TECHNICAL BACKGROUND DOCUMENT

POPULATION RISKS FROM INDIRECT EXPOSURE PATHWAYS, AND POPULATION EFFECTS FROM EXPOSURE TO AIRBORNE PARTICLES FROM CEMENT KILN DUST WASTE

Office of Solid Waste
U.S. Environmental Protection Agency

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INTRODUCTION AND OVERALL FINDINGS

1.1 INTRODUCTION

This Technical Background Document analyzes the extent to which current practices for managing cement kiln dust (CKD) onsite at cement manufacturing plants pose a health risk to nearby, offsite populations. The study focuses on: (1) population risks from indirect, or foodchain, exposure pathways; and (2) population effects from exposure to airborne particles. This work builds on earlier CKD analyses focusing on the health risks to maximally exposed individuals, presented in the 1993 Report to Congress (RTC) on CKD[1] and supporting documentation,[2] the 1994 Notice of Data Availability (NODA) on CKD,[3] and a background document supporting the 1995 CKD Regulatory Determination.[4]

The assessment of population risks from indirect exposure, presented in Chapter 2, estimates the number of cancer cases and the number of people potentially exposed above noncancer effect thresholds through the ingestion of vegetables, beef and milk, and fish near cement plants. This assessment starts by eliminating from concern those facilities that have negligible potential for significant population risk, based on previous estimates of individual risk at a sample of 82 facilities. For remaining facilities, population risk for the vegetable ingestion pathway is calculated by combining prior estimates of individual risk with estimates of nearby farmers and backyard gardeners determined using census data. Population risk for the fish ingestion pathway is estimated using the prior individual risk estimates along with numbers of recreational fishers that could be exposed, calculated based on fish yield data from local streams. This chapter also includes a discussion of the major uncertainties and limitations associated with the assessment of population risks from indirect exposure.

The assessment of population effects from exposure to airborne particles, presented in Chapter 3, estimates the number of people potentially exposed to fugitive CKD at levels above the National Ambient Air Quality Standards (NAAQS) for particulate matter. Both the existing NAAQS for coarse particles and a new NAAQS proposed for fine particles are considered. New modeling of CKD emissions and downwind dispersion is performed for selected "high risk" cement plants, substantially improving on the previous work by using a more sophisticated model, estimating emissions from all CKD handling stages rather than just final disposal as modeled previously, and considering the effect of terrain, among other refinements. The concentrations of airborne particles are then overlaid on census block grids to estimate populations potentially exposed above the NAAQS. This chapter also includes a discussion of the major uncertainties and limitations associated with the assessment of population risks due to exposure to airborne particles.

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[1] *Report to Congress on Cement Kiln Dust.* EPA Office of Solid Waste, December 1993.

[2] *Technical Background Document: Human Health and Environmental Risk Assessment in Support of the Report to Congress on Cement Kiln Dust Waste.* EPA Office of Solid Waste, December 1993.

[3] *Technical Background Document for the Notice of Data Availability on Cement Kiln Dust: Human Health and Environmental Risk Assessment in Support of the Regulatory Determination on Cement Kiln Dust.* EPA Office of Solid Waste, August 31, 1994.

[4] *Technical Background Document on Potential Risks of Cement Kiln Dust in Support of the Cement Kiln Dust Regulatory Determination.* EPA Office of Solid Waste, January 31, 1995.

1.2 OVERALL FINDINGS

The overall results of EPA's effort to characterize risks via indirect exposure pathways to populations living near cement facilities are summarized in Exhibit 1-1. Results shown are for the "most reasonable" estimates of risks extrapolated to the entire universe of cement plants; the bounds on the most reasonable estimates are discussed in Section 2.4.3 of Chapter 2.

The Agency estimates that exposures via indirect pathways occurring in populations within five miles of all cement plants nationwide potentially result in a total of 0.04 excess cancer cases over a 70-year period. That is, exposures would potentially lead to about 0.009 excess cancer cases in the subsistence farmer population, and about 0.03 excess cancer cases in the "homegrown" population. (Cancer cases predicted for the recreational fisher population are negligible.) The total population within five miles of all cement facilities nationwide is approximately 3.4 million.[5] Thus, the overall population cancer risk can be characterized as follows: *a total of 0.0006 excess cancer cases per year could potentially occur within this population of 3.4 million due to indirect exposures.*

Population Risk Terminology

EPA uses in this document the terminology "population cancer risk" and "population noncancer effects," to be consistent with existing EPA guidance, in particular the March 21, 1995 memorandum from the EPA Administrator entitled *Policy for Risk Characterization at the U.S. EPA*. In this document EPA uses three specific terms: (i) "population cancer risk" to denote "excess cancer incidence," i.e., the number of excess cancer cases in the exposed population over a 70-year period; (ii) "population noncancer effects" to denote the number of persons exposed to levels above the thresholds for noncancer effects; and (iii) "population risk" as a loose, collective term to refer to both population cancer risk and population noncancer effects (recognizing that noncancer effects are not equivalent to probabilistic risks, per se).

