Public Health Assessment

Final Release

LAFARGE CEMENT PLANT

RAVENA, ALBANY COUNTY, NEW YORK

EPA FACILITY ID: NYD002069557

Prepared by
New York State Department of Health

JULY 25, 2013

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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For additional information about this document, you may contact the:

New York State Department of Health
Center for Environmental Health
Empire State Plaza, Corning Tower
Albany, New York 12237
(518) 402-7530

E-mail ceheduc@health.state.ny.us

TABLE OF CONTENTS

TEXT ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ADD	Attention Deficit Disorder
ADHD	Attention Deficit Hyperactivity Disorder
AGCs	Annual Guideline Concentration
ATSDR	Agency for Toxic Substances and Disease Registry
BACT	Best Available Control Technology
BPIP	Building Profile Input Program
CASE	Community Advocates for Safe Emissions
CDC	United States Centers for Disease Control and Prevention
C-HANES	City Health and Nutrition Examination Survey
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
CV	Comparison Value (health basis)
dL	Deciliter
EPHT	Environmental Public Health Tracking
HC	Health Consultation
HOD	Health Outcome Data
HSPH	Harvard School of Public Health
MET	Meteorological
$\mu g/m^3$ or mcg/m^3	micrograms per cubic meter
N/RC	Needs to Resource Capacity Index
NAAQS	National Ambient Air Quality Standard
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NHANES	National Health and Nutrition Examination Survey
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NSPS	New Source Performance Standards
NYC	New York City
NYCDOHMH	New York City Department of Health and Mental Hygiene
NYS	New York State
NYS DEC	New York State Department of Environmental Conservation
NYS DOH	New York State Department of Health
NYS ED	New York State Education Department
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PB HAP	Persistent and Bioaccumulative Hazardous Air Pollutant
PHA	Public Health Assessment
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter with average aerodynamic diameter of 2.5 micrometers or less
PM_{10}	Particulate Matter with average aerodynamic diameter of 10 micrometers or less
Ppb	Parts per billion
RCS	Ravena-Coeymans-Selkirk

SEDCAR	Strategic Evaluation, Data Collection, Analysis and Reporting
SEQR	State Environmental Quality Review
SGCs	Short-term Guideline Concentration
SIR	Standardized Incidence Ratio
SO_2	Sulfur Dioxide
SPARCS	Statewide Planning and Research Cooperative System
US EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

SUMMARY

In 2009, Community Advocates for Safe Emissions (CASE) requested that the New York State Department of Health (NYS DOH) investigate the potential impact on community health posed by the cement plant located in Ravena, New York. To accomplish this, the NYS DOH is working with the Agency for Toxic Substances and Disease Registry (ATSDR) under a cooperative agreement to complete an overall assessment of the possible public health impact of contaminants released from the cement plant currently owned and operated by Lafarge Building Materials Incorporated. We are completing the overall assessment of the health impact of the cement plant in two sequential phases, each with a separate report. Phase One is completion of a Final Health Consultation (HC) report. Phase Two is completion of a Final Public Health Assessment (PHA) report), which is based on information presented and conclusions reached in the HC report.

The Final Phase One Health Consultation report "Lafarge Cement Plant, Ravena, Albany County, New York: Summary of Environmental Data and Exposure Pathway Evaluation; Health Risk Assessments; and Health Outcome Data (HOD)" was completed in 2012. The Final Phase One HC provides all members of the community with a comprehensive, transparent summary of all information about chemical releases from the cement plant over its nearly 50 years of operation. The Final Phase One HC includes an explanation of how the information presented is used to identify how people might be or have been exposed to chemicals released from the plant (i.e., exposure pathways); and, how the information summarized will be used to complete this Phase Two PHA report. Release of the Public Comment Draft Phase One HC in November 2010 gave the public an opportunity to comment on whether the health assessment process described, and the available information summarized, would adequately address their desire for an assessment of the health impact of the cement plant. Through the public comment process, members of the public asked questions about the health assessment process, and also noted additional information they wanted to be considered in the Phase Two PHA. All questions raised by the public about the health assessment process for the cement plant are addressed in the Final Phase One HC, and all information suggested by the public is incorporated into the Final Phase One HC.

The Final Phase One HC identified two complete exposure pathways through which people might be exposed to contaminants released from the cement plant. These are an air exposure pathway (through which people may contact contaminants released in cement kiln stack emissions) and a settled dust exposure pathway (through which people may contact dust containing some cement or clinker dust from the plant). The Final Phase One HC also described readily available health information for communities near the plant given community concerns about their health status.

This Phase Two PHA builds on the conclusions in the Final Phase One HC. Environmental data summarized in the Final Phase One HC are used to estimate and characterize potential air and dust exposures. Specifically, this Phase Two PHA compares maximum, predicted ground-level air concentrations of contaminants released in the cement kiln stack emissions with air comparison values. An air comparison value is a chemical concentration in air that may be an existing regulatory, guidance, or other health based value. For contaminants exceeding air comparison values, this Phase Two PHA further characterizes their potential to harm health. This Phase Two PHA also describes potential health effects that might result from exposure to settled

dust originating from the cement plant and whether those exposures could be harmful. This Phase Two PHA also provides a summary of HOD for the population living in, or receiving mail at, ZIP codes around the Ravena cement plant. The HOD results are compared to HOD results for other areas in the region and the state to determine whether differences exist.

Together, both phases of the health assessment for the Ravena cement plant enable federal, state and local health agencies to identify and prioritize approaches to answer public health questions and determine what activities are necessary to protect public health. Both the Final Phase One HC and this Phase Two PHA rely on, and are limited by, the data made available to NYS DOH and ATSDR.

In this PHA, NYS DOH and ATSDR have come to four conclusions regarding the past and current emissions from the Ravena cement plant in Albany County, New York.

Conclusion 1

NYS DOH and ATSDR conclude that breathing the ground-level air concentrations of metals (e.g., mercury), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), carbon monoxide, lead, particulate matter (PM), dioxins, furans, hydrocarbons, volatile organic compounds (VOCs) and ammonia released in kiln stack emissions is not expected to harm people's health.

Basis for Decision

The maximum, modeled ground-level air concentrations of these chemicals (a prediction using maximum production conditions and assuming the plant operates at full capacity, an overestimate of overall operation) appropriately reflect past and present emissions and are below applicable short and long term air comparison values (pollutant concentrations at which exposures are not expected to be associated with adverse health effects).

Conclusion 2

NYS DOH and ATSDR conclude that for the general public, breathing ground-level air concentrations of sulfur dioxide (SO_2) or nitrogen dioxide (NO_2) released in the kiln stack emissions is not expected to harm people's health.

Basis for Decision

Maximum, modeled ground level air concentrations of SO_2 and NO_2, (the modeling assumes all nitrogen oxide (NO_x) stack emissions are NO_2) are below applicable long-term (annual) air comparison values. Maximum, modeled estimates of peak short-term (one-hour) concentrations of SO_2 and NO_2 are above applicable air comparison values but are below levels of respiratory health concern for the general public.

Available human studies suggest that people with pre-existing respiratory conditions, if engaged in vigorous activity where and when SO_2 and NO_2 short-term concentrations exceed air comparison values, might experience a worsening of their symptoms. However, the air modeling results likely over estimate exposures to both SO_2 and NO_2 (this is especially true for NO_2 as we have assumed that all NO_x emitted is NO_2, the nitrogen oxide of health concern in ambient air). The maximum modeled ground-level short-term elevations of SO_2 and NO_2 from the cement plant emissions are estimated to occur only at isolated hilltop locations (indicated by the point of maximum impact on air concentration contour maps) limiting the potential for exposure.

Next Steps

NYS DOH and ATSDR recommend that people, especially those with respiratory conditions such as chronic obstructive pulmonary disease (COPD), pay attention to air quality advisories, and until the cement plant completes the steps to reduce its SO_2 and NO_x emissions to achieve new regulatory requirements, be aware that some isolated hilltops west of the facility may experience short-term episodic increases in air concentrations of SO_2 and NO_2 that may exacerbate their symptoms.

New York State Department of Environmental Conservation (NYS DEC) will continue to monitor compliance with requirements to reduce emissions of SO_2 and NO_x as required under the Title V air permit for the cement plant issued in July 2010. The proposed, modernized plant, which was issued final permits by NYS DEC in July 2011, will further reduce SO_2 and NO_x emissions.

Conclusion 3

NYS DOH and ATSDR conclude that touching, breathing or accidentally eating dust that originated from the Ravena cement plant and other sources is not expected to harm the health of people who reside, work, or attend school in the community.

Basis for Decision

Outdoor settled dust samples were collected on residential properties near the cement plant in the past (before 2002) to support enforcement actions to address off-site dust migration from the cement plant (not to evaluate health risk). Some of these samples contained evidence of cement and clinker dust from the cement plant. Settled dust containing cement or clinker dust will contain calcium compounds, but contact with small amounts of dust containing these types of compounds is not known to harm health. Materials such as silica might be present in trace amounts in cement plant dust. Low level exposure to these materials in trace amounts is not expected to harm health.

Settled dust from a variety of other sources (e.g., traffic, agriculture, quarries) is typically present in any community and is likely present in the Ravena area. Settled dust that becomes airborne may cause temporary eye or respiratory irritation, but is not expected to cause other short-term or long-term health effects. Similarly, settled dust that gets on the skin or is accidentally ingested is generally not expected to harm health, although it may create a nuisance.

Next Steps

NYS DEC will continue to work with Lafarge to control on-site dust to prevent off-site dust migration and comply with permit conditions.

People concerned about exposure to any type of settled dust may wish to take steps to prevent the re-suspension and tracking of dust using damp cleaning methods (for example, using a wet cloth or damp mop on surfaces that people come into contact with, or hosing off outdoor surfaces with water if there is visible dust accumulation) or closing windows if windblown dust is observed.

People in the community who witness off-site dust migration from the Lafarge cement plant should report their observations to NYS DEC Region 4 at 518-357-2350.

Conclusion 4

NYS DOH and ATSDR conclude that current health status of the communities near the cement plant is similar to health status of other areas in the region and state. There is, however, an elevated rate of hospitalization for chronic obstructive pulmonary disease (COPD), in the area.

Basis for Decision

Incidence and/or rates for most of 30 health outcomes examined for the six ZIP codes surrounding the cement plant were similar to those in the comparison areas. Age-adjusted hospitalization rates for the respiratory diseases COPD and chronic bronchitis (a component of COPD) were significantly higher in the six ZIP code area than rates in regional and statewide comparison areas. COPD is commonly associated with smoking history, and symptoms of COPD can be exacerbated by exposure to indoor and outdoor gaseous and particulate pollutants.

