorded on the birth certificate. Other defects may not be observable and become recognizable only over the long term. Obviously, these defects are not considered here. Also they can only become known by research that systematically follows up local residents over many years, and to wherever they may have subsequently moved.

The results of this research quite clearly show that defects recorded at birth are scattered across the County and that the primary explanatory factor may be other than the acid pits, but it does not exclude the acid pits as a causal factor in areas near the waste site. The statistical analysis results are mixed specifying that race/ethnicity is differentially related to birth defects and that the socioeconomic relationship is contrary to what most researchers might expect. That is, there is a positive association between socioeconomic status and congenital anomalies. An adequate explanation of this more complex than expected nexus awaits further analysis and contemplation.

The alternatives appear to be at least the following: (1) there is a relationship between the acid pits and congenital anomalies; (2) while birth defect rates are higher in the SAP area, they also are systematically being underrecorded so that the relationship is even stronger than that shown here; (3) the impact of the acid pits on both defects and infant mortality will only be known later when higher rates of cancer, lack of physical fitness, reduced intelligence, etc. are measured, and/or if there are mutagenic effects with descendants of these children having higher than expected defects and deformities; (4) since there are high rates scattered throughout the County, as yet unknown factors account for the reported differences; and (5) the data on birth certificates may not be reliable and valid enough for such an analysis as carried out here.

Research that would unravel some of these alternatives would utilize a County-wide, relatively large sample of particular birth cohorts and follow them over a long period of time to determine if mild or moderate retardation, developmental disabilities, other handicaps, and/or a higher incidence of cancer emerges. Since the lag may be a long one, i.e. as per cigarette smoking, a life cycle approach undoubtedly is necessary.

In order to explore possible mutagenic effects, of course, children of these children will have to be followed. A control group will be difficult to develop because of the anticipated residential mobility of the population and the potential exposure to other hazardous wastes and other environmental conditions over the life cycle. Without an adequate longitudinal study the long term impact of SAP on these children and subsequent generations will remain a mystery and subject of continued speculation. In the interim, until such studies are conducted, it would seem prudent to assume the worst and to focus on prevention.[34]

CONCLUSIONS

The present paper examined possible relationships between toxic wastes from the Stringfellow Acid Pits dump site and congenital anomalies. A comparison of areas with individual data has not yet been possible, because the Riverside County Health Department has not released the birth certificates. An analysis of individual data may or may not result in alternate conclusions. Congenital anomalies were examined in relation to various demographic and socioeconomic variables, including income, race/ethnicity, economic status, and vacancy rates.

Our analysis suggested that geographical proximity to the dump site has a significant relationship to birth defects. In fact, the area in which SAP is located had a statistically significant higher birth defect rate during 1980–82 period. Since birth certificate data tends to underreport congenital anomalies, we also investigated infant mortality. The analysis suggested that the death rate for congenital anomalies was higher in Riverside County than for California, while the state's rates were higher than the national average.

That hazards from toxic waste dumps exist and are real is at least partially confirmed by the vast number of Federal, state, and local laws that have been passed over the past several years attempting to control toxic wastes and their disposal. These laws culminated in the passage of the "Comprehensive Environmental Response, Compensation, and Liability Act of 1980," the so-called Superfund Act. These Federal laws are administered primarily by the Environmental Protection Agency (*EPA*). However, given the current climate regarding environmental concerns, it is highly likely that these laws will not be fully implemented and that chemical warfare on our society will continue during the next several decades. Since chemical warfare components can be assumed to be related to hazardous health conditions and to mutagenic effects, and because all of them are amenable to some degree of correction given contemporary technology, it is fair to ask why they still continue to exist.

APPENDIX

The major chemicals in the pits are as follows:

Trichloroethylene

TCE is a solvent that can act as an anesthetic, depressing the central nervous system. It can cause neurological impairment, liver and kidney damage and, at high concentrations, death.

Dichloromethane

Acute exposure to dichloromethane can produce narcotic effects in humans and cause nausea, lassitude, headaches, labored breathing, unconsciousness and at high levels, ultimately, death. This chemical can also have adverse and potentially lethal effects on the heart. Chronic exposure can produce behavioral and central nervous system disorders. Researchers have reported personality changes and mental depression, sometimes leading to suicide among exposed individuals.