In terms of population noncancer effects EPA predicts that, across all populations within five miles of all cement facilities nationwide, a total of about 1,040 people are potentially exposed via indirect exposure pathways to contaminant levels above the hazard index.[6] That is, about 6 individuals from the homegrown vegetable population are exposed to contamination exceeding noncancer effects thresholds (i.e., hazard index greater than 1). At the same time, about 37 individuals from the subsistence farmer population and about 1,000 individuals from the recreational fisher population are estimated to be exposed to contamination exceeding noncancer effects thresholds. The overall population noncancer effects can be characterized as follows: *a total of about 1,040 people, or less than one-tenth of one percent, from among the population of 3.4 million within five miles of all cement plants nationwide is likely to be exposed via indirect exposure pathways to contamination exceeding noncancer effects thresholds.*

Note that the noncancer population effects estimates should not be interpreted as "cases;" instead, the estimates should be viewed simply as the number of people with exposures above the noncancer effects thresholds, or hazard index of 1. Unlike the estimates for population cancer risk, the

[5] This is an estimate based on site-specific data for 61 facilities and extrapolated data for the remaining 47 facilities.

[6] This total assumes that the three receptor populations, i.e., the subsistence farmer, "homegrown," and recreational fisher populations, are independent and there is no overlap of exposures among the populations.

Exhibit 1-1
Estimated Population Risks[7] from Indirect Exposures to CKD

	No. of Facilities (percent of all cement plants nationwide)	Population Cancer Risks (i.e., number of excess cancer cases)			Potential Population Noncancer Effects (i.e., number of people potentially exposed to levels above the threshold for noncancer effects)		
		"Homegrown" Population	Subsistence Farmer Population	Recreational Fisher Population	"Homegrown" Population	Subsistence Farmer Population	Recreational Fisher Population
No population effects because facility does not generate net CKD	22 (20 percent)	0	0	0	0	0	0
Negligible[a] population risks estimated by Tier 1 screening	31 (29 percent)	0	0	0	0	0	0
Population risks estimated based on Tier 2 methodology	29[b] (27 percent)	0.02	0.006	0	4	25	670[c]
Population risks estimated based on extrapolation from "known universe"[d]	26 (24 percent)	0.01	0.003	0	2	12	330
TOTAL	**108**	**0.03**	**0.009**	**0**	**6**	**37**	**1,000**

[a] For Tier 1 screening, negligible risks mean the facilities (i) had facility-specific population cancer risks equal to zero or risks so low that they did not contribute significantly to the total population cancer risk across facilities in the Tier 1 screening, or (ii) had facility-specific population noncancer effects equal to zero.
[b] A total of 26 facilities for the subsistence farmer and homegrown" populations and 4 facilities for the recreational fisher population (1 facility is common to both sets).
[c] For the fish ingestion pathway, Tier 2 analysis needed to be conducted for only 4 facilities.
[d] The results presented here represent the "most reasonable" risk estimates based on extrapolation to the full universe of facilities; see Exhibit 2-9 for estimated ranges.

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[7] As explained in Chapter 2, page 2-9, EPA uses in this document the term "population risk" as a loose, collective term to refer to both population cancer risk and population noncancer effects. Population cancer risk is used to denote "excess cancer incidence," i.e., the number of excess cancer cases in the exposed population, and population noncancer effects is used to denote the number of persons exposed to levels above the thresholds for noncancer effects.

noncancer population effects estimates are not based on probabilistic individual risk estimates. One can predict neither how many of these individuals would actually have adverse noncancer effects as a result of these exposures, nor when these effects are likely to occur in relation to the exposure duration. Also, one cannot compare *directly* the estimates for population cancer risks and population noncancer effects. That is, although the estimates for noncancer population effects are numerically higher (because all the people exposed above a certain contaminant level are counted), the actual number of people exhibiting the effects will most likely be lower, by an unknown amount, than those counted as being exposed above the effects-based reference level. The estimate of 1,040 for potential noncancer population effects, therefore, should not be viewed as necessarily being several orders of magnitude higher than the estimate of 0.04 excess cancer cases.