Next Steps

NYS DOH and ATSDR recommend that people, especially those with respiratory diseases such as COPD, pay attention to air quality advisories, and restrict their outdoor activities as recommended.

Compliance with the Title V permit issued in September 2010, and with the permits to modernize the plant issued in July 2011, will reduce air pollution emissions from the cement plant that can contribute to regional air levels of pollutants that have the potential to aggravate existing respiratory conditions such as COPD. NYS DEC will continue to monitor compliance with requirements to reduce emissions as required under these Title V air permits.

For More Information

If you have questions about this document or NYS DOH's ongoing work regarding the Lafarge cement plant in Ravena, please contact Bettsy Prohonic of the NYS DOH at 518-402-7530. If you have questions about the Lafarge cement plant, please contact Don Spencer of the NYS DEC at 518-357-2350.

PURPOSE AND HEALTH ISSUES

The NYS DOH is working under a cooperative agreement with the ATSDR to complete a health assessment for the cement plant located in Ravena New York. The health assessment is being completed in two phases – a Phase One Health Consultation (HC) and a Phase Two Public Health Assessment (PHA). HCs are public health evaluations of data or information conducted in response to a specific public health issue or question (e.g. what environmental data are available for the Lafarge plant). PHAs are the evaluation of data and information on the release of hazardous substances into the environment to assess past, current, or future impact on public health, develop recommendations, and identify studies or actions needed to evaluate and mitigate or prevent human health effects.

The Phase One HC, Lafarge Cement Plant, Ravena, Albany County, New York: Summary of Environmental Data and Exposure Pathway Evaluation; Health Risk Assessments; and Health Outcome Data (HOD) report was completed in 2013 (NYS DOH, 2013). The Phase One HC identified two complete exposure pathways through which people might be exposed to contaminants released from the cement plant based on a comprehensive review and evaluation of all historical environmental and other information about the cement plant. These are an air exposure pathway (through which people may contact contaminants released in cement kiln stack emissions) and a settled dust exposure pathway (through which people may contact dust containing cement or clinker dust from the plant). The Phase One HC also described readily available health information for communities near the plant in response to interest in the community's health status.

The purpose of this Phase Two PHA is to complete the health assessment for the Ravena cement plant. This Phase Two PHA uses environmental data summarized in the Phase One HC to estimate and characterize potential air and dust exposures. This Phase Two PHA compares maximum, predicted ground-level air concentrations of contaminants released in cement kiln stack emissions with air comparison values to evaluate whether potential exposures might be of health concern. This Phase Two PHA also evaluates the potential health effects from exposure to settled dust containing cement or clinker dust from the plant. In addition, this Phase Two PHA compares HOD for the population living around the Ravena cement plant with HOD for other areas in the region and the state to evaluate whether differences exist.

BACKGROUND

A. SITE DESCRIPTION

The Ravena cement plant is located in the Town of Coeymans, Albany County and is currently operated by Lafarge Building Materials, Inc. The Final Phase One HC provides a comprehensive description of the facility, its cement making operation and its surroundings.

B. REGULATORY BACKGROUND

In 1962, when the Ravena cement plant began operations, it was subject to regulation 6 NYCRR Part 220 Portland Cement Plants, promulgated on June 29, 1961, to regulate emissions or releases. Over time, additional laws, regulations and permit conditions applicable to the Ravena

cement plant and enforced by NYS DEC and the United States Environmental Protection Agency (US EPA) were promulgated to control air emissions, discharges to water bodies, landfilling of waste materials, storage of waste materials, and wastewater and leachate collection and treatment. Currently, Ravena cement plant operations are regulated under Title V of the Clean Air Act Amendments.[1] The NYS DEC issued the initial Title V Air Permit for the Ravena cement plant in April 2001.

In January 2010 a federal consent decree was filed which encompassed 13 facilities owned by Lafarge and two subsidiaries, including the Ravena cement plant (US Department of Justice, 2010). The ruling requires that Lafarge and its affiliates reduce emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) at their cement plants. To comply with this decree, the Ravena cement plant is required to reduce SO_2 and NO_x emissions 80 and 30 percent from averages of 11,825 and 5,223 tons per year, respectively. To do so Lafarge must modernize the plant or install new pollution controls. For the period of time before modernization is complete, SO_2 and NO_2 emissions must be no more than 11,500 and 3,750 tons per year, respectively. The 2010 annual emissions statements indicate that SO_2 and NO_x emissions were markedly below these targets at 8,145 and 3,541 tons, respectively.

The NYS DEC renewed the Title V permit for the Ravena cement plant in September 2010. This permit caps SO_2 and NO_x emissions to no more than 11,500 and 3,750 tons per year as required under the 2010 federal consent decree. The renewal also capped mercury emissions at no more than 176 pounds for each 12 month period. Sampling of raw materials, fuels, and dust destined for the landfill is to be used to calculate compliance.

Over the same general period Lafarge sought renewal of its Title V permit, it also sought a permit to modernize the Ravena cement plant. Lafarge originally applied for permits to construct a modern, new kiln system in April 2009. In July 2011, NYS DEC issued the final necessary air and water permits to Lafarge to modernize and expand its Ravena cement plant. With modernization, the Ravena cement plant will replace the existing 'wet' cement-making process with a more energy-efficient 'dry' cement-making process. The two current kilns and their associated 325-foot smoke stack will be replaced by a single kiln and an associated 525-foot stack. The permit incorporates US EPA requirements to apply Best Available Control Technology (BACT) to control greenhouse gases (such as carbon dioxide) under Prevention of Significant Deterioration regulations issued in June 2010 (US EPA, 2010a). The permit also requires lower emissions of mercury, other hazardous pollutants, and particulates by September 2013 consistent with the National Emission Standards for Hazardous Air Pollutants (NESHAP) for the Portland cement industry issued by EPA in September 2010 (US EPA, 2010c). Also, consistent with New Source Performance Standards (NSPS) issued in September 2010, when

[1] Title V of the Clean Air Act Amendments established a facility-based operating permit program combining all regulated emission sources at a facility into a single comprehensive permit. Title V Permits are required for all facilities with air emissions greater than major stationary source thresholds. NYS enacted amendments to Environmental Conservation Law Articles 19 (Air Pollution Control) and 70 (Uniform Procedures), and amended regulations 6 NYCRR Parts 200, 201, 621 and 231. With this demonstration of authority, NYS DEC received delegation of the Title V operating permit program from the US EPA. Today's air pollution control permitting program combines the federal air operating permitting program with long-standing features of the state program (i.e., pre-construction permitting requirement and assessment of environmental impacts pursuant to the State Environmental Quality Review Act). For each major stationary source facility, NYS DEC issues a Title V Facility Permit, a comprehensive permit containing all regulatory requirements applicable to all sources at the facility. Title V permits dictate all applicable environmental regulations. Title V permits are documents containing all enforceable terms and conditions as well as any additional information, such as the identification of emission units, emission points, emission sources and processes. Permits also may contain information on operation procedures, requirements for emission control devices as well as requirement for satisfactory state of maintenance and repair to ensure the device is operating effectively. Permits also specify the compliance monitoring requirements, recordkeeping and reporting requirements for any violation of applicable state and federal emission standards. Title V Permits can be viewed at www.dec.ny.gov/chemical/32249.htm.

completed, the new plant will reduce SO_2 emissions by 95percent and NO_x emissions by 60 percent. In addition, fine particulates ($PM_{2.5}$) will be reduced from 560 to 351 tons per year. More details about the Lafarge Title V permit for the Ravena cement plant can be found at http://www.dec.ny.gov/dardata/boss/afs/issued_atv_1.html.

C. DEMOGRAPHICS

Demographic data from the 2010 and 2000 U.S. Census are presented in Tables 1 and 2. From the 2000 and 2010 Census, the NYS DOH estimated that approximately 15,000 people live within the geographic area defined by five ZIP codes around the cement plant (12046, 12087, 12143, 12156 and 12158, see Figure 1). There is one additional ZIP code, 12045, within this geographic area for a post office offering only on-site postal boxes (i.e., it has no delivery area). This is referred to as a point ZIP code. Census data are collected for street addresses, so they capture demographic data for people residing in the geographic area whether they receive their mail via home delivery or post office box. Census estimates do not indicate any overall large scale population growth or decline within the combined ZIP code area although there were some changes in individual ZIP codes. The two larger ZIP codes in the area (12143, 12158) each have about 6,000 people, while the three smaller ZIP codes (12046, 12156, 12087) have between approximately 600 and 1,500 people. Four schools are located in the area: the Ravena-Coeymans-Selkirk (RCS) Senior High School and Middle School; the Albertus W. Becker Elementary School; and the Peter B. Coeymans Elementary School. All are within the RCS School District.

DISCUSSION

The Final Phase One HC (NYS DOH, 2012) comprehensively summarizes all available environmental data describing contaminants in air, on-site waste and soil, on-site groundwater, on and off-site surface water, off-site soil, and some plants and animals. Considering all these data, the Phase One HC concludes that completed exposure pathways for cement plant related contaminants are exposures to contaminants released in kiln stack emissions and exposures to settled, off-site dust that may contain cement or clinker dust. The Final Phase One HC concludes that potential exposure pathways for all other environmental media (e.g., ground water, surface water, soil) are incomplete. An incomplete exposure pathway is one that is missing one of five essential criteria: a source of contamination, a contaminated medium (air, water, soil, biota) a place where there is exposure to the contaminated medium, a route of exposure (e.g., eating, breathing, touching), and a population of people who are exposed to the contaminated medium.

The air and settled dust exposure pathways identified in the Phase One HC are described and evaluated in this Phase Two PHA.

A. ENVIRONMENTAL CONTAMINATION

1. Contaminants in Air

The Final Phase One HC concludes that kiln stack emissions data collected in 2004 are the most comprehensive set of data characterizing contaminants released to air from the cement plant. These data are measured kiln stack emissions from the Ravena cement plant when it was operating at full production. The analyses include metals, polycyclic aromatic hydrocarbons

(PAHs), polychlorinated biphenyls (PCBs), five criteria pollutants (i.e., carbon monoxide, lead, nitrogen dioxide, PM, sulfur dioxide), dioxins and furans, some hydrocarbons, volatile organic compounds (VOCs) and ammonia. Table 3 (a-d) presents the contaminants measured and their associated emissions rates.

The 2004 kiln stack emission data adequately characterize maximum past and current emissions. The plant configuration has changed little since 1962 and uses the original kilns and pollution controls (personal communication, Don Spencer NYS DEC). Although fuel composition and limestone composition may have varied over the years of operation, kiln operations (e.g., operating temperatures and capacity) are not likely to have changed over the years. As described in the Final Phase One HC, other air emissions reported for the plant to the US EPA Toxic Release Inventory or in the NYS DEC Annual Emissions Statements are estimates and may not be actual kiln stack emission measurements. Therefore, the 2004 measured stack emissions constitute the most accurate and comprehensive data describing contaminants released to air from the cement plant. These are the data used in an air dispersion model to estimate community exposures, as described in the pathway analysis below and in Appendix A.

