

Assessment of Environmental Impacts of the Holcim Cement—Dundee Plant, Dundee, Michigan

Ecology Center

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Environmental Impact of Holcim—Dundee Plant

The Ecology Center has been working with community members to mitigate the impact of the Holcim Cement—Dundee Plant on the surrounding community for many years. Much of this work has focused on addressing the impact of Holcim's air emissions, which place the plant as one of the top polluters in the state. However, the plants impacts go far beyond air pollution.

These impacts are significant and varied, but include the impact of blasting in the quarry on the peace of mind of residents and the integrity of their homes; the impact of Holcim's large water withdrawals on local aquifers and surrounding streams; and the impact of hundred of trucks a day on local roads. Many local residents have in the past and will no doubt in the future continue to raise these issues.

The focus of this document is to assess the overall impact of Holcim's operations on the SE Michigan regions air quality. Equally important is the very real potential that these impacts will be made worse with the current proposal to burn 79 different types of waste materials at the plant.

Since, the final waste burning permit was only recently public noticed we have not yet conducted technical review of the final proposed permit. As such, this document represents an initial assessment of the plants environmental impact and reviews some of the potential impacts of burning waste materials at the plant. Ultimately we are asking the company to step forward, be a good neighbor and make real investments in the long term sustainability of this plant, not the bottom line profits of the company.

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ENERGY CONSUMPTION AND GLOBAL WARMING ISSUES

Holcim's cement production using the wet process at the Dundee location is no longer environmentally sustainable and economically competitive as it uses a third more energy per ton of clinker than many of the modern dry process plants that are now predominant in Europe and Japan. The dry process has also become the dominant trend in the U.S. cement industry. Since energy use is directly coupled with CO₂ emission, the Dundee plant emits roughly a third more carbon dioxide for fuel use than dry process-based plants.

In addition to CO₂ emissions from fuel combustion and calcination of limestone, the Dundee plant is also permitted to emit 7,200 tons per year of VOC's that originate from its unique source of limestone containing kerogen hydrocarbons. The global warming potential of such hydrocarbons exceeds that of CO₂ by a factor of eleven. Thus, 7,200 tpy of VOC's are equivalent to approximately 80,000 tpy of CO₂ in terms of global warming potential.

Table 1: Global Warming Potential of Selected chemicals

CHEMICAL	GWP
carbon dioxide	1
methane	21
VOC's (average)	11

Due to atmospheric photochemical activity, VOC's undergo oxidation and, intermittently lead to the formation of products of incomplete combustion (PIC's), often coupled with sharply increased toxicity.

e.g. CH_3OH (methanol) Plus (UV light, heat, oxygen) = HCHO (formaldehyde)

Under favorable climatic conditions and in the presence of nitrogen oxides (NO_x), (the company is also permitted to emit 3,377 ton per year of NO_x) VOC's in the atmosphere lead to the generation of highly toxic ground level ozone and products of incomplete combustion (PIC's):

VOC's + NO_x (heat, UV) = O₃ + PIC's

It must be noted that while a significant portion of the plant's carbon dioxide emission can be avoided by converting to a dry process, this conversion will not eliminate the VOC problem. Michigan DEQ does not currently require pollution control for these VOC's at this plant. However, due to enforcement action from the Michigan DEQ, the company agreed to "voluntarily" employ a scrubber/oxidizer system for this purpose. This system has been noted for being notoriously malfunctioning, and, since not being required by regulation, its use is not enforceable. Therefore, it must be noted that air quality determinations based on modeling and health screening levels do not account for the conversion of these VOC's, into toxic compounds and ground level ozone. These additional pollutants can only be assessed through ambient air quality monitoring.

As regards the avoidable emission of CO₂ due to employing the wet process, the company first stated that conversion to a dry process is not economically feasible. Later however they stated reasons of a technical nature associated with the kerogen content of the limestone raw material. To reduce energy costs Holnam now plans to burn a wide variety of waste materials that have the potential of further increasing their already high level of toxic emissions. Many of the alternative fuels considered by Holcim are valuable biological or technical nutrients that contain large amounts of embedded energy. By burning rather than recycling and reusing these nutrients, their embedded energies (the energy which was used to produce the materials) are wasted resulting in additional greenhouse gas emissions for new raw material production.

These issues raise the fundamental question of the long-term sustainability of producing cement at this site. There are clearly physical and geological facts about the current plant location which make ongoing cement production highly polluting to air quality in the State of Michigan and unsustainable from a resource consumption perspective.