As shown in Exhibit 1-1, all the population cancer risks and population noncancer effects appear to be due primarily to 55 cement facilities nationwide; the remaining cement facilities (about 50 percent of total) have negligible population risks for the indirect exposure pathways. Of the 55 facilities contributing to total population risks, 29 had risk estimates derived in the Tier 2 analysis and the remaining had risk estimates derived based on extrapolation. For the 29 facilities evaluated in Tier 2, none individually had population cancer risks equal to or greater than one cancer case over 70 years. In contrast, a total of 10 facilities had potential population noncancer effects of significance, i.e., one or more people with exposures above the noncancer effects thresholds. These 10 facilities include seven for the subsistence farmer and "homegrown" populations, and four for the recreational fisher population (with one facility in common between the recreational fisher and the other populations).

Because the population risks for the subsistence farmer and homegrown vegetable populations are estimated initially based on the number of people living within five miles of the facilities, it is important to describe in socio-economic terms the exposed populations for these seven facilities. Census block-level data for socio-economic characteristics were available for six of these seven facilities, and are summarized in Exhibit 1-2 (comparisons to county-, state-, and national-level data are also provided). The socio-economic findings indicate that there is no definite trend across all the facilities with respect to whether certain types of subpopulations are more at risk than others. Nevertheless, the findings do indicate that, for some facilities, the population risks are concentrated within certain subpopulations (i.e., low-income or minority populations). For example, two facilities (facilities 29 and 60) have higher minority percentages for the five-mile radius than do the county or the state as a whole. Similarly, for the populations living within five miles of facilities 29, 30, 55, and 60, a given household earns less on average than the average American household. Particularly for the vicinities of facilities 55 and 60, a given household earns less on average when compared to average household in the county and the state as well. Facility 29 appears to be located in a relatively poor county, where there is a greater percentage of people living below poverty level for the five miles surrounding facility 29 than there is in the state as a whole.

In terms of population effects due to exposure to airborne particulate matter released from CKD waste management activities, EPA characterized the numbers of residents around cement plants who are exposed to ambient PM_{10} and $PM_{2.5}$ concentrations above the respective NAAQS. The Agency estimated that about 18 people living around 82 cement plants may be exposed to airborne

Exhibit 1-2
Socio-economic Characteristics of Exposed Populations Within 5 Miles

Facility I.D.	Location	Percent minority	Median annual household income	Percent below the poverty level
United States	United States	19.71	$30,056	13.12
29	State	9.91	$27,291	11.48
	County	9.83	$20,864	15.68
	5-mile radius	10.32	$24,131	14.98
30	State	17.87	$23,577	16.71
	County	17.21	$17,945	21.75
	5-mile radius	15.73	$25,547	15.04
55	State	12.33	$26,362	13.34
	County	24.38	$27,853	13.04
	5-mile radius	5.81	$26,177	11.48
60	State	3.37	$26,229	11.48
	County	2.13	$25,116	8.92
	5-mile radius	3.71	$24,833	9.49
62	State	29.02	$39,386	8.27
	County	6.86	$41,382	4.83
	5-mile radius	3.60	$36,465	4.67
66	State	11.46	$29,069	11.13
	County	5.80	$32,890	7.31
	5-mile radius	2.25	$39,106	3.12

Note: "Percent minority" includes people of Black, American Indian, Eskimo, Aleut, Asian, or Hispanic origin.

PM concentrations in excess of the NAAQS.[8] It is not known what percentage of the population exposed above the NAAQS is likely to develop any morbid effects because the dose-response relationship for PM exposures is not well defined. In essence, the population effects results are being driven by a very small number of facilities because the 18 people are estimated to be those living within 100 or 200 meters of two cement plants. All the other facilities in the universe analyzed were predicted to have zero population effects either because there are no residences within 100, 200, or 500 meters (44 facilities), CKD is watered and unlikely to be emitted at levels above the NAAQS (three facilities), or site-specific modeling and analysis indicate that no people live in areas where the NAAQS are exceeded (three facilities). As with the indirect exposures analysis, EPA derived a more complete picture of potential population effects due to PM exposures by extrapolating from results within the known universe to determine the potential population effects for the full universe of cement

[8] The estimate of 18 people is based on an evaluation of 52 of the 82 cement facilities; based on analyses conducted previously, the remaining 30 facilities were determined to have zero or negligible effects in terms of PM exposures because they do not manage CKD on-site (see methodology and results presented in *Technical Background Document on Potential Risks of Cement Kiln Dust in Support of the Cement Kiln Dust Regulatory Determination*, January 31, 1995).

facilities. In sum, EPA estimated that, across all 108 facilities, a total of between *18* and *4,118* people living within 500 meters of the facility boundary may be exposed to airborne PM concentrations in excess of the NAAQS, with the best estimate being *2,378* people.