

MUNICIPAL LANDFILLS & PUBLIC HEALTH

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Most of the solid waste from our homes, businesses, schools, etc. goes to a *municipal* landfill. Highly toxic waste can go to a hazardous waste landfill. Debris from building projects and raising existing structures may go to a construction and demolition debris landfill. And incinerator or power plant residue will likely end up in fly ash landfill.

The potential public health effects of these and other landfill types differs. The focus of this document is the first category – the *municipal landfill*. Most of the adverse health effects are attributable to pollutants released to the air.

Many experts believe that 80% or more of wastes traditionally buried in a municipal landfill could be turned into marketable products via recycling, composting and other processes. In fact, a number of counties and cities have adopted [Zero Waste](#) plans for ending the need to bury or burn municipal waste over a decade or so. Ironically, one of the factors holding back efforts to end the need for landfills are landfills themselves.

In a number of cases it's cheaper to bury waste then to set up the collection and processing facilities required to recycle and compost waste then deliver it to locations where these materials can be put to constructive use. A missing factor from waste management decision-making is the public health costs of landfills. The goal of this document is to provide a starting point for those concerned about landfills to demand factoring in this cost.

In the interest of full disclosure, I am not an expert on landfills or public health. And some might say that I make money by helping those concerned about landfills. This is why I provided a link ([blue text](#)) to each of the 14 papers included in this document. I also reprinted the abstract so the reader can judge the accuracy of my *Key Relevant Findings*. Most papers include contact information for the researchers. You should feel free to contact the researchers about the relevancy of their findings to your situation.

A portion of the research addressed in the 15 papers was conducted at landfills that do not benefit from current protection measures like impermeable liners and caps, gas collection and treatment systems, and exclusion of toxic-hazardous waste. On the other hand, as liners and caps fail and collection-treatment system age, the impact of a modern landfill could come to resemble, over time, that of an older facility.

A 2003 paper noted the need to determine if, in fact, new control measures did resolve health impact concerns. It appears that the studies needed to make this determination have not been published. In a 2009 paper it was reported that odorous compounds concentrations emitted from facilities in France and Poland were affected by “failures of the landfill gas collection system, heavy truck traffic, machinery operations and compacting fresh waste.” Detection of odors has been linked to adverse health effects among those living near landfills.

Another issue affecting applicability of these papers is that a number of the landfills were located outside the U.S. Waste composition and control measures may differ in other countries. Lastly, many of the researchers who noted adverse effects called for more thorough investigations to verify their findings. Unfortunately, it appears these more rigorous studies seldom occur.

Now that all the qualifications are covered, you'll find that many of these papers noted a small but statistically significant increased risk of adverse health effects among those living up to two-miles from municipal landfills. Adverse health effects may also be experienced by those living along the route travelled by trucks hauling waste to regional landfills.

Adverse effects range from nausea to low-birth weight to cancer. The bottom line is that while we'll need landfills for the next decade or two, it is imperative that we rapidly expand recycling, composting and other approaches that reduce the need to bury 80% or more of the waste we currently landfill. Otherwise we'll simply be exposing more of our neighbors – who are likely to live in minority or low-income areas – to adverse health effects and a poorer quality of life.

Please forward any other research studies which should be included I this document to Richard Klein at Rklein@ceds.org.

Municipal Solid Waste Management and Adverse Health Outcomes: A Systematic Review

Key Relevant Findings: In this 2021 paper, 29 recent studies into the effects of municipal solid waste facilities were reviewed an international team. The principal conclusions were:

“There was some evidence of an increased risk of adverse birth and neonatal outcomes for residents near each type of MSW site [including municipal landfills]. There was also some evidence of an increased risk of mortality, respiratory diseases, and negative mental health effects associated with residing near landfills. However, in many cases, the evidence was inadequate to establish a strong relationship between a specific exposure and outcomes, and the studies rarely assessed new generation technologies. Evidence gaps remain, and recommendations for future research are discussed.”