2. Contaminants in Settled Dust

The Final Phase One HC concludes that cement or clinker cooler dust might be present in settled dust in the nearby community, based on microscopic evaluation of the type of dust present in off-site settled dust samples collected in or prior to 2001. (Clinker is an intermediate product in cement manufacture. See the Final Phase One HC for a description of the cement making process and settled dust samples.) There have been no complaints about dust at residences since 2001, and there are no analytical data describing the specific chemical composition of settled dust in the community in the past. However, consideration of the chemical composition of materials in the cement production process can help to characterize the chemical composition of dust that may have originated from the cement plant and settled off-site.

Clinker dust would be similar in composition to clinker. During cement production, the high temperature rotary cement kiln removes the volatile constituents (those able to leave the material in the form of a gas) in the raw ingredients (limestone, water, additives), leaving non-volatile, solid material, which is called clinker. Clinker ranges in size from about one to twenty-five millimeters in diameter and is predominantly made up of calcium silicates and aluminates.

Cement dust will contain the constituents in clinker and the ingredients that are mixed with clinker to make Portland cement. The Ravena cement plant mixes gypsum with the clinker it produces. Gypsum is also called calcium sulfate.

Other elements and compounds may be present in trace amounts in the clinker and cement dust. Whether or not they are present depends on variations in the raw materials (e.g., limestone and gypsum) and in the fuels used to heat the kiln (e.g., coal, fuel oil). These other materials can include, oxides of calcium and magnesium, potassium and sodium sulfates, nickel or chromium compounds, and crystalline silica.

B. PATHWAY ANALYSIS

Ways that people might contact site-related contaminants are called exposure pathways. The Final Phase One HC identified two complete exposure pathways for the Ravena cement plant – an air exposure pathway and a settled dust exposure pathway.

1. Air and the Inhalation Pathway

Kiln emissions disperse in ambient air once they leave the stack. The way they disperse (mix and move) is dependent on plant operation, meteorology and geographic factors. People can breathe in cement plant related contaminants if, following their release from the stack, they disperse to the air at ground level. An air dispersion model can be used to estimate concentrations of air contaminants at ground-level in the community, and where those concentrations may occur.

In the Final Phase One HC, an air dispersion model was used to identify areas near the cement plant where contaminants released to air from existing sources at the cement plant (kiln stack; clinker cooler stack) might be present at ground level (see Final Phase One HC, Appendix E - Air Modeling). These results were used in identification of ZIP code areas that might be impacted by air releases from the plant and were used in our health outcome data review. In this Phase Two PHA, an air dispersion model is used to estimate maximum concentrations of air contaminants at ground-level based on kiln stack emissions measured at the stack in 2004, as well as where those concentrations might occur (i.e., the point of maximum impact) as described in Appendix A. These estimated levels and their public health implications are described below.

2. Settled Dust and the Inhalation, Dermal and Ingestion Pathways

Dust, or settled particulate material, is a mixture of particles. A particle's size, shape and density will determine when, where and whether it is deposited (i.e., settles out of the air), is carried along by air movement, or re-enters the air once it has settled. A particle's size, characteristics and composition influences the likelihood and type of health effects it might produce if people breathe it, get it in their eyes or eat it. Particulates of possible health concern are generally categorized as either coarse (particles larger than 2.5 micrometers but less than ten micrometers in aerodynamic diameter) or fine particulates (particles 2.5 micrometers or less in aerodynamic diameter, $PM_{2.5}$).

Activities associated with the manufacture and transport of cement can generate both coarse and fine particulates. Coarse particulates are generally formed by crushing, grinding and abrading of surfaces, creating pieces that can be suspended in air for short periods by wind or activity (examples are sea salt, sand). Mining and agricultural activities are other examples of man-made sources of coarse particles. Fungal spores, pollen and plant and insect fragments are examples of natural sources of coarse particles. The visible dust that was present on surfaces in the Ravena community in the past was likely made up of relatively large, or coarse, particles that would not remain airborne for long after they are released into the air. Once settled, people can get this dust on their skin, or can accidentally eat it if it gets in their mouth. In some cases, human activity or strong air movements (e.g., wind or a passing vehicle) can lift settled dust back into the air where people could breathe it or get it in their eyes.

C. PUBLIC HEALTH IMPLICATIONS AND TOXICOLOGICAL AND EPIDEMIOLOGICAL EVALUATIONS

The public health implications of exposures to cement plant related contaminants in air are determined here by comparing modeled concentrations at points of maximum impact with air comparison values (CVs). Air CVs are chemical concentrations in air and can be existing regulatory or guideline concentrations or other health-based values. CV are not concentrations of chemicals or levels of exposure at which health effects would be expected. They are often much lower than known or calculated concentrations that are suspected or known to cause adverse health effects. So, even if a concentration is above a CV, it is not necessarily of health concern. Concerns about health impacts arise when air concentrations exceed health comparison values, approach concentrations that have been associated with health effects observed in studies, or when a pollutant is present where there might be people who are especially susceptible.

Comparison values for many air contaminants of human health concern have been developed by federal and state agencies (e.g., US EPA, ATSDR, NYS DOH, NYS DEC). These values are developed for the length and frequency of exposure that is likely to occur, for example short-term exposures that occur for a few hours or days, and long- term exposures that might happen daily throughout a lifetime. A chemical may have more than one long-term CV based on its potential to cause non-cancer effects and another based on its potential to cause cancer (see Appendix B).

The public health implications of exposures to settled dust potentially containing cement or clinker dust are discussed qualitatively, because settled dust samples were analyzed microscopically to assess their origin for enforcement, not to determine their chemical composition.

1. Contaminants in kiln stack emissions

Contaminants in air might harm health if their concentrations exceed air comparison values (comparison values indicate levels of exposure without expectation of harm). To determine whether contaminant air concentrations exceed air comparison values, estimated or measured concentrations where contact may occur are compared to appropriate air comparison values. If contaminant concentrations in air at points of exposure do not exceed their air comparison values, then they are considered unlikely to harm health and are not considered further. If contaminant concentrations in air at points of exposure exceed comparison values, then they are further evaluated to better characterize whether and how they might harm health, and to determine whether further studies or actions to reduce or mitigate exposure are needed.

The NYS DEC used the AERMOD dispersion model (as described in Appendix A) to estimate maximum, offsite, ground-level air concentrations of chemicals released in cement kiln stack emissions. The off-site point of maximum impact varies depending on what time period we are interested in (i.e., averaging time), because meteorology varies over time (e.g., hourly, daily, seasonally). The assumptions used in the dispersion model are selected to overestimate ground-level concentrations by using model inputs that illustrate worst case conditions for dispersion (conditions that prevent pollutants from mixing with air and moving away from the source). In this way, modeled values can be used to support the requirement of additional actions to reduce emissions and provide enhanced public health protection. The highest modeled ground-level air

concentration (1-hour, 24-hour and annual) and appropriate (short- and or long-term) air comparison value for metals, PAHs, PCBs and other chemicals, and criteria pollutants are presented in Tables 3a, b, c and d, respectively.

Metals, PAHs, PCBs and Other Chemicals

Tables 3a, b and c show that estimated long-term (annual) and short-term (1- or 24-hour) maximum modeled air concentrations for all metals, PAHs, and PCBs and other chemicals released in the cement plant kiln emissions are below applicable long- and short-term air comparison values for both non-cancer and cancer health effects.

Furthermore, the maximum modeled long-term ground level air concentrations of persistent and bioaccumulative hazardous air pollutants (PB-HAPS, e.g., mercury, PCBs, PAHs) are less than one percent of their long-term comparison values. This indicates that significant deposition and accumulation of these contaminants in soil around the plant is not likely, and therefore evaluation of possible exposures and health effects from these contaminants in soil (e.g., in a multi-pathway risk assessment) is not necessary (NYS DEC and NYS DOH, 2002). The limited community soil sampling described in the Final Phase One HC provides some support for this conclusion. Reported soil concentrations of metals, for example mercury, a contaminant of concern to the community, were not elevated compared to available background soil concentrations in New York State.

Criteria Air Pollutants ($PM_{2.5}$, PM_{10}, Carbon monoxide (CO), Lead, SO_2, NO_2, Ozone)

Table 3d shows that maximum estimated long-term (annual) and short-term (1- or 24-hour) concentrations for the criteria air pollutants $PM_{2.5}$, PM_{10} (particles 10 micrometers or less in aerodynamic diameter)[2], CO and lead are below applicable air comparison values.

Table 3d also shows that maximum modeled ground-level (annual) SO_2 and NO_x concentrations are below applicable long-term (annual) air comparison values (e.g., NYS DEC AGC's). However, maximum modeled short-term (1 hour) concentrations of SO_2 and NO_x (assuming all NO_x emissions are present as NO_2) exceed short term (1-hour) air comparison values.

SO_2 and NO_x are produced naturally and through human activity (e.g., motor vehicle exhaust, electricity generating units). Both are criteria air pollutants regulated under the federal Clean Air Act which requires US EPA to set National Ambient Air Quality Standards (NAAQS) for these and other criteria air pollutants considered. The US EPA considers health consequences of both short- and long-term exposures when setting the NAAQS, and several of the criteria pollutants, including SO_2 and NO_2, have both short- and long-term NAAQS. Determination of compliance with NAAQS is based on criteria pollutant monitoring done on a regional or other basis as specified in the NAAQS requirements for each criteria air pollutant.

[2] The approved modernization permit requires the installation and operation of two $PM_{10}/PM_{2.5}$ monitors for one year near the Ravena cement plant site (one fenceline monitor on the northwestern edge of the site, and one monitor at the RCS High School). This monitoring is being required to demonstrate that particulate emissions from the new plant do not significantly contribute to ambient $PM_{2.5}$ levels such that it could jeopardize compliance with the National Ambient Air Quality Standards (NAAQS) for PM (NYS DEC, 2011).