VOC EMISSIONS

According to 1999 TRI data the company is by far the highest VOC emitter in the U.S cement industry. The draft permit calls for an emission limit of 7,217 tpy of VOC's. The source of these VOC's is limestone containing about 0.3% of kerogens, bitumen-like high molecular paraffines. At the current production capacity of 1.1 million tpy of clinker, the company emits:

13.12 lbs of VOC's/ton of clinker

(Methodology: Total U.S. clinker capacity in 1999 was 78,750,000 tpy and actual production was 77,340,000 tpy(1). National plant by plant production data is not available. Therefore, since production levels are very close to industry capacity, we have used individual plant capacity for these calculations. Thus: 14,434,000 lbs (7,217 tons) divided by 1,100,000 tons = 13.12 lbs of VOC/ ton of clinker)

On the same basis the average U.S. emission from 104 plants in 1999 is only

0.33 lbs of VOC's/ton of clinker (see table 2).

As mentioned in section 1) The Global Warming Potential (GWP) of VOC's is eleven times higher than that of carbon dioxide. In addition, VOC's in conjunction with NOx emissions from the plant, have the potential of ground-level ozone formation. Both of these environmental impacts make the Holcim plant a serious polluter in relation to the rest of the cement industry and suggests that Holcim either finds better sources of limestone or relocates closer to such a source.

Since kerogens boil out during the pre-heating process they escape the primary combustion zone in the kiln and thus leave as stack emissions. It is also noteworthy to mention that the kiln functions as a chemical reactor with 1,000's of tons of organic toxic chemicals interacting at elevated temperatures prior to being emitted. However, the State of Michigan does not require these VOC emissions to be controlled, giving the company the option to voluntary control the kerogen related emissions. Holcim installed a scrubber/oxidizer system to abate some of these VOC emissions, but they are not required to operate the system and company operations logs indicate frequent periods of inoperable conditions when the system is actually operating. Without specific permit requirements, there is no guarantee for actual reductions of these emissions.

SULFUR EMISSIONS

In accordance with the draft permit, the company is allowed to emit 11,940 tpy (tons/year) of sulfur dioxide. Based on 8000 hours/year of operation, this amounts to 2,985 pounds of sulfur dioxide for every hour of operation, an enormous amount relative to their production capacity and compared with emissions data from other plants. According to 1999 TRI data, 104 cement plants in the U.S. released 209,647 tons of SO₂. At a production capacity of 78.75 million tons this calculates to an average of:

$$209,647/78,750,000 = .00266 \text{ tons or } \mathbf{5.32 \text{ lbs of SO}_2/\text{ton of clinker}}$$

At Holcim's 2003 production capacity of 1.1 million tpy of clinker; and SO₂ emissions: of 11,940 tpy of SO₂; this would yield:

$$11,940 \text{ tpy}/1,100,000 \text{ tpy of clinker} = 0.011 \text{ tons or } \mathbf{21.71 \text{ lbs of SO}_2/\text{ton of clinker}}$$

It should be noted that among the 104 U.S. cement plants analyzed in 1999 Holcim/Dundee is the seventh largest emitter of sulfur dioxide (see table 2).

Sulfur dioxide is responsible for many respiratory diseases and may even lead to lung cancer (2). Under conditions of sunlight SO₂ is oxidized to SO₃ which in turn converts to sulfuric acid in the presence of water vapor. Sulfuric acid is well known to literally dissolve organic tissues that in the case of lungs may lead to necrosis (3). Currently, the company operates 8000 hours per year and uses 13 tph of a mixture of coal and coke. The sulfur content of coal is limited to 2.17 % by weight of sulfur which is equivalent to 4.34 % of SO₂. Assuming a 100 % coal fuel this calculates to:

$$104,000 \text{ tpy of coal generating } 4,514 \text{ tpy of SO}_2$$

This amount of SO₂ is conservative considering the usage of sulfur-free coke in the fuel mixture. However, it is very important to realize that only about one half of the sulfur dioxide emissions of the plant derive from coal. The other half must come from the raw materials used to make cement or from alternative fuels. This again - like the kerogen content of the limestone - indicates a very poor source of raw materials.

SUMMARY OF VOC, SO₂, AND NO_x EMISSIONS

In 1999, 116 U.S. Cement facilities reported emissions for CO, SO₂, NO_x, and VOC. However, since production capacity data were available for only 104 of these plants, only these facilities were used for comparative analysis. The total clinker production capacity at the 104 plants in 1999 was 78,750,000 tons. In the absence of actual production data we used these to analyze emission averages for these facilities and compare them with those emitted by the Holcim(Holnam) Dundee plant during the same calendar year. As stated above, actual U.S. clinker production in 1999 was very close to production capacity,

Table 2: Comparative Emissions of VOC's, SO₂, and NO_x for 1999

	VOC emissions	SO ₂ emissions	NO _x emissions
1999 Holnam total - tpy	6,225	9,259	2,177
Holnam average - lbs/ton	12.09	17.98	4.22
U.S. Total - tons (104 plants)	13,099	209,647	205,212
U.S. Average - lbs/ton	0.333	5.32	5.21
Holnam ranking among 104	#1	#7	#59

Note: Holnam produced 1,030,000 tons of clinker during 1999.