Abstract: Municipal solid waste (MSW) can pose a threat to public health if it is not safely managed. Despite prior research, uncertainties remain and refurbished evidence is needed along with new approaches. We conducted a systematic review of recently published literature to update and expand the epidemiological evidence on the association between MSW management practices and resident populations' health risks. Studies published from January 2005 to January 2020 were searched and reviewed following PRISMA guidelines. Eligible MSW treatment or disposal sites were defined as landfills, dumpsites, incinerators, waste open burning, transfer stations, recycling sites, composting plants, and anaerobic digesters. Occupational risks were not assessed. Health effects investigated included mortality, adverse birth and neonatal outcomes, cancer, respiratory conditions, gastroenteritis, vector-borne diseases, mental health conditions, and cardiovascular diseases. Studies reporting on human biomonitoring for exposure were eligible as well. Twenty-nine studies were identified that met the inclusion criteria of our protocol, assessing health effects only associated with proximity to landfills, incinerators, and dumpsites/open burning sites. There was some evidence of an increased risk of adverse birth and neonatal outcomes for residents near each type of MSW site. There was also some evidence of an increased risk of mortality, respiratory diseases, and negative

mental health effects associated with residing near landfills. Additionally, there was some evidence of increased risk of mortality associated with residing near incinerators. However, in many cases, the evidence was inadequate to establish a strong relationship between a specific exposure and outcomes, and the studies rarely assessed new generation technologies. Evidence gaps remain, and recommendations for future research are discussed.

Relation between malodor, ambient hydrogen sulfide, and health in a community bordering a landfill

Key Relevant Findings: In this 2011 paper, researchers reported that odors from a North Carolina municipal landfill were strongly associated with alteration of daily activities like going outside, negative mood states, mucosal irritation, and upper respiratory symptoms. These adverse effects were experienced by those living at least 0.75 miles from the landfill. The researchers provided the following:

“Although newer landfills may be better designed and operated than older facilities, communities near some Subtitle D landfills continue to report problems with noise, malodor, and animal pests. In the USA (Martuzzi et al., 2010) and North Carolina (Norton et al., 2007), landfills tend to be disproportionately located in areas with lower housing value and larger concentrations of people of color. Poorer housing, lack of air conditioning and clothes dryers, and dependence on the local neighborhood for recreation, make low income communities more vulnerable to impacts of pollutants than communities with well-insulated homes where residents have the means to travel to other locations for exercise and entertainment at times when their homes and neighborhoods are affected by malodor.”

Abstract

Background: Municipal solid waste landfills are sources of air pollution that may affect the health and quality of life of neighboring communities.

Objectives: To investigate health and quality of life concerns of neighbors related to landfill air pollution.

Methods: Landfill neighbors were enrolled and kept twice-daily diaries for 14 d about odor intensity, alteration of daily activities, mood states, and irritant and other physical symptoms between Jan–Nov, 2009. Concurrently, hydrogen sulfide (H₂S) air measurements were recorded every 15-min. Relationships between H₂S, odor, and health outcomes were evaluated using conditional fixed effects regression models.

Results: Twenty-three participants enrolled and completed 878 twice-daily diary entries. H₂S measurements were recorded over a period of 80 d and 1-hr average H₂S = 0.22 ppb (SD = 0.27; range: 0–2.30 ppb). Landfill odor increased 0.63 points (on 5-point Likert-type scale) for every 1 ppb increase in hourly average H₂S when the wind was blowing from the landfill towards the community (95% confidence interval (CI): 0.29, 0.91). Odor was strongly associated with reports of alteration of daily activities (odds ratio (OR) = 9.0; 95% CI: 3.5, 23.5), negative mood states (OR = 5.2; 95% CI: 2.8, 9.6), mucosal irritation (OR = 3.7; 95% CI = 2.0, 7.1) and upper respiratory symptoms (OR = 3.9; 95% CI: 2.2, 7.0), but not positive mood states (OR = 0.6; 95% CI: 0.2, 1.5) and gastrointestinal (GI) symptoms (OR = 1.0; 95% CI: 0.4, 2.6).