Based on concern that short term spikes in SO_2 and NO_2 air concentrations could produce respiratory effects in susceptible people (the young, elderly, and those with existing respiratory conditions, or of low socioeconomic status), the US EPA established short-term (one-hour) NAAQS for these pollutants in 2010. The one-hour SO_2 standard of 75 parts per billion (ppb) (196 micrograms per cubic meter of air (mcg/m^3)) went into effect in August 2010 (US EPA, 2010b), and the one-hour NO_2 standard of 100 ppb (188 mcg/m^3) went into effect in April of 2010 (US EPA, 2010). Ravena is located in Albany County which is in the Albany-Schenectady-Troy NAAQS region. Based on past criteria pollutant monitoring, the Albany-Schenectady-Troy region currently complies with these as well as all other health based NAAQS (US EPA, 2011 http://epa.gov/oaqps001/greenbk/ancl.html). This means that for the Albany-Schenectady-Troy region, regional SO_2 and NO_2 levels are below applicable federal health-based levels and the general public is not likely to experience health effects. However, because the modeling results and air dispersion contour plots (see Appendix A) suggest that the short-term air comparison values for these compounds (NYS DEC SGCs) might be exceeded on hilltops in the western portion of the area when weather limits atmospheric mixing, we consider the public health implications of short-term excursions in SO_2 and NO_x (assuming all emissions are NO_2) further.

Studies of people with asthma have shown that breathing air with levels of SO_2 close to the maximum short-term level of 585 micrograms of SO_2 per cubic meter of air predicted by the model during five or ten minutes of vigorous indoor exercise can cause reversible declines in respiratory function (US EPA, 2010b). Studies have also suggested that short-term exposures to NO_2 concentrations close to the modeled, maximum, short-term level of 282 mcg/m^3 of NO_2 may temporarily decrease lung function in people who have respiratory disease (US EPA, 2010).

If, on occasion, hourly concentrations are as high as the model predicts, people working or exercising outdoors (e.g., farming, hiking) in the undeveloped or sparsely populated areas where elevations occur, could be at greater risk of experiencing respiratory symptoms, particularly if they already have respiratory disease.

Further, the 2004 stack emissions test reported results for NO_x, which include NO_2 and other nitrogen compounds. For our analysis, we are assuming that all the NO_x emissions are NO_2. This approach is a conservative one with respect to potential health impacts. Since some of the NO_x emissions may be compounds that are not NO_2, and that do not change into NO_2, this assumption will overestimate the cement plant's contribution to ground-level NO_2 concentrations. Motor vehicles are a primary source of NO_x to ambient air, and levels are likely to be greater near roadways. For this reason, US EPA requires that compliance with the NO_x NAAQS be based, in part, on near-road monitoring for NO_2. Traffic on US Route 9W and the NYS Thruway (Interstate 87) is an additional source for NO_x in the Ravena community.

Ozone is not emitted by the kiln stack, but NO_x and VOCs contribute to formation of ozone, another criteria pollutant that can cause adverse respiratory and cardiovascular effects. The Albany-Schenectady-Troy region meets the current NAAQS for ozone based on the most recent ozone ambient monitoring data (using the 3-year average of the 4th highest values, US EPA, 2011, http://epa.gov/oaqps001/greenbk/ancl.html). However, during the warm weather months, there are days when the average eight-hour ozone concentration is above the health based standard. On days when the eight hour average of ozone is 75 ppb or above, people who actively work or exercise outdoors and people who already suffer respiratory problems may experience shortness of breath, a burning sensation in their chest or aggravation of their usual respiratory

problems. You can find daily air quality information about ozone air levels across New York State on the NYS DEC website (http://www.dec.ny.gov/cfmx/extapps/aqi/aqi_forecast.cfm).

In summary, possible excursions of SO_2 and NO_2 above short-term air comparison values at the hilltop locations identified by the air dispersion modeling are not anticipated to be of health concern to the general public. Although excursions above air comparison values might be a concern for those with pre-existing respiratory conditions, it is unlikely that vulnerable people will be present at the exact locations the air dispersion model predicts excursions might occur or at the same time such excursions might occur.

2. Contaminants in Cement-related Dust

We do not have any information about the specific chemical composition or chemical concentrations in settled dust in the community around the cement plant. Settled dust can remain on surfaces, or can be resuspended if it is disturbed. Therefore, the public health implications of settled dust, which could include dust originating from the cement plant, are discussed qualitatively.

Resuspended Dust

Typical outdoor settled dust, including dust that contains some clinker or cement dust, is composed of a mixture of coarse and fine particulates that can become airborne. Coarse particulates are also referred to as thoracic particles because if you breathe them in they can travel beyond the mouth and nose (the head airways) to the bronchial region of the respiratory tract, located in the thoracic (chest) cavity, where they might cause irritation and produce symptoms such as coughing (US EPA, 2009; Foster and Costa Eds., 2005). Short-term inhalation exposures to airborne or resuspended dust can irritate the respiratory system causing a variety of symptoms such as itching and watery discharge from the nose, a scratchy or sore throat, coughing, chest tightness, wheezing or shortness of breath. People with pre-existing lung diseases, such as chronic obstructive pulmonary disease (COPD) might find their conditions aggravated by exposure to resuspended dust. However, community concerns that prompted the settled dust sampling focused on property damage (soiling) not reports of health effects.

Clinker and cement dust is made up mostly of calcium compounds (calcium silicates, calcium aluminates and calcium sulfates) and may also contain trace amounts of chromium or nickel. If dust containing clinker or cement dust is inhaled in small amount for short periods, the soluble calcium compounds present are likely to be quickly cleared from the respiratory tract and lungs, and so are unlikely to pose a health threat (American Conference of Governmental Industrial Hygienists (ACGIH) 2001, New York City Department of Health and Mental Hygiene (NYCDOHMH) & ATSDR, 2002). The ability of the body to effectively remove calcium compounds is also thought to be why long-term respiratory effects are not seen even following long-term, high-level inhalation exposures to calcium compounds present in airborne dust in occupations such as mining (NYCDOHMH & ATSDR, 2002).

Settled Dust

Short-term exposure to large amounts of cement or clinker dust on the skin might cause irritation (redness, swelling, heat, and pain) or chemical burns if it is wet (from mixing with water before

contact). Irritation might also result when cement or clinker dust contacts moist membranes like the eye, nose, throat or sweaty skin. People with chromium or nickel hypersensitivity might find their conditions aggravated by skin contact with clinker or cement dust if it contains chromium or nickel. Breathing high concentrations of silica in air for long periods of time (years) has been associated with lung diseases such as silicosis and lung cancer (NYCDOHMH and ATSDR, 2002). Some, but not all studies of workers in the portland cement industry have reported changes in some measures of lung function (ACGIH, 2001, Nordby et al., 2011).

Lafarge has instituted a number of strategies to limit fugitive releases and off-site migration of dust, and thus community exposures to the dust. Those strategies include fabric filters, electrostatic precipitators, covered conveyors, covers, shrouds, sheds, and application of water to unpaved roads, loaded cement trucks, material storage piles, and dust designated for disposal in the on-site landfill.

The adjacent Callanan's facility also used exhaust filtration and watersprays to control dust from conveyors, and unpaved roads. The existing Callanan processing operations were terminated at the Ravena site at the end of 2011. The termination of Callanan aggregate processing operations will eliminate fugitive dust from its operations and air pollutant emissions from the related truck traffic (NYS DEC, 2011).

Based on the above (i.e., small amounts of dust, low expected toxicity), settled dust containing cement or clinker is not anticipated to be of public health concern to the general public or to vulnerable (e.g., those with pre-existing respiratory conditions) individuals. The chemical composition of dust containing cement or clinker is not likely to impart properties that make the dust any more harmful than settled dust that is typically present outdoors. Moreover, dust control strategies at the plant are enforced by NYS DEC and will continue to be enforced under Title V permits.

D. HARVARD UNIVERSITY SCHOOL OF PUBLIC HEALTH BIOMARKER STUDY

In May 2010, researchers from the Harvard School of Public Health (HSPH) collected hair and blood samples from volunteers who lived within ten miles of the Ravena cement plant and agreed to have their blood and hair, or their children's blood and hair analyzed for metal content. Studies that look at chemicals in biological specimens such as blood, hair, urine or saliva, are called biomarker studies. For some, but not all of the metals looked at in the HSPH study, scientists have found that the levels in biological specimens may be related to environmental exposures. For example, an ATSDR Fact Sheet (ATSDR, 2009) developed to help health care providers assess patients' mercury exposure, provides some background information on what we know about biomarkers of mercury exposure:

- Urine levels of mercury provide the most appropriate assessment of acute and chronic elemental mercury exposure.
- Mercury has a short half-life in blood of about 3 days, (so blood analysis may be useful when it is done during the first 3 days after an acute, high level, elemental mercury exposure).
- Elevated blood mercury levels may be due to chronic or very recent (in the 1-3 days before blood sampling) dietary sources of organic mercury.
- A blood concentration of 50 mcg/L or greater is considered the threshold for

symptoms of mercury toxicity.

- Hair analysis for mercury primarily reflects past organic (methyl) mercury exposure (the predominant form of mercury found in fish) and is not useful for assessing recent exposures (those that occurred within the previous month).

The relationships seen for mercury are unique to mercury exposure and cannot be applied to exposures to other metals. For example, suspected exposures to lead are routinely evaluated through blood tests, but suspected arsenic exposures are evaluated through urine testing. Blood tests for arsenic and urine tests for lead would not indicate what type of arsenic or lead exposure had occurred, because no consistent relationship between these biomarkers and exposure has been established.

In a presentation given to the community on January 6, 2011, the HSPH researchers summarized their preliminary data for mercury, lead and cadmium in blood (note: they reported that the laboratory used for the analysis does not hold New York State certification for measuring lead in blood), and described some of their preliminary findings for arsenic, selenium and aluminum in blood, and mercury in hair. The researchers compared the mercury, lead and cadmium blood levels found in the study participants to recent national results from an ongoing biomarker study in the United States, called the National Health and Nutrition Examination Survey (NHANES, Centers for Disease Control and Prevention (CDC), 2009). Overall, the results for lead, cadmium and mercury in blood for the participants in the HSPH study appear to fall in the range of results seen in the NHANES surveys.

Other researchers have looked at the 1999-2006 NHANES data and found that there were regional differences in women's blood mercury concentrations (Mahaffey et al., 2009). Average blood mercury levels in women were higher in the Northeast compared to the West, Midwest and South, and in women who lived along the coasts (Atlantic, Pacific and Great Lakes). The higher average levels in the Northeast have been attributed to the relatively higher rate of mercury deposition in the Northeast due to upwind sources in the Midwest. The authors attributed the higher average blood mercury levels for women living along the coasts (marine and freshwater) to greater access to seafood. In 2007, NYCDOHMH reported blood mercury results from the City Health and Nutrition Examination Survey (C-HANES) (McKelvey et al., 2007). Although differences in the study design, survey questions and sample populations between the HSPH study and HANES surveys need to be considered when comparing results from different studies, these preliminary results suggest that blood mercury levels in the Ravena community are not unusual.