It should be noted that this analysis, made with available data, represents an average performance of the industry and that values for individual plants will vary when actual production data are used. Finally, as previously discussed, the company emits at least double the amount of SO₂/ton of clinker as the amount calculated from its use of coal/coke as a fuel source.

OTHER HEAVY METAL EMISSIONS

According to company staff, heavy metals are generally assumed to be incorporated into the clinker matrix. This can only be assumed when none of the metals or possible chemical derivatives have boiling points lower than the temperature in the kiln. The current draft permit 60-710, dated 11/20/02 under Special Conditions/Testing requirements lists the heavy metals and their allowable emission limits. It also specifies the testing/monitoring method as the parametric operating monitoring system (POMS) to be applied as shown in Attachment G of the Draft Permit. Instead of requiring direct stack testing for at least the more volatile and toxic metals, it instead relies on the AFM management process data provided by generators and on "periodic quality control checks" of the raw materials and fuels assuming that emissions follow a pre-ordained pattern. In other words, it assumes a constant correlation between metal content of raw materials/fuels and their subsequent emissions without considering changes in chemistry in the kiln and in the composition of raw materials. Because of the inconsistency of raw materials, particularly when using AFM, we completely disagree with this approach including the time periods and testing/monitoring methods specified for these metals as listed on page 10/11 in the draft permit. Time periods for testing these toxic heavy metals should be substantially reduced and actual stack tests of emissions must be required in order to allow for verification of the assumptions made in the draft permit.

In this connection it should be emphasized that the methods employed for metal analysis must take into account the temperature conditions of the kiln under which all of these metals can be liberated and potentially escape (for more elaboration of this aspect, see section 4). This generally requires spectrographic analysis.

DEFINITION OF HAZARDOUS WASTE.

An integral part of the AFM management plan requires testing of the raw materials regarding hazardous characteristics (Attachment F of the Draft Permit). This entails testing for ignitability, corrosivity, reactivity and the toxicity characteristic leachability procedure (TCLP) as required under RCRA regulations. It must be noted that the TCLP test was developed with regard to potential leaching of these metals through contact with rain water when disposed off in landfills. Considering the extreme temperature conditions and chemical environment of cement kilns, *the TCLP test is completely inadequate in characterizing the raw materials as hazardous or non-hazardous in this particular application.* Auto fluff, or ASR is a relevant example for this statement.

A study conducted by the German Umweltbundesamt (Federal Environmental Agency), which presents the most complete data, found high concentrations of toxic contaminants in ASR, including lead (4). The U.S. EPA conducted a pilot study of ASR, which also found high concentrations of PCBs, lead, and cadmium (5). Based on its 1989 evaluation of analytical data on untreated ASR, the California Department of Health Services concluded that lead is one of the metals of concern in ASR (6).

The table below presents the concentrations of toxic contaminants in ASR, as reported in four studies. The most complete data are from a report by the German Umweltbundesamt (Environmental Agency), which found high concentrations of a number of contaminants in ASR, including mercury. The U.S. EPA conducted a pilot study of ASR, which also found high concentrations of PCBs, lead, and cadmium. The EPA study did not evaluate mercury. Based on its 1989 evaluation of analytical data of untreated ASR, the California Department of Health Services concluded that mercury is one of the metals of concern in ASR (6).

Table 3: Toxic Contaminants found in Automotive Shredder Residue(ASR)

Contaminant	Concentration in mg/kg			
	<u>German ASR</u> (4)-	<u>U.S. ASR -</u> (5)	<u>California ASR -</u> (6)	<u>NorthStar Steel ASR</u> (7)
<u>Mercury</u>	<u>6-15</u>	<u>Not measured</u>	<u>0.7</u>	<u>0.33-3.2</u> Mean: 1.15
<u>Lead</u>	<u>3,500-7,050</u>	<u>570-12,000</u> mean: 2,700	<u>2330-4616</u>	<u>Not measured</u>
<u>Cadmium</u>	<u>60-100</u>	<u>14-200</u> mean: 47	<u>46-54</u>	<u>Not measured</u>
<u>Chromium</u>	<u>370-770</u>	<u>Not measured</u>	<u>247-415</u>	<u>Not measured</u>
<u>Arsenic</u>	<u>57-63</u>	<u>Not measured</u>	<u>Not measured</u>	<u>Not measured</u>
<u>PVC/phthalates etc.</u>	<u>ca. 6%</u>	<u>Not measured</u>	<u>Not measured</u>	<u>Not measured</u>
<u>Other (e.g. PCB's)</u>	<u>Unknown</u>	<u>1.7-210</u> mean: 32	<u>Not measured</u>	<u>Not measured</u>