Conclusions: Results suggest air pollutants from a regional landfill negatively impact the health and quality of life of neighbors.

Options for management of municipal solid waste in New York City: a preliminary comparison of health risks and policy implications

Key Relevant Findings: In this 2008 paper the researchers compared health risks of New York City Waste-To-Energy (WTE) incinerators to a regional, municipal landfill in Pennsylvania. The researchers also examined health risks among the population exposed to waste as it was transported to a regional landfill. They concluded: “The overall results indicate that the individual cancer risks for both options would be considered generally acceptable, although the risk from landfilling is approximately 5 times greater than from WTE treatment; the individual non-cancer health risks for both options would be considered generally unacceptable, although once again the risk from landfilling is approximately 5 times greater than from WTE treatment.”

Abstract: Landfill disposal and waste-to-energy (WTE) incineration remain the two principal options for managing municipal solid waste (MSW). One critical determinant of the acceptability of these options is the different health risks associated with each. In this analysis relying on published data and exposure modeling, we have performed health risk assessments for landfill disposal versus WTE treatment options for the management of New York City’s MSW. These are based on the realistic scenario of using a waste transfer station (WTS) in Brooklyn and then transporting the untreated MSW by truck to a landfill in Pennsylvania or using a WTE facility in Brooklyn and then transporting the resultant ash by truck to a landfill in Pennsylvania. The overall results indicate that the individual cancer risks for both options would be considered generally acceptable, although the risk from landfilling is approximately 5 times greater than from WTE treatment; the individual non-cancer health risks for both options would be considered generally unacceptable, although once again the risk from landfilling is approximately 5 times greater than from WTE treatment. If one considers only the population in Brooklyn that would be directly affected by the siting of either a WTS or a WTE facility in their immediate neighborhood, individual cancer and non-cancer health risks for both options would be considered generally acceptable, but risks for the former remain considerably higher than for the latter. These results should be considered preliminary due to several limitations of this study such as: consideration of risks only from inhalation exposures; assumption that only volume and not composition of the waste stream is altered by WTE treatment; reliance on data from the literature rather than actual measurements of the sites considered, assuming comparability of the sites. However, the results of studies such as this, in conjunction with ecological, socioeconomic and equity considerations, should prove useful to environmental managers, regulators, policy makers, community representatives and other stakeholders in making sound and acceptable decisions regarding the optimal handling of MSW.

Systematic review of epidemiological studies on health effects associated with management of solid waste

Key Relevant Findings: In this 2009 paper, British and Italian researchers concluded that there was limited evidence that those living within two kilometers (1.2 miles) of old landfills were at higher

risk for congenital anomalies and low birth weight based on peer-reviewed literature published between 1983 and 2008.

Abstract

Background: Management of solid waste (mainly landfills and incineration) releases a number of toxic substances, most in small quantities and at extremely low levels. Because of the wide range of pollutants, the different pathways of exposure, long-term low-level exposure, and the potential for synergism among the pollutants, concerns remain about potential health effects but there are many uncertainties involved in the assessment. Our aim was to systematically review the available epidemiological literature on the health effects in the vicinity of landfills and incinerators and among workers at waste processing plants to derive usable excess risk estimates for health impact assessment.

Methods: We examined the published, peer-reviewed literature addressing health effects of waste management between 1983 and 2008. For each paper, we examined the study design and assessed potential biases in the effect estimates. We evaluated the overall evidence and graded the associated uncertainties.

Results: In most cases the overall evidence was inadequate to establish a relationship between a specific waste process and health effects; the evidence from occupational studies was not sufficient to make an overall assessment. For community studies, at least for some processes, there was limited evidence of a causal relationship and a few studies were selected for a quantitative evaluation. In particular, for populations living within two kilometres of landfills there was limited evidence of congenital anomalies and low birth weight with excess risk of 2 percent and 6 percent, respectively. The excess risk tended to be higher when sites dealing with toxic wastes were considered. For populations living within three kilometres of old incinerators, there was limited evidence of an increased risk of cancer, with an estimated excess risk of 3.5 percent. The confidence in the evaluation and in the estimated excess risk tended to be higher for specific cancer forms such as non-Hodgkin's lymphoma and soft tissue sarcoma than for other cancers.