When blood mercury levels of New York State residents are found to exceed 5 nanograms of mercury per milliliter of blood (ng/mL), the analytical testing laboratory (which must hold a NYS permit under NYS Public Health Law Article 5, Title V Section 574) is required to notify the NYS Heavy Metals Registry. In June 2011, the NYS Heavy Metals Registry received completed reports for 13 adult participants in the HSPH study whose blood mercury levels exceeded 5ng/mL. None of the blood mercury levels reported was unusually high when compared with blood mercury levels common in the general population. Although some values were above the NYS HMR reportable levels, the values were below blood levels at which NYS DOH conducts follow-up activities to learn more about potential exposures and suggest strategies to reduce exposures. Each of these participants was notified of their blood mercury level results by letter from the NYS DOH on June 27, 2011. These participants were also

provided information about mercury, how people are most often exposed to mercury (via seafood in their diet), and the potential adverse health effects associated with mercury exposure.

E. HEALTH OUTCOME DATA REVIEW

The Final Phase One HC included a summary and detailed explanation of community-wide health outcome information for the ZIP code areas surrounding the cement plant. Health outcomes summarized included: numbers and rates of respiratory and cardiovascular hospitalizations for 1997 to 2006; observed and expected number of cancer cases for 2002 to 2006; numbers and rates of perinatal (the time around birth) health outcomes for 1998 to 2007; incidence rate of elevated child blood lead levels for 2005 to 2007; and, numbers and rates of children in the local school district receiving services for developmental disabilities for 2003 to 2008. Overall, although statistical comparisons were not made in the Phase One HC, the health outcome rates appeared similar to rates across New York State.

Health outcome rates were presented in the Final Phase One HC because members of the community expressed a desire to understand the health status of their community. This information was also presented in the Final Phase One HC to illustrate the types of health outcomes that could be examined in greater detail if exposure pathway analyses in this Phase Two PHA found that air levels of contaminants released from the cement plant exceeded air comparison values or that dust from the cement plant might harm health. If exposure pathway analyses suggested possible harmful exposures, then the rates of one or more of these health outcomes could be examined for a longer period of time and/or for a smaller, potentially impacted population within the ZIP code areas.

While this Phase Two PHA found that neither air nor dust releases from the cement plant are likely to have harmed the health of the general public, because of continuing community interest in the health status of the Ravena area, we have further evaluated some of the health outcome data presented in the Final Phase One HC to include statistical comparisons of ZIP code area health outcome rates with appropriate comparison areas. Thus, this Phase Two PHA summarizes health outcomes for additional comparison areas and provides statistical comparisons. This Phase Two PHA also provides updated information from the 2010 Census which became available since completion of the Phase One HC. Here, demographic and health outcome data are compared against those in 1) Albany County, since approximately 85 percent of the population under review resides in Albany County; 2) a combination of Albany, Rensselaer, Greene and Columbia Counties, since individuals in portions of each of these counties are included in the review; and 3) New York State, excluding New York City, to provide a large general population. Although informative, these types of statistical comparisons cannot prove a causal relationship between the occurrence of a health outcome and a specific pollution source, rather they can distinguish between communities with significantly different health outcome rates which, in turn, can lead to additional public health actions.

As was done previously, health outcomes are presented for ZIP codes in the vicinity of the Ravena cement plant. Readily available health records often contain a ZIP code of residence, which allows for the identification and tabulation of health outcome data at the ZIP code level. In this type of public health surveillance activity, health outcome rates are examined across ZIP codes (or counties, or states or time periods) to identify unusual patterns and trends when compared to those in other areas or the general population.

1. Sources of Community Wide Health Outcome Data (HOD)

A variety of types of HOD are available for describing health in a specific community. In the Phase One HC and in this Phase Two PHA data review, we used data from NYS DOH's Vital Records (births), Cancer Registry, Congenital Malformations Registry (birth defects), and Statewide Planning and Research Cooperative System (SPARCS) hospitalization data. These data sources are thoroughly described in the Final Phase One HC.

The NYS DOH has used these types of HOD for many years to conduct community health assessments that evaluate disease patterns or trends. We also used NYS Education Department's (NYS ED) Strategic Evaluation, Data Collection, Analysis and Reporting (SEDCAR) to evaluate developmental disabilities in school children. Definitions and health outcomes summarized in this PHA are presented in Table 4. However, it should be noted that in order to preserve confidentiality, reports from these databases may not provide numbers of cases when there are very few cases (e.g., less than five) within smaller categories, such as when looking at occurrences in a specific ZIP code, or age class.

2. Health Outcome Data - Area for Review

Using air dispersion modeling for guidance, the Final Phase One HC identified five area ZIP codes surrounding the Ravena cement plant, where at least 40 percent of the population fell within the potentially impacted area. These are 12143, Ravena; 12158, Selkirk; 12046, Coeymans Hollow; 12156, Schodack Landing, and 12087, Hannacroix. In addition, the Ravena ZIP code (12143) contains what is known as a point ZIP code or a Post Office only ZIP code, Coeymans; 12045. Because this ZIP code has no defined geographic area, it is difficult to determine a population for it, so it was included in the Ravena ZIP code. The contour maps for the kiln stack emissions from the 2004 stack test presented in this Phase Two PHA (Appendix A, Figures 1–3) provide further confirmation of the selection of these ZIP codes for the health outcome data review.

3. Health Outcome Data - Analysis

The HOD analysis summarizes up to ten years of available data, depending upon the outcome and data source. Rates for each health outcome are calculated for each area ZIP code separately, for all ZIP codes combined, and for three comparison areas. Age-adjusted rates were calculated for respiratory and cardiovascular outcomes since these outcomes are influenced by age. Significance testing using 95 percent confidence intervals (CI) was conducted for all health outcomes (shown only for cancer incidence, Table 6) to indicate whether differences in rates between the ZIP codes evaluated and comparison area rates were greater than expected by chance alone (i.e., statistically significant). Even if a ZIP code rate is statistically significantly different than the comparison areas' rates, this does not tell us the reason for the difference. Health outcome rates are influenced by multiple factors, and each needs to be considered when exploring reasons for differences in rates between areas.

Because rates based on very small numbers are difficult to interpret, the Cancer Registry provided the number of cases observed in the five area ZIP codes and the number of cases that would be expected in a population of similar size and age. For these, a Standardized Incidence

Ratio (SIR) and a 95 percent CI are provided. An SIR is a ratio of the observed over the expected number of cases. If the SIR is greater than one, more cases of a disease are seen in the area compared to what would be expected in a population of similar size and age. The 95 percent CI provides a basis for significance testing and tells us if the observed measure is stable. A wide CI, is typical in studies of small populations and rare diseases. A wide CI indicates that the actual measure could be quite different from what we observed whereas a narrow CI tells us that the measure is likely very close to what we observed.

4. Health Outcome Data - Results

Based on the 2000 and 2010 Census data presented in Tables 1 and 2, about 15,000 people live within the five area ZIP codes (see Figure 1). The two larger ZIP codes in the area (12143, 12158) each have about 6,000 people, while the three smaller ZIP codes (12046, 12156, 12087) have between 600 and approximately 1,500 people. In ZIP codes with small populations, it is often difficult to generate meaningful health outcome rates because of the small number of cases. This is especially true of rare diseases. Because of this, health outcome data are presented for all ZIP codes combined as well as for each individual area ZIP code.

a. Respiratory and Cardiovascular Disease

Respiratory and cardiovascular disease hospitalization rates are summarized in Table 5. Total (all ages) asthma hospitalization rates in individual ZIP codes and the combined ZIP code area were lower than in the four-county area, and significantly lower than rates in Albany County and statewide. Childhood asthma hospitalization rates were also lower in the combined ZIP codes than those in all comparison areas. However there were some differences between ZIP codes. Rates of childhood asthma in the Selkirk ZIP code, 12158 were significantly higher than in the four-county area, while rates in the Ravena ZIP code, 12143, were significantly lower than rates in Albany and the four-county area.

Chronic obstructive pulmonary disease (COPD) hospitalization rates and chronic bronchitis hospitalization rates (which account for more than three quarters of COPD hospitalizations) were significantly higher in the combined ZIP codes than in both Albany County and New York State excluding New York City. Myocardial infarction (a type of heart attack) hospitalization rates as well as rates for all cardiovascular disease hospitalizations were similar to Albany County rates, but significantly lower than statewide rates and rates in the four-county area.

b. Cancer

Cancer rates are summarized in Table 6. All observed cancer counts are within the expected ranges for each of the cancer sites examined among both males and females (adults and children combined) based on statewide rates. Although not statistically significantly higher than expected, non-Hodgkin's lymphoma among women and breast cancer among women were slightly higher than expected. Among males, the lung cancer rate was elevated, but was not statistically significantly higher than expected. Total childhood cancers in the combined ZIP codes were also examined between 2002 and 2006. There were about one-third fewer cases of childhood cancer than would be expected in a population of this size over five years. The exact number of cases was too small to include in the table without compromising confidentiality.

As discussed in the Final Phase One HC, NYS DOH Cancer Registry staff was contacted about concerns that a rare form of childhood bone cancer, known as Ewing's sarcoma, was elevated in the RCS area. Staff checked the NYS DOH Cancer Registry files for cases of Ewing's sarcoma reported since 2000 in the five area ZIP codes near the Ravena cement plant (the point ZIP code 12045 was also included) plus an additional ZIP code (12054). The number of cases identified in the area was too small to draw any conclusions, consistent with the fact that Ewing's sarcoma is very rare. There is about one case per year per 250,000 children under age 20 in New York State, excluding New York City. (We are unable to report the exact number of cases confirmed due to policies for protecting confidentiality of individuality in small populations.)

c. Perinatal Health

Perinatal (the time around birth) and childhood health outcome counts and rates are summarized in Table 7. In the 10-year period from 1998–2007, the rates of low birth weight and the prematurity measures examined were all similar to those expected, based on both state and county comparison groups. However, the sex ratio was unusually high for ZIP code 12046, where there were 37 male and 19 female singleton births during the 10-year period (sex ratio=1.9). Fourteen children were born with one or more of 45 types of birth defects examined among births occurring in the six ZIP codes for the five-year period from 2000–2004 which is similar to the number that would be expected in a population this size based on countywide or statewide rates.

d. Developmental Disability Data

There are four public schools located in the five ZIP codes examined: the Ravena Senior High School and Middle school; the Albertus W. Becker Elementary School; and the Pieter B. Coeymans Elementary School. All are within the RCS School District.

Data on students receiving Special Education Services for Disabilities from the NYS ED SEDCAR are summarized in Table 8 and Table 9. Table 8 shows data for several developmental disabilities, including autism, for the RCS School District for a five school-year period (2003–2008) and for all school districts in Albany County combined. Information from the NYS ED's annual school report card database was used to obtain enrollment information for the districts to use as a denominator (NYS ED, 2009).