Chloroform

Chloroform can cause liver and kidney damage. It can also cause headaches and unconsciousness and, at high exposure levels, death.

1,2-Dichloroethane

Acute exposure to 1,2-dichloroethane depresses the central nervous system and causes nausea, headaches, unconsciousness and at high exposures, death. Repeated exposure to 1,2-dichloroethane has been associated with loss of appetite, nausea, abdominal pain, injury to the liver and kidneys and neurological disorders.

Tetrachloroethylene

Tetrachloroethylene can adversely affect the human central nervous system, causing depression, nausea and at high exposure, kidney dysfunction, unconsciousness and ultimately,, death.

Cadmium

Cadmium can affect the kidneys, bones, liver, reproductive system, respiratory tract and immune system. It can interact with other metals, such as copper, iron and zinc, and can cause symptoms associated with the deficiency of such metals, such as anemia. Cadmium can accumulate in the kidneys and liver of humans.

Chromium

Some chromium compounds can cause liver and kidney damage.

Nickel

Symptoms of chronic nickel "intoxication" may include headaches, muscular weakness, cramps and visual disturbances, difficulty in breathing, cyanosis (lack of oxygen), liver and kidney damage, and at sufficient concentrations, death. Nickel compounds have been found to concentrate in embryonic tissues and to be lethal, toxic or cause malformation in embryos and fetuses in laboratory studies.

Lead

Exposure can cause a decrease in the concentration of blood protein such as hemoglobin, which transports oxygen throughout the body, and can impair the utilization of iron. Such exposure can also produce neurobiological defects, such as learning disabilities and behavioural problems in children. As exposure levels increase, stillbirths and miscarriages can occur, and severe, often irreversible, damage can develop in the blood-forming system, the nervous system, the heart and blood vessels, kidneys and liver. Lead crosses the placental membrane in humans and may affect the fetus.

Notes and References

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8. R. P. Wilcoxin, *Determination of Imminent or Substantial Endangerment, Stringfellow Hazardous Waste Site* (Sacramento, State of California, Toxic Substances Control Division, October, 1983).
9. *Press Enterprise* (Riverside Newspaper) (31 January, 1985).
10. California, Department of Health Services, "Hazardous waste sites in California—state priority ranking list" (April, 1985).
11. *Press Enterprise* (Riverside Newspaper) (21 March, 1985).
12. There is a great deal of confusion regarding the most elementary aspects of the Stringfellow acid pits. Even its size is reported differently in the same report. Wilcoxon (1983) reports its size in one section as being 17 acres and in another place in the same report it is reported to be 22 acres.
13. The major chemicals in the pits are as follows: Trichloroethylene, Dichloromethane, Chloroform, 12-Dichloroethane, Tetrachloroethylene, Cadmium, Chromium, Nickel and Lead *Press Enterprise* (Riverside Newspaper) (22 April, 1983).
14. D. Warton, UCLA, as reported in the *Press Enterprise* (22 April, 1983).

15. *Press Enterprise* (Riverside Newspaper) (30 March, 1983).
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17. *Press Enterprise* (Riverside Newspaper) (1 November, 1983).
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31. California, Department of Health Services, "Hazardous waste sites in California—state priority ranking list" (April, 1985) p. 3.
32. K. Stanton, "*EPA* accuses pesticide firm of illegal sales" *Arizona Republic* (April 27, 1985).
33. G. J. Trezek, *Engineering Case Study of the Stringfellow Superfund Site* (Office of Technology Assessment, Congress of the United States, August, 1984).
34. Other hazardous waste sites exist in California with reported birth defects (*LA Times*, 17 and 18 January, 1985). Numerous other sites exist elsewhere, with virtually none of them having been studied (*EPA,* 1982). Also, new sites are consistently being located. For example, the Norton Air Force Base site is *not* listed on any current priority list, yet it threatens the water supply of the Riverside–San Barnardino metropolitan area, and may have contaminated the Santa Ana River.