Conclusions: The studies we have reviewed suffer from many limitations due to poor exposure assessment, ecological level of analysis, and lack of information on relevant confounders. With a moderate level confidence, however, we have derived some effect estimates that could be used for health impact assessment of old landfill and incineration plants. The uncertainties surrounding these numbers should be considered carefully when health effects are estimated. It is clear that future research into the health risks of waste management needs to overcome current limitations.

Health hazards and waste management

Key Relevant Findings: In this 2003 literature review of 48 studies, a British researcher found there was insufficient information to assess the effect of new waste disposal technologies on mitigating health impacts.

Abstract: Different methods of waste management emit a large number of substances, most in small quantities and at extremely low levels. Raised incidence of low birth weight births has been related to residence near landfill sites, as has the occurrence of various congenital malformations. There is little evidence for an association with reproductive or developmental effects with proximity

to incinerators. Studies of cancer incidence and mortality in populations around landfill sites or incinerators have been equivocal, with varying results for different cancer sites. Many of these studies lack good individual exposure information and data on potential confounders, such as socio-economic status. The inherent latency of diseases and migration of populations are often ignored. Waste management workers have been shown to have increased incidence of accidents and musculoskeletal problems. The health impacts of new waste management technologies and the increasing use of recycling and composting will require assessment and monitoring.

[Analysis of odorous compounds at municipal landfill sites](#)

Key Relevant Findings: In this 2009 paper, researchers reported that odorous compound concentrations from facilities in France and Poland were affected by “failures of the landfill gas collection system, heavy truck traffic, machinery operations and compacting fresh waste.”

Abstract: The aim of this investigation was to determine odorous compounds in the air over the landfill sites in France and Poland. Air samples were collected by passive and dynamic methods of preconcentration analytes and analysed by GC-MS and GC-FID. The coupling μ TD- μ GC-MS was also used for on-site analysis of odorous compounds. The achieved results indicated that the concentrations of odorants in the air varied and strongly depended on the sampling site. The highest concentrations were observed at the points situated near biogas wells and above the fresh waste layer. The concentrations were influenced by landfill activities such as failures of the landfill gas collection system, heavy truck traffic, machinery operations and compacting fresh waste.

[Health Effects of Residence Near Hazardous Waste Landfill Sites: A Review of Epidemiologic Literature](#)

Key Relevant Findings: In this 2000 paper, a British researcher reviewed 76 epidemiologic studies and noted that a hazardous waste landfill can pose a greater threat to public health than one accepting only municipal waste. However, it is unclear whether the studies included in this literature review were focused on landfills in general or just those restricted to hazardous waste. While increased symptoms of adverse health effects – fatigue, sleepiness, headaches - were reported by those living near landfills, the researcher noted the need for more rigorous study.

Abstract: This review evaluates current epidemiologic literature on health effects in relation to residence near landfill sites. Increases in risk of adverse health effects (low birth weight, birth defects, certain types of cancers) have been reported near individual landfill sites and in some multisite studies, and although biases and confounding factors cannot be excluded as explanations for these findings, they may indicate real risks associated with residence near certain landfill sites. A general weakness in the reviewed studies is the lack of direct exposure measurement. An increased prevalence of self-reported health symptoms such as fatigue, sleepiness, and headaches among residents near waste sites has consistently been reported in more than 10 of the reviewed papers. It is difficult to conclude whether these symptoms are an effect of direct toxicologic action of chemicals present in waste sites, an effect of stress and fears related to the waste site, or an effect of reporting bias. Although a substantial number of studies have been conducted, risks to health from landfill sites are hard to quantify. There is insufficient exposure information and effects of low-level

environmental exposure in the general population are by their nature difficult to establish. More interdisciplinary research can improve levels of knowledge on risks to human health of waste disposal in landfill sites. Research needs include epidemiologic and toxicologic studies on individual chemicals and chemical mixtures, well-designed single- and multisite landfill studies, development of biomarkers, and research on risk perception and sociologic determinants of ill health.