MERCURY EMISSIONS

Current permit conditions allow for 115 lbs/yr of mercury emissions, most of it is assumed to derive from coal burning. The actual Hg emissions for 2002 were 99 lbs/yr. The mercury content of coal, while quite variable, is generally known to fall below 1 ppm (8) and therefore is below that of ASR. Notably, Table F-1 submitted by Holcim (see Draft Permit & Permit Application) shows a mercury concentration for all coal and coke sources to be only 0.1 ppm. Using this Hg concentration yields a mercury loading of only 42 lbs/yr indicating mercury coming from other sources, such as limestone, shale and probably from TDF. Since plant emission test data at Holcim basically show the same mercury emissions when burning 0 %; 15 % and 21 % TDF, we assume TDF having zero effect on the overall mercury emission. The calculations for this are shown in the Appendix to this document and results summarized in the table below.

Since Holcim wants to replace any coal/coke fuel over 25 % with alternative fuels and still burn 21 % TDF, we can calculate the worst case change in mercury emissions using either 54 % ASR or 54 % sewage sludge (for details see Appendix). There are currently no conditions in the proposed permit which would prevent such a worst case scenario from happening. The results are shown in the table below:

Table 4: Potential Worst Case Mercury Loadings Under Different Fuel Conditions

Operating conditions: (see Appendix) Fuel Mix (TDF assumed with zero Hg content)	Mercury loading from Coal/coke lbs/yr	Mercury loading from ASR (sludge)	Potential Percent Increase Over Baseline
coal 79 %; TDF 21 %	42 (99 total)	0	baseline
coal 25 %; TDF 21 %; ASR 54 %	12	313.3	328%
coal 25 %; TDF 21 %; sludge 54 %	12	571.3	589%

Thus, we must expect a sharp increase in mercury emissions under AFM mode when burning ASR or sewage sludge.

A similar emission increase must be expected for other heavy metals contained in ASR regardless of what is found in the TLCP test procedure. Our assessment clearly illustrates the need for stack testing of any alternative fuel being considered and also strengthens the argument not to issue a generic permit for the materials listed by the applicant.

As mentioned in the section 1) the burning of technical nutrients containing the energy embedded for their production is not only wasteful but also contributes to greenhouse emissions that are unnecessary. A case in point is the use of ASR as fuel. A recent study (12) shows that recovery of the plastics contained in the 3 million tons of ASR (estimated amount generated annually in the U.S.) would save 130,800 billion BTU in relation to incineration with energy recovery. It would also reduce annual VOC emissions by 43,000 tons. A similar energy saving can be expected when recycling rather than burning of tires which have large quantities of embedded energy. In general, the combustion of energy-rich technical nutrients is not environmentally sustainable as it contributes to global warming by wasting energy and raw materials. In addition it contributes to VOC emissions both from production of new materials and from the combustion of scrap tires.

ORGANIC EMISSIONS OTHER THAN KEROGEN-RELATED VOC'S

Due to the long retention time and high temperature in the kiln, the company expects a destruction efficiency of 99.999 % for all organic materials but is lacking appropriate data to support this assumption. The MDEQ assumed a worst case scenario with a destruction efficiency of only 99.99 % and calculated emissions under these conditions for 195 pure compounds including a few selected PAH's (polycyclic aromatic hydrocarbons). These data were used in MDEQ's air modeling program according to which none of the pollutants exceeded the limits for health-based screening levels. Products of incomplete combustion (PIC's) and PAH's formed during combustion were only partially considered by MDEQ. This procedure and its underlying assumptions is highly questionable for several reasons.

First, how can one assume that none of the combustion products are highly toxic and, second, how are cumulative effects accounted for? Furthermore, the air model used by MDEQ assumes ideal/convective conditions. This is highly unrealistic and therefore unacceptable. Employment of an air distribution model that represents real world conditions should be used instead. Ultimately, measurements of emissions by actual plant tests for organics and metals under the AFM mode is the only way to verify these theoretical emissions estimates. These tests must include monitoring of ambient air quality.