Several types of disabilities for which data are collected by NYS ED are shown: autism, emotional disturbance, learning disability, mental retardation and "other health," which includes attention deficit disorder (ADD) and attention deficit hyperactivity disorder (ADHD) among many other conditions. Definitions of these disabilities can be found in Table 4.

Rates of autism in the RCS School District were similar to those in other Albany County school districts. Rates of students classified as having emotional disturbances and learning disabilities were significantly higher in the RCS School District than in the rest of Albany County (Table 8). Rates of all 13 classes of disabilities combined were higher in the RCS School District than in school districts in Albany County. As stated previously, no statewide percentages are presented here because summarizing data from all schools would not be appropriate. Rates of mental retardation were significantly lower in the RCS School District compared to other districts in

Albany County, while rates of "other health" disabilities (Table 8) in the RCS School District were similar to those in other Albany County school districts.

Table 9 shows the percentages of enrolled children identified as having disabilities in all districts in the four counties surrounding the cement plant having student enrollment of more than 1,000. This table gives readers an idea of the variation in the rates of children receiving services for disabilities from one district to the next, even among neighboring districts. The districts are grouped by Needs to Resource Capacity (N/RC) within each county. The NY SED classifies public school districts across the state into high, average and low N/RC based on their ability to meet students' needs relative to their ability to generate resources locally. Specifically, according to NY SED:

> "The need/resource-capacity index, a measure of a district's ability to meet the needs of its students with local resources, is the ratio of the estimated poverty percentage[3] (expressed in standard score form) to the Combined Wealth Ratio[4] (expressed in standard score form). A district with both estimated poverty and Combined Wealth Ratio equal to the State average would have a need/resource-capacity index of 1.0." (http://www.p12.nysed.gov/stateaidworkgroup/2011-12RSAP/RSAP1112final.pdf).

N/RC categories are then defined as high, average or low based on the percentile into which a district's N/RC score falls. (Districts in the high need category are further subdivided based on size and population density.) The RCS school district has an N/RC of 5 meaning it has average needs to resources (between the 20th and 70th percentile) compared to other districts in the state. High N/RC school districts generally have more poverty, lower test scores and higher dropout rates yet may not be as able to provide resources to students as districts in lower N/RC categories.

As discussed in the Final Phase One HC, neither the review of health outcome data sources done by the Environmental Public Health Tracking (EPHT) project nor the Environmental Justice HOD Workgroup included these NYS ED data in the top category of health data sources. This is because of differences in identification, classification and reporting of disabilities between public school districts that can lead to apparent variation in rates of disabilities among districts due to reporting differences, rather than to actual differences in the rates of disabilities. There is also uncertainty in disability rates for public school districts because children with special education needs who do not attend public schools may be included in disability counts but not in the enrollment counts of the district. In addition, parents may choose to relocate to districts they believe are better able to provide services for children with disabilities, thus inflating the rates in these districts. However, as noted in the Final Phase One HC, the NYS ED data are potentially useful. Recently the NYS ED has been working with school districts to identify and standardize identification and reporting of disabilities.

5. Health Outcome Data Summary

This HOD review compared health outcome rates in the six ZIP code areas surrounding the Ravena cement plant to those in other parts of the state. This type of comparison is not an

[3] Estimated Poverty Percentage: A weighted average of the 2000-01 and 2001-02 kindergarten through grade 6 free- and reduced-price lunch percentage and the 2000 Census poverty percentage. (An average was used to mitigate errors in each measure.) The result is a measure that approximates the percentage of children eligible for free- or reduced-price lunches.

[4] Combined Wealth Ratio: The ratio of district wealth per pupil to State average wealth per pupil, used for 2000-01 aid."

analytical health study and cannot provide evidence of an association between emissions from the facility and the health outcomes evaluated. The goal of this review is to provide an overview of certain health outcomes in the area over the past five to ten years. As evident in Tables 5 through 9 and described in Table 4, several types of HOD were available for the six ZIP code area around the Ravena cement plant evaluated.

Most of the health outcome rates across the ZIP codes reviewed are similar to rates in Albany County, the combined population of Albany, Rensselaer, Columbia and Green counties and New York State, excluding New York City. There were some exceptions however, and they are discussed below.

Hospitalization rates for the respiratory diseases, COPD and chronic bronchitis were significantly higher than rates in Albany County and New York State, excluding New York City (Table 5). There are a number of personal risk factors for COPD and chronic bronchitis, but smoking is by far the biggest risk factor. However, smoking is also a major risk factor for myocardial infarction and cardiovascular disease, and hospitalization rates for these health outcomes in the six ZIP code area were significantly lower than rates in the four-county area and in New York State, excluding New York City. We do not know the smoking rates of the six ZIP code area. Thus, given the conflicting evidence of the COPD and heart disease hospitalization rates, it is difficult to speculate whether or not smoking contributed to the increased numbers of hospitalizations for COPD and chronic bronchitis. Studies in other areas of the country have found that air pollution (e.g., particulates, SO_2, ozone and NO_2) may play a role in worsening existing respiratory conditions, such as COPD, that could lead to an increase in the number of hospitalizations (US EPA, 2008, 2009, 2010, 2010a).

Hospitalization rates for childhood asthma were somewhat lower overall than hospitalization rates in the comparison areas (Table 5). Rates varied quite a bit between ZIP codes, however. In addition, hospitalization rates for cardiovascular disease as well as asthma among individuals of all ages in the area were significantly lower than in comparison areas.

Among perinatal and childhood health indicators only the sex ratio in ZIP code 12046 was significantly higher than expected (Table 7). This was based on a total of 56 full term singleton births, over a period of 10 years. While this includes averages for about 5 to 6 births a year, during some years the birth cohort was nearly all male and the pattern of excess male births is fairly consistent over time. Studies that have looked at elevated sex ratios at birth tend to attribute the elevation in the number of males to social and economic, rather than environmental factors (e.g., Bonde and Wilcox, 2007; Bulik et al., 2009; Catalano et al., 2008; Rueness et al., 2012; Wilcox and Baird, 2011). Levels of several other outcomes of concern to the community, such as childhood cancer and birth defects, were similar to those expected.

The rates of children receiving services for two types of developmental disabilities examined (i.e., emotional disturbance, learning disability), as well as the rate for children receiving services for any type of disabilities, are higher in the RCS School District than in other districts in Albany County (Table 8).

The rate of children receiving services for autism was slightly lower in RCS School District than in other Albany County districts. Rates of children diagnosed with autism in the RCS School District as well in the rest of the county have been increasing over the last 10 years. The

increases observed locally mirror national trends of increased diagnoses of autism, which is approaching an average prevalence of 1 percent nationwide according to the CDC (2009).

The cause of most developmental disabilities is unknown and the rates for children receiving disability services may be affected by a number of factors unrelated to environmental pollution. Researchers believe that many factors, such as genetic makeup, maternal behaviors (e.g., smoking, alcohol use) and exposures to some environmental chemicals (e.g., lead, mercury, PCBs) may all contribute. Scientific and epidemiological studies have not established a link between autism and mercury exposures. More information about possible causes of learning disabilities or autism is available from the National Institute of Child Health and Human Development (http://www.nichd.nih.gov/) or the CDC (http://www.cdc.gov/ncbddd/dd/).

F. NYS DOH AND ATSDR CHILD HEALTH CONSIDERATIONS

ATSDR and NYS DOH consider children when evaluating exposure pathways and potential health effects from environmental contaminants. We recognize that children are of special concern because of their potential exposures during play and other behaviors. Children and adults may differ in their susceptibility to the effects of hazardous chemicals, but whether there is a difference depends on the chemical. Children may be more or less susceptible than adults to health effects from a chemical and that susceptibility may change with age and behavior. We consider these differences when developing the comparison values that are used to screen environmental data, deliberately taking care to be protective of those most at risk.

The HOD review looked at a number of outcomes in children. This included rates of childhood asthma hospitalizations, childhood cancer incidence and an investigation of Ewing's sarcoma. In addition, we examined the rates of several types of developmental disabilities among children in the RCS School District, including autism. We also examined perinatal outcome rates including low birth weight, prematurity and birth defects among children born to mothers living in the area.

COMMUNITY HEALTH CONCERNS

From the 1960s to the 2000s there were isolated complaints of property damage and respiratory effects and asthma associated with dust releases from the plant. Community concerns were also recorded in spoken and written comments in 2005 on an application by Lafarge to NYS DEC to burn tire derived fuel. The comments included concerns about emissions of heavy metals, PCBs, VOCs, dioxins, furans and other tire components. Those commenting expressed concerns about the possible contribution of cement plant emissions to cancer, Parkinson’s disease, asthma, altered intelligence quotients (IQ), rheumatoid arthritis, lupus and other health conditions in the community around the Ravena cement plant. Highlighted among the concerns was the possible impact of mercury emissions from the cement plant on the health of school children and employees at the RCS Middle and High Schools. These issues were also raised with the RCS School District Superintendent in 2008 by individuals representing CASE, and at the December 2010 public meeting for the Phase One HC. This public health assessment was released for a public comment period which ran from March 22, 2013 to May 17, 2013. NYS DOH received no comments from the public.

CONCLUSIONS

Air Emissions

NYS DOH and ATSDR conclude that breathing the ground-level concentrations of metals (e.g., mercury, selenium), PAHs, PCBs, carbon monoxide, lead, PM, dioxins, furans, hydrocarbons, VOCs and ammonia from the Ravena cement plant kiln stack emissions is not expected to harm people's health. The reason for this is ground-level air concentrations of these chemicals are below levels of health concern.

NYS DOH and ATSDR conclude that for the general population, breathing maximum, modeled, ground-level concentrations of criteria pollutants (e.g., NO_2, SO_2, PM) emitted from the kiln stack, is not expected to harm people's health. Although maximum modeled peak, short-term (one-hour) concentrations of SO_2 and NO_2 are above applicable air comparison values, they are below levels of respiratory health concern for the general public, and occur at isolated hilltop locations.

Dust

NYS DOH and ATSDR conclude that touching, breathing or accidentally eating dust from the Ravena cement plant is not expected to harm the health of people who reside, work or attend school in the community. Settled dust from a variety of sources (e.g., traffic, agriculture, quarries, industry), is typically present in any community), and consists mostly of larger particulates that may cause eye or respiratory irritation. These are temporary effects and are unlikely to harm health. Settled dust containing some cement or clinker cooler dust may contain more calcium compounds than other kinds of dust, but contact with dust containing calcium or trace amounts of other compounds is not expected to harm health.