Influence of a municipal solid waste landfill in the surrounding environment: Toxicological risk and odor nuisance effects

Key Relevant Findings: In this 2014 paper, Italian researchers reviewed the findings from 61 other studies and noted the possibility that area residents would be exposed to potentially toxic compounds and nuisances such as odors. The researchers studied emissions from a landfill located in Italy. They found that risks for cancer and non-cancer were orders of magnitude below World Health Organization acceptable levels.

Abstract: The large amounts of treated waste materials and the complex biological and physicochemical processes make the areas in the proximity of landfills vulnerable not only to emissions of potential toxic compounds but also to nuisance such as odor pollution. All these factors have a dramatic impact in the local environment producing environmental quality degradation. Most of the human health problems come from the landfill gas, from its non-methanic volatile organic compounds and from hazardous air pollutants. In addition, several odorants are released during landfill operations and uncontrolled emissions. In this work we present an integrated risk assessment for emissions of hazard compounds and odor nuisance, to describe environmental quality in the landfill proximity. The study was based on sampling campaigns to acquire emission data for polychlorinated dibenzo-p-dioxins and dibenzofurans, dioxin-like polychlorobiphenyls, polycyclic aromatic hydrocarbons, benzene and vinyl chloride monomer and odor. All concentration values in the emissions from the landfill were measured and used in an air dispersion model to estimate maximum concentrations and depositions in correspondence to five sensitive receptors located in proximity of the landfill. Results for the different scenarios and cancer and non-cancer effects always showed risk estimates which were orders of magnitude below those accepted from the main international agencies (WHO, US EPA). Odor pollution was significant for a limited downwind area near the landfill appearing to be a significant risk factor of the damage to the local environment.

Environmental Stressors: The Mental Health Impacts of Living Near Industrial Activity

Key Relevant Findings: In this 2005 paper, researchers used U.S. Census and Toxic Release Inventory data to assess the mental health effects of living near a number of “industrial activities” including landfills. The researchers found that living close to industrial activities has a negative impact on mental health. They also found the impact is greater for minorities and the poor.

Abstract: A growing literature examines whether the poor, the working class, and people of color are disproportionately likely to live in environmentally hazardous neighborhoods. This literature assumes that environmental characteristics such as industrial pollution and hazardous waste are detrimental to human health, an assumption that has not been well tested. Drawing upon the

sociology of mental health and environmental inequality studies, we ask whether industrial activity has an impact on psychological well-being. We link individual-level survey data with data from the U.S. Census and the Toxic Release Inventory and find that residential proximity to industrial activity has a negative impact on mental health. This impact is both direct and mediated by individuals' perceptions of neighborhood disorder and personal powerlessness, and the impact is greater for minorities and the poor than it is for whites and wealthier individuals. These results suggest that public health officials need to take seriously the mental health impacts of living near industrial facilities.

[Public perception of odour and environmental pollution attributed to MSW treatment and disposal facilities: A case study](#)

Key Relevant Findings: In this 2013 paper, researchers reported that once an Italian landfill closed area residents reported fewer odors.

Abstract: If residents' perceptions, concerns and attitudes towards waste management facilities are either not well understood or underestimated, people can produce strong opposition that may include protest demonstrations and violent conflicts such as those experienced in the Campania Region of Italy. The aim of this study was to verify the effects of the closure of solid waste treatment and disposal facilities (two landfills and one RDF production plant) on public perception of odour and environmental pollution. The study took place in four villages in Southern Italy. Identical questionnaires were administered to residents during 2003 and after the closure of the facilities occurred in 2008. The residents' perception of odour nuisance considerably diminished between 2003 and 2009 for the nearest villages, with odour perception showing an association with distance from the facilities. Post closure, residents had difficulty in identifying the type of smell due to the decrease in odour level. During both surveys, older residents reported most concern about the potentially adverse health impacts of long-term exposure to odours from MSW facilities. However, although awareness of MSW facilities and concern about potentially adverse health impacts varied according to the characteristics of residents in 2003, substantial media coverage produced an equalisation effect and increased knowledge about the type of facilities and how they operated. It is possible that residents of the village nearest to the facilities reported lower awareness of and concern about odour and environmental pollution because the municipality received economic compensation for their presence.