RECENT COMPLIANCE HISTORY OF THE COMPANY

Some aspects of Holcim's environmental compliance are publicly available through their operations logs that are quarterly submitted to the MDEQ. A initial review of these files shows ongoing compliance problem for the facility.

Odor Problems: Very frequently residents complain about intolerable odor problems from the plant. This is an ongoing violation of Michigan Air Pollution Rule 901. After many years of odor and nuisance violation in the 1990's the Michigan DEQ did negotiate a settlement which involved an experimental emission control device (the scrubber-oxidizer system). However this system has been largely a failure and the community continues to experience ongoing odor levels which we believe are in violation of State of Michigan Rule 901.

Exceedance of Opacity Limits: The current operating permit for the plant requires that opacity of the plant stack emissions not exceed 15 percent. Between October 1999 and September 2002, the company exceeded opacity limits for:

- 148 hrs in the 15-40% range;
- 25 hrs in the 40-60% range;
- 9.4 hrs in the 60-80% range, and;
- 21.1 hrs in the 80-100% range.

Low Activated Carbon Feed: Activated carbon is fed to reduce emissions of VOC's and also mercury. The company is required to report the hours when the 1 hour average feed falls below 280 lbs/hr and the hours when the 5 hour average feed is less than 295 lbs/hr for all days when this emission control system is active. Table 5 shows a summary of hours when operations were out of compliance. These data show that the company was out of compliance and incorrectly operating emission control equipment for minimum over 52 days total between October 1999 and December 2002(just over 3 years).

Table 5: Times of Non-Compliance of Carbon Feed Emission Control System

Time period	Hours with less than 280 lbs/hr -1 hr average	Hours with less than 295 lbs/hr -5 hr average
Oct.3/99-Dec.31/99	188	390
Jan.1/00-Dec. 31/00	72	188
Jan.1/01-Dec.31/01	549	No data found
Jan.1/02-Dec.31/02	288	678
Total Hours	1097	1256

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APPENDIX: DATA USED FOR CALCULATIONS OF MERCURY LOADINGS IN THE AFM MODE

ASSUMPTIONS:

BTU values

Coal/coke	12,000 BTU/lb	(ref. 9)
Sludge	7,000 BTU/lb	(ref.10)
ASR	10,000 BTU/lb	(ref. 11))

Mercury content

Coal/coke	0.1 mg/kg=0.1 g/mton	(Table F1-Holcim Application)
Sludge	1.275 mg/kg=1.275 g/mton	(ref. 10)
ASR	1.0 mg/kg=1.0 g/mton	(see table 3)

Holcim Data and Assumptions

Annual clinker production	1.1 E+12 tpy
BTU (wet process)	5.26 E+06 BTU/ton of clinker
Annual BTU needed	5.79 E+12 BTU/yr
Typical coal use	13 tons/ton of clinker

CASE 1: USE OF COAL/COKE 79 % AND TDF 21 %

79 % coal of $5.79 \text{ E}+12 \text{ BTU/yr}$ = $4.57 \text{ E}+12 \text{ BTU/yr}$ from coal/coke
 coal at 12,000 BTU/lb yields:
 190,588 mtons of coal
 at 0.1 g of Hg/mton of coal yields
 19,059 g or 42 lbs/yr of mercury from coal/coke

CASE 2: USE OF ASR

Assume: coal 25 %; TDF 21 %; ASR 54 %

25 % coal of $5.79 \text{ E}+12 \text{ BTU/yr}$ = $1.45 \text{ E}+12 \text{ BTU/yr}$ from coal/coke
 coal at 12,000 BTU/lb yields:
 54,830 mtons of coal
 at 0.1 g of Hg/mton of coal yields
 5,483 g or 12.09 lb/yr of mercury from coal/coke

21 % TDF **no Hg data available**

54 % ASR of $5.79 \text{ E}+12 \text{ BTU/yr}$ = $3.13 \text{ E}+12 \text{ BTU/yr}$ from ASR
 ASR at 10,000 BTU/lb yields
 156,500 tons of ASR = 142,273 mtons of ASR
 at 1g of Hg/mton of ASR yields
 142,273 g or 313.3 lbs/yr of mercury from ASR

Case 3: Use of sludge (coal and TDF as in case 1)

Assume: coal 25 %; TDF 21 %; Sludge 54 %

54 % sludge of $5.79 \text{ E}+12 \text{ BTU/yr}$ = $3.13 \text{ E}+12 \text{ BTU/yr}$ from sludge
 sludge at 7,000 BTU/lb yields
 223,571 tons of sludge = 203,246 mtons of sludge
 at 1.275 g of Hg/mton of sludge yields
 259,139 g or 571.29 lbs/yr of mercury from sludge

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