Health Outcomes

NYS DOH and ATSDR conclude that incidence and/or rates for most health outcomes and childhood developmental disabilities for the six ZIP code area are in general, similar to other areas in the region and state. However, in some ZIP codes there is an elevated rate of hospitalization for COPD, a disease commonly related to smoking history, which could suggest an increase in exacerbations or indicate people with more severe or poorly controlled disease in this population. People with lung diseases such as COPD or asthma can have their conditions exacerbated by exposure to indoor and outdoor gaseous and particulate pollutants.

The rates of children receiving services for two types of developmental disabilities examined (i.e., emotional disturbance, learning disability), as well as the rate for children receiving services for any type of disabilities, are higher in the RCS School District than in other districts in Albany County. The cause of most developmental disabilities is unknown and the rates for children receiving disability services may be affected by a number of factors unrelated to environmental pollution.

RECOMMENDATIONS

- Episodes or observations of off-site dust migration should be reported to NYS DEC Region 4 at 518-357-2350.
- NYS DOH will continue to provide support to NYS DEC for permit activities.
- NYS DOH and ATSDR recommend that people with respiratory and cardiovascular conditions pay attention to Air Quality Advisories and be aware that SO_2, NO_2 or other air pollutants may exacerbate their conditions.

PUBLIC HEALTH ACTION PLAN

- NYS DOH will continue to work with NYS DEC to announce regional air pollution advisories to let residents, school systems and local health departments know when outdoor physical activities should be limited to protect health.
- NYS DOH and NYS DEC will continue to respond to citizen complaints of off-site dust migration and to work with Lafarge to control on-site dust sources to prevent migration off-site.
- NYS DOH will continue disease surveillance activities to identify unusual patterns of disease.
- ATSDR and NYS DOH physicians and toxicologists will continue to provide assistance to private physicians concerned about their patients' exposure to environmental hazards.

REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 2009. Evaluating Mercury Exposure: Information for Health Care Providers. Atlanta, GA. Accessed 2/10/2011 http://www.atsdr.cdc.gov/mercury/docs/InfoHealthCareProviders.pdf.

ATSDR. 2010. Minimal Risk Levels for Hazardous Substances. Accessed January 2011 http://www.atsdr.cdc.gov/mrls/mrllist.asp.

ATSDR Health Guideline Values. SEQUOIA database updated February 2011.

American Conference of Governmental Industrial Hygienists (ACGIH). 2001. Portland Cement Documentation of the Threshold Limit Values and Biological Exposure Indices 7Th Edition Cincinnati, OH.

Bonde JP and A. Wilcox 2007. Ratio of Boys to Girls at Birth *BMJ* 334:486-487.

Bulik, C. Von Holle A. Gendall K. Lie K. Hoffman E. Torgersen L. Reichborn-Kjennerud T. 2009. Maternal Eating Disorders Influence Sex Ratio at Birth *Obstetrical and Gynecologic Survey* 64(1):9-10.

California Air Resources Board. 2010. Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values. Air Resources Board and Office of Environmental Health Hazard Assessment. Accessed January 2010 http://www.arb.ca.gov/toxics/healthval/healthval.htm.

Catalano R, Bruckner T, Smith K. 2008. Ambient Temperature Predicts Sex Ratios and Male Longevity *PNAS* 105(6):2244-2247.

Department of Health and Human Services Centers for Disease Control and Prevention (CDC). 2009. The Fourth National Report on Human Exposure to Environmental Chemicals, http://www.cdc.gov/exposurereport/pdf/FourthReport.pdf.

Foster, Michael W. and Daniel L. Costa Editors. Air Pollution and the Respiratory Tract Second Edition Lung Biology in Health and Disease Volume 204. 2005 Taylor and Francis Boca Raton, FL.

Mahaffey K, Clickner R, Jeffries R. 2009. Adult Women's Blood Mercury Concentrations Vary Regionally in the United States: Association with Patterns of Fish Consumption (NHANES 1999–2004). *Environ Health Perspect* 117:47–53.

McKelvey W, Gwynn C, Jeffery N, Kass D, Thorpe L, Garg R, Palmer C, Parsons P. 2007. A Biomonitoring Study of Lead, Cadmium, and Mercury in the Blood of New York City Adults *Environ Health Perspect* 115:1435–1441.

New York City Department of Health and Mental Hygiene (NYCDOHMH) and ATSDR. 2002. Final Report of the Public Health Investigation to Assess Potential Exposures to Airborne and Settled Surface Dust in Residential Areas of Lower Manhattan. Atlanta GA.

New York State Department of Environmental Conservation (NYS DEC). 2010. DAR-1 AGC/SGC Tables Accessed January 2011 http://www.dec.ny.gov/chemical/30560.html.

NYS DEC. 2011. State Environmental Quality Review (SEQR) Findings Statement, Lafarge Ravena Plant Modernization, Town of Coeymans, Albany County, New York July 19, 2011.

NYS DEC and New York State Department of Health (NYS DOH). 2006. New York State Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document. http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf.

NYS DEC and NYS DOH. 2002. Final Stipulations KeySpan Energy Development Corporation Spagnoli Road Energy Center.

New York State Department of Health 2013 (NYS DOH) Health Consultation Lafarge Cement Plant, Ravena, Albany County New York: Summary of Environmental Data and Exposure Pathway Evaluation; Health Risk Assessments; and Health Outcome Data.

New York State School Education Department (NY SED). 2009. The New York State School Report Card. Access 4/11/2011 http://www.p12.nysed.gov/irs/reportcard/.

Nordby, K-C, Fell A, Noto H, Eduard W, Skogstadt M, Thomassen Y, Bergamaschi A, Kongerud J, Kjuus H. 2011. Exposure to thoracic dust, airway symptoms and lung function in cement production workers. Eur. Respir. J 38:1278-1286.

Rueness J, Vatten L, Eskild A. 2012 The human sex ratio: effects of maternal age. Human Reproduction 27(1):283–287.

US Department of Justice 2010 Press Release United States Announces Two Major Clean Air Act New Source Review Settlements at 28 Industrial Plants Nationwide. Accessed February 2010 http://www.justice.goc/opa/pr/2010/January/10-enrd-059.html.

US Environmental Protection Agency (US EPA). 2011. National Emission Standards for Hazardous Air Pollutants From the Portland Cement Manufacturing Industry and Standards of Performance for Portland Cement Plants; Denial in part and grant in part of petitions to reconsider. Federal Register / Vol. 76, No. 95 / Tuesday, May 17, 2011.

US EPA. 2011a. Integrated Risk Information System. Accessed January 2011 http://www.epa.gov/iris/index.html.

US EPA. 2010. Primary National Ambient Air Quality Standards for Nitrogen Dioxide; Final Rule Federal Register 75(26):6474-6537. February 9, 2010. Accessed January 2011 http://www.epa.gov/ttn/naaqs/standards/nox/fr/20100209.pdf.

US EPA. 2010a. Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule; Final Rule Federal Register 75(106):31514-31608 June 3, 2010.

US EPA. 2010b. Primary National Ambient Air Quality Standard for Sulfur Dioxide; Final Rule

Federal Register 75(119):35520-35603 June 22, 2010. Accessed January 2011 http://www.epa.gov/ttn/naaqs/standards/so2/fr/20100622.pdf.

US EPA. 2010c. Final Rule National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry and Standards of Performance for Portland Cement Plants. Federal Register 75(174):54970-55066.

US EPA. 2009. Integrated Science Assessment for Particulate Matter (ISA). Center for Environmental Assessment- RTP Division, Office of Research and Development. /600/R-08/139F.

US EPA. 2008. National Ambient Air Quality Standards for Ozone (Ozone); Final Rule 40 CFR Parts 50 and 58.

Wilcox A and D Baird. 2011. Invited Commentary: Natural Versus Unnatural Sex Ratios - A Quandary for Modern Times. *Am J Epidemiol.* 174(12):1332-1334.

REPORT PREPARATION

This Public Health Assessment for the Lafarge Cement Plant was prepared by the New York State Department of Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented. ATSDR's approval of this document has been captured in an electronic database.

Authors – NYS DOH, Center for Environmental Health

Patricia Fritz, Research Scientist, Bureau of Toxic Substance Assessment

Steve Forand, Research Scientist, Bureau of Environmental and Occupational Epidemiology

Jan E. Storm Ph.D., Assistant Bureau Director, Bureau of Toxic Substance Assessment

Betsy Lewis-Michl Ph.D., Section Chief, Bureau of Environmental and Occupational Epidemiology

Elizabeth Prohonic, Program Research Specialist, Outreach and Education Group

Technical Advisors – NYS DEC

Donald Spencer, Regional Air Pollution Control Engineer, Division of Air Resources

Thomas Gentile, Section Chief, Bureau of Air Quality Analysis and Research

Randi Walker, Research Scientist, Bureau of Air Quality Analysis and Research

Margaret Valis, Section Chief, Bureau of Stationary Sources

ATSDR Reviewers

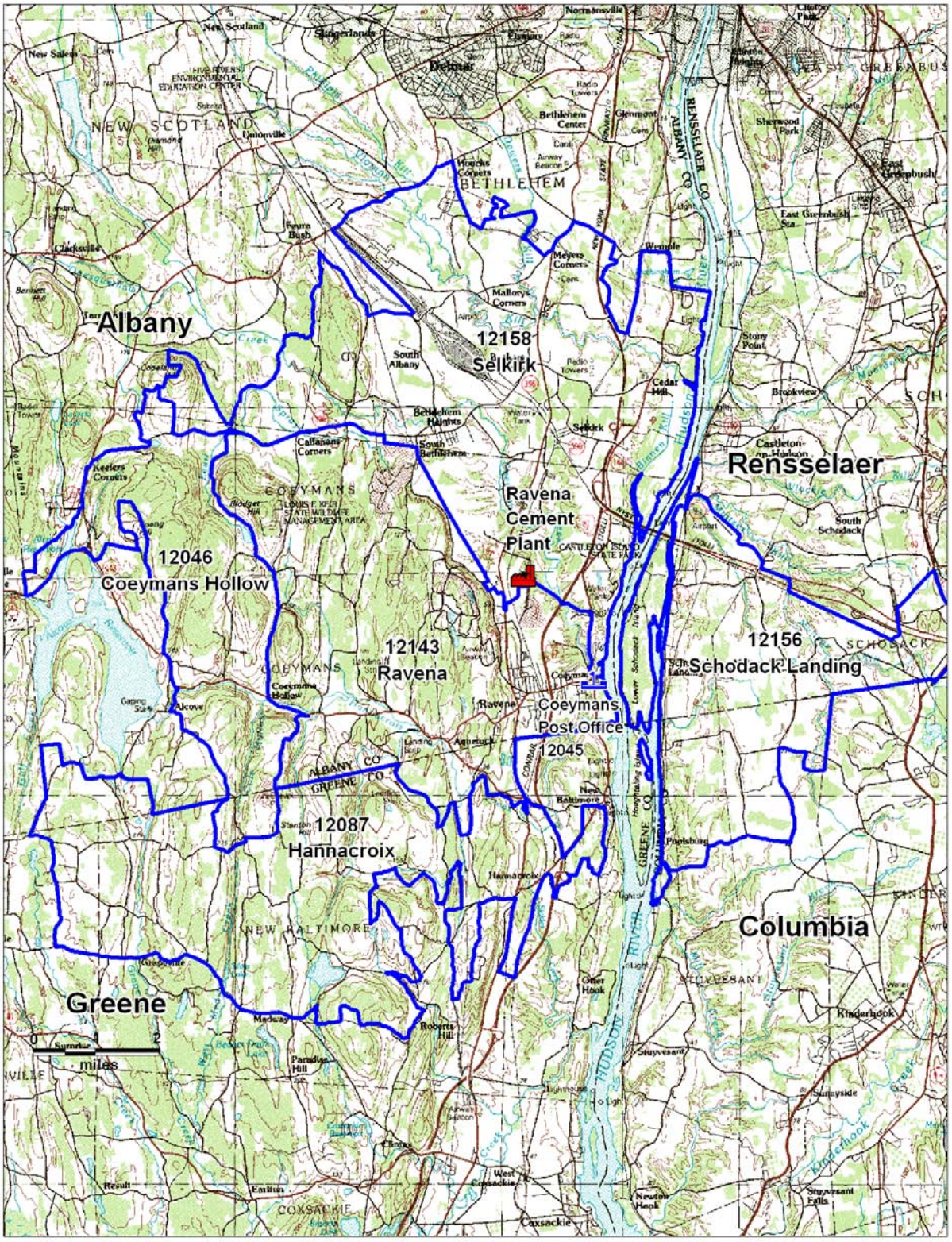
Gregory V. Ulirsch Ph.D., Technical Project Officer, Division of Community Health Investigations (DCHI)

Richard Gillig, Branch Chief, DCHI, ATSDR

Lynn Wilder, Assistant Director for Science, DCHI, ATSDR

FIGURES

Figure 1. Map of the area surrounding the Ravena cement plant showing the boundaries of the ZIP codes used for the Health Outcome Data Review in blue.



TABLES

Table 1. Demographics of the Six Area ZIP Codes (Individually and Combined), the Ravena-Coeymans-Selkirk (RCS) School District, Albany County, the Four County Area (Albany, Rensselaer, Columbia, Greene), and New York State Excluding New York City. Data are from the 2010 US Census and the 2005-2009 American Community Survey.

Census Demographics Estimates	12143 Ravena (including 12045 Coeymans)	12158 Selkirk	12046 Coeymans Hollow	12156 Schodack Landing	12087 Hannacroix	Six ZIP codes Combined	RCS School District	Albany County	Albany, Rensselaer, Columbia, Greene Counties	New York State (excluding New York City)
Total Population[1]	5,927	6,531	611	851	1,471	15,391	14,124	304,204	575,950	11,202,969
Percent Male	50.2	49.6	49.8	51.1	50.8	49.9	49.6	51.7	49.2	49.0
Percent Female	49.8	50.4	50.2	48.9	49.2	50.1	50.4	48.3	50.8	51.0
Age Distribution[1] **(%)**										
<6 years	6.7	6.9	4.7	6.2	6.9	6.7	6.4	6.0	6.1	6.9
6-19 years	19.6	20.1	18.8	17.5	17.8	19.5	18.3	17.9	17.8	19.0
20-64 years	61.2	59.6	62.8	61.8	59.8	60.5	61.4	62.2	61.5	59.6
>64 years	12.4	13.4	13.6	14.5	15.5	13.3	13.9	13.9	14.6	14.5
Race/Ethnic Distribution[1] **(%)**										
White	92.6	88.9	97.4	96.2	96.4	91.8	92.1	78.2	83.2	81.6
Black	3.2	6.2	<1	<1	1.5	4	4.2	12.7	9.5	8.7
Native American	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Asian	<1	2.1	<1	<1	<1	1.2	<1	4.8	3.4	3.4
Pacific Islander	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Other	1.2	<1	<1	<1	<1	<1	<1	1.6	1.3	3.4
Multi-Racial	2.1	2.2	1.1	3.2	1.1	2.1	1.8	2.5	2.4	2.3
Percent Hispanic	5.6	4.1	2.3	1.3	2.7	4.4	4.2	4.9	4.5	9.6
Percent Minority*	10.9	14.1	4.6	5.1	5	11.1	10.8	24	19	23.4
Economic Description[2]										
Median household income	$60,844	$70,467	$59,416	$71,594	$54,723	$64,458	$64,918	$55,349	$53,859	$59,127
Percent below poverty level	6	8.1	8.1	7.1	5	7	7.3	12.4	11.7	10.2

[1] US Census Bureau. Census 2010 Summary File 1 - New York State/ prepared by the U.S. Census Bureau, 2011.

[2] US Census Bureau 2005-2009 American Community Survey 5-Year Estimates Summary File Tracts and Block Groups. 2010.

Note- Following the 2000 Census, the Census Bureau discontinued use of the SF3 file and now uses the American Community Survey to provide estimates of socioeconomic and housing factors including, income, poverty, education and employment, housing value.

* Minorities include Hispanics, African Americans, Asian Americans, Pacific Islanders and Native Americans, Multi-Racial and Other Americans.

Table 2. Demographics of the Six Area ZIP Codes (Individually and Combined), Ravena-Coeymans-Selkirk (RCS) School District, Albany County, the Four County Area (Albany, Rensselaer, Columbia, Greene), and New York State Excluding New York City. Data are from the 2000 US Census.

Census Demographics Estimates	12143 Ravena (including 12045 Coeymans)	12158 Selkirk	12046 Coeymans Hollow	12156 Schodack Landing	12087 Hannacroix	Six ZIP codes Combined	RCS School District	Albany County	Albany, Rensselaer, Columbia, Greene Counties	New York State (excluding New York City)
Total Population[1]	6,247	6,276	649	838	1,366	15,376	14,505	294,565	558,392	10,968,179
Percent Male	48.6	48.6	53	50	51.1	49.1	48.6	47.8	48.7	48.8
Percent Female	51.4	51.4	47	50	48.9	50.9	51.4	52.2	51.3	51.2
Age Distribution[1] **(%)**										
<6 years	8	8.6	5.9	6.2	6.6	7.9	7.9	6.9	6.9	7.7
6-19 years	21.8	23.2	26	21.1	21.7	22.5	22.3	19.4	19.7	20.1
20-64 years	57.9	57.9	58.4	58.8	60	58.2	58.2	59.3	58.8	58.3
>64 years	12.3	10.3	9.7	13.8	11.7	11.4	11.7	14.5	14.5	13.8
Race/Ethnic Distribution[1] **(%)**										
White	94.1	90.7	99.2	96.3	97.4	93.3	93.4	83.2	87.0	84.9
Black	2.3	6	<1	1.7	<1	3.5	3.6	11.1	8.1	8.1
Native American	<1	<1	<1	<1	<1	<1	<1	<1	2.1	<1
Asian	<1	1.1	<1	1	<1	<1	<1	2.7	<1	2.4
Pacific Islander	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Other	1	<1	<1	<1	<1	<1	<1	1.1	1	2.4
Multi-Racial	2	1.5	<1	<1	1.1	1.6	1.6	1.7	1.5	1.8
Percent Hispanic	3.7	2.8	1.8	1	1	2.9	3.2	3.1	2.9	6.4
Percent Minority[2]	7.8	11.3	2.3	4.3	2.9	8.4	8.5	18.2	14.3	18.3
Economic Description[3]										
Median household income	$44,179	$51,522	$59,814	$53,865	$47,681	$49,163	$50,280	$42,935	42,385	$47,641
Percent below poverty level	7.3	5.7	5.7	5.1	6.9	6.4	6.4	10.6	10.3	9.7

[1] US Bureau of the Census. *2000 Census of population and housing summary file 1(SF1).* US Department of Commerce. 2001.
[2] Minorities include Hispanics, African Americans, Asian Americans, Pacific Islanders and Native Americans, Multi-Racial and Other Americans.
[3] US Bureau of the Census. *2000 Census of population and housing summary file 3 (SF3).* US Department of Commerce. 2002.

Table 3a. AERMOD Modeling Results for Estimated Maximum Ground-level Air Concentrations of Metals from Kiln Stack Emissions Using Appropriate Averaging Times for Short- and Long-Term Air Comparison Values (CV).

Metal	2004 Test			Air Comparison Value		Conclusion
	Emissions grams / second	Maximum Ground-level Concentration (mcg/m^3) and averaging time		Value (mcg/m^3)	Reference for CV	
Antimony	0.00030	0.000006	annual	1.2	AGC[1]	Ground-level concentrations are below levels of public health concern
Arsenic	0.00307	0.004642 0.000056	1-hour annual	0.2 0.00023 0.0002	CA EPA[2] 1- hour AGC CREG[3] lifetime	
Barium	0.00058	0.000011	annual	0.5	AGC	
Beryllium	0.00000422	<0.000001	annual	0.00042 0.0004	AGC CREG lifetime	
Cadmium	0.00024	0.000369 0.000034 0.000004	1-hour 24-hour annual	0.03 0.00024	ATSDR[4] acute AGC	
Chromium	0.00044	0.000008	annual	45	AGC	
Hexavalent Chromium	0.00002	0.000024 <0.000001	1-hour annual	0.1 0.00002	ATSDR acute AGC	
Cobalt	0.00003	<0.000001	annual	0.001	AGC	
Copper	0.00050	0.000763 0.000009	1-hour annual	100 0.02	SGC AGC	
Manganese	0.00136	0.000025	annual	0.05	AGC	
Mercury	0.00668	0.010084 0.000122	1-hour annual	0.6 0.09	SGC NYS DEC/DOH[5]	
Nickel	0.00034	0.000514 0.000006	1-hour annual	6 0.0042	CA EPA AGC	
Selenium	0.0111	0.000202	annual	48	NYS DEC/DOH	
Silver	0.00006	0.000001	annual	18	AGC	
Thallium	0.00212	0.000039	annual	0.048	AGC	
Vanadium	0.00031	0.00047 0.000006	1-hour annual	0.8 0.1	ATSDR acute ATSDR chronic	
Zinc	0.00897	0.000163	annual	45	AGC	

[1]New York State Department of Environmental Conservation 2010 DAR-1 AGC/SGC tables. The AGC/SGC tables list all the short term (one-hour) and Annual Guideline Concentrations (SGCs & AGCs), (II) Federal and State one-hour and annual air quality standards and