[Residential Proximity to Environmental Hazards and Adverse Health Outcomes](#)

Key Relevant Findings: This 2011 paper, presented a review of the numerous environmental hazards – including landfills – that may adversely affect public health. The authors concluded: “Government agencies should consider these findings in establishing rules and permitting and enforcement procedures to reduce pollution from environmentally burdensome facilities and land uses.”

Abstract: How living near environmental hazards contributes to poorer health and disproportionate

health outcomes is an ongoing concern. We conducted a substantive review and critique of the literature regarding residential proximity to environmental hazards and adverse pregnancy outcomes, childhood cancer, cardiovascular and respiratory illnesses, end stage renal disease, and diabetes. Several studies have found that living near hazardous wastes sites, industrial sites, cropland with pesticide applications, highly trafficked roads, nuclear power plants, and gas stations or repair shops is related to an increased risk of adverse health outcomes. Government agencies should consider these findings in establishing rules and permitting and enforcement procedures to reduce pollution from environmentally burdensome facilities and land uses.

[Health Studies Related to Landfill Gas Exposures \(Appendix C in Landfill Gas Primer - An Overview for Environmental Health Professionals\)](#)

The following caution appears in the webpage for this publication: *This document is provided by the Agency for Toxic Substances and Disease Registry (ATSDR) ONLY as an historical reference for the public health community. It is no longer being maintained and the data it contains may no longer be current and/or accurate.*

Key Relevant Findings: In this 2001 report, five studies were summarized.

1. Study of Reproductive Effects from Exposure to Landfill Gas, Montreal, Canada:

Researchers found that there were elevated instances of low birth weight and smallness for gestational age in the areas where exposure was assumed. No increase in instances of very low birth weight or premature birth was found. The researchers could not definitively conclude whether low birth weight and smallness for gestational age are associated with exposure to landfill gas.

2. Study of Cancer Incidences Surrounding a Municipal Solid Waste Landfill, Montreal, Canada:

A statistical analysis found that among men living in the exposure zone closest to the site, elevated risks were observed for cancers of the prostate, stomach, liver, and lungs. Among women, rates of stomach cancer and cervix uteri cancer were elevated, but breast cancer incidence was less than expected. The researchers, therefore, were unable to assess cancer incidence directly in relation to landfill gas concentrations. Because of the lack of environmental data and other limiting factors, the researchers stated that they were unable to conclude whether the excess cancer risks found in this study represent true associations with exposure to landfill gas or other factors. The finding most consistent with the earlier study was the excess risk of liver cancers in high-exposure zones. Without actual exposure data, no strong conclusions can be drawn, but investigators controlled for other risk factors (e.g., alcohol consumption, hepatitis-B virus) and noted the presence of vinyl chloride (a recognized liver carcinogen) in the landfill gas collection system.

3. Study of Cancer Incidences Surrounding Municipal Solid Waste Landfills, New York State:

These landfills were not lined or capped as they would be if constructed today because New York State and the federal governments did not begin regulating landfills until 1973 and 1976, respectively. Gas collection systems had been installed in 22 of the study landfills at the time of the NYSDOH study. By the end of the 1980s, only three of the study landfills were operating; currently none are active. Using a statistical comparison of these results, this study found a statistically significant four-fold elevation of risk for bladder cancer and leukemia for women living in the areas

of potential exposure. These results should be viewed with consideration of the study's limitations, including the lack of exposure (type and duration of exposure) and possible confounding factors. NYDOH concluded that this study does not prove that there is a relationship between living very close to the landfill and female bladder cancer and leukemia. But the study does suggest that there may be an increased risk for these cancers for women who lived within 250 feet of the landfills during the 1960s and 1970s, based on the reporting dates of cancer incidence and the expected latency period. Since the 1960s and 1970s, when individuals may have been exposed, cleanup efforts have changed the conditions at New York State landfills.

4. A Panel Study of Respiratory Outcomes, Staten Island, New York: ATSDR concluded that the results of this study suggest that the perception of odors is associated with worsening of respiratory symptoms of some people in the study group.

5. Risk of Congenital Anomalies Near Hazardous Waste Landfill Sites in Europe: The EUROHAZCON study concluded that there was a small, but significant, increased risk of birth defects to babies whose mothers lived within 3 km of a hazardous waste landfill. Another, potentially more important confounding factor is the presence of other industrial sites or toxic exposures near landfill sites.

Risk of adverse birth outcomes in populations living near landfill sites

Key Relevant Findings: In this 2001 paper, British researchers reported a small excess risk of congenital anomalies and low and very low birth weight in populations living within 2 kilometers (1.2 miles) of municipal landfills.

Abstract

Objective To investigate the risk of adverse birth outcomes associated with residence near landfill sites in Great Britain.

Design Geographical study of risks of adverse birth outcomes in populations living within 2 km of 9565 landfill sites operational at some time between 1982 and 1997 (from a total of 19 196 sites) compared with those living further away.

Setting Great Britain.

Subjects Over 8.2 million live births, 43 471 stillbirths, and 124 597 congenital anomalies (including terminations).

Main outcome measures All congenital anomalies combined, some specific anomalies, and prevalence of low and very low birth weight (< 2500 g and < 1500 g). Results For all anomalies combined, relative risk of residence near landfill sites (all waste types) was 0.92 (99% confidence interval 0.907 to 0.923) unadjusted, and 1.01 (1.005 to 1.023) adjusted for confounders. Adjusted risks were 1.05 (1.01 to 1.10) for neural tube defects, 0.96 (0.93 to 0.99) for cardiovascular defects, 1.07 (1.04 to 1.10) for hypospadias and epispadias (with no excess of surgical correction), 1.08 (1.01 to 1.15) for abdominal wall defects, 1.19 (1.05 to 1.34) for surgical correction of gastroschisis and exomphalos, and 1.05 (1.047 to 1.055) and 1.04 (1.03 to 1.05) for low and very low birth weight respectively. There was no excess risk of stillbirth. Findings for special (hazardous) waste sites did not differ systematically from those for non-special sites. For some specific anomalies, higher risks

were found in the period before opening compared with after opening of a landfill site, especially hospital admissions for abdominal wall defects.

Conclusions We found small excess risks of congenital anomalies and low and very low birth weight in populations living near landfill sites. No causal mechanisms are available to explain these findings, and alternative explanations include data artefacts and residual confounding. Further studies are needed to help differentiate between the various possibilities.

Risk of congenital anomalies after the opening of landfill sites

Key Relevant Findings: In this 2005 paper, British researchers reported an increased risk of births with congenital malformations among those living within 4 kilometers (2.4 miles) of landfills. The researchers cautioned though: "Causal inferences are difficult because of possible biases from incomplete case ascertainment, lack of data on individual-level exposures, and other socioeconomic and lifestyle factors that may confound a relationship with area of residence."

Abstract: Concern that living near a particular landfill site in Wales caused increased risk of births with congenital malformations led us to examine whether residents living close to 24 landfill sites in Wales experienced increased rates of congenital anomalies after the landfills opened compared with before they opened. We carried out a small-area study in which expected rates of congenital anomalies in births to mothers living within 2 km of the sites, before and after opening of the sites, were estimated from a logistic regression model fitted to all births in residents living at least 4 km away from these sites and hence not likely to be subject to contamination from a landfill, adjusting for hospital catchment area, year of birth, sex, maternal age, and socioeconomic deprivation score. We investigated all births from 1983 through 1997 with at least one recorded congenital anomaly [International Classification of Diseases, Ninth Revision (ICD-9), codes 7400–7599; International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10), codes Q000–Q999]. The ratio of the observed to expected rates of congenital anomalies before landfill opened was 0.87 [95% confidence interval (CI), 0.75–1.00], and this increased to 1.21 (95% CI, 1.04–1.40) after opening, giving a standardized risk ratio of 1.39 (95% CI, 1.12–1.72). Enhanced congenital malformation surveillance data collected from 1998 through 2000 showed a standardized risk ratio of 1.04 (95% CI, 0.88–1.21). Causal inferences are difficult because of possible biases from incomplete case ascertainment, lack of data on individual-level exposures, and other socioeconomic and lifestyle factors that may confound a relationship with area of residence. However, the increase in risk after the sites opened requires continued enhanced surveillance of congenital anomalies, and site-specific chemical exposure studies.

Adverse pregnancy outcomes near landfill sites in Cumbria, northwest England, 1950-1993

Key Relevant Findings: In this 2003 paper, British researchers reported an increased risk of death from "other congenital anomalies of nervous system" for those living near a landfill.

Abstract: Although several researchers have addressed the risk of congenital anomaly in relation to proximity to landfill sites, few have considered the risks of stillbirth or neonatal death for mothers who reside near landfills. The authors studied all 4,325 stillbirths, 3,430 neonatal deaths, and 1,569

lethal congenital anomalies that occurred among 287,993 births to mothers residing in Cumbria, northwest England, during the years 1950 to 1993. Logistic regression models, with data stratified by time period and adjusted for subject-specific demographic factors, were used to investigate the risk for each outcome in regard to proximity at birth to landfill sites within Cumbria. For the years 1970-1993, a small but significantly increased risk of death from "Other congenital anomalies of nervous system" (International Classification of Diseases, 9th rev. [ICD-9], code 742) was found in children of mothers living near domestic waste landfill sites. There was no increased risk of any other lethal adverse pregnancy outcome associated with residence near the landfills studied. The authors' finding of increased risk of death from "Other congenital anomalies of nervous system" closer to landfill sites (e.g., continuous odds ratio = 1.14 [95% confidence interval = 1.03, 1.25] for increasing proximity to landfill sites during 1976-1993) was consistent with findings of other researchers; however, a causal effect could not be inferred from this statistical association, and the possibility that this was a chance finding (in view of multiple significance testing) could not be excluded. Further research incorporating actual pollution data collected around landfill sites and the examination of both lethal and nonlethal congenital anomalies is recommended.

[Incidence of cancer among persons living near a municipal solid waste landfill site in Montreal, Québec](#)

Key Relevant Findings: In this 1995 paper, Canadian researchers reported an elevated risk of cancer among those living in the landfill vicinity.

Abstract: The Miron Quarry municipal solid waste landfill site in Montreal, Quebec, generates copious quantities of methane and other gases, including a rich mixture of volatile organic compounds, some of which are recognized or suspected human carcinogens. The site is the third largest in North America and is located in the center of a densely populated area. Using data from the Quebec Tumour Registry, we conducted Poisson regression analyses to evaluate whether cancer incidence among persons who lived near the site was higher than expected. Potential exposure to ambient air pollutants from the site was defined in terms of a set of geographic exposure zones proximal to the site. A set of reference areas distal from the site was selected to be similar to these exposure zones with respect to several key sociodemographic factors. Risk ratios (RRs) were adjusted for age and calendar year. Among men living in the exposure zone closest to the site, elevated risks were observed for cancers of the stomach (RR 1.3, 95% confidence interval [95% CI] = 1.0-1.5); liver and intrahepatic bile ducts (RR = 1.3, 95% CI = 0.9-1.8); and trachea, bronchus, and lung (RR = 1.1, 95% CI = 1.0-1.2). Among women, rates of stomach cancer (RR = 1.2; 95% CI = 0.9-1.5) and cervix uteri cancer were elevated (RR = 1.2, 95% CI = 0.9-1.5), but breast cancer incidence was less than expected (RR = 0.9, 95% CI = 0.9-1.0). Prostate cancer was also elevated in one of the proximal exposure subzones (RR = 1.2, 95% CI = 1.0-1.4). Further studies at this and at other landfill sites are needed to confirm or refute these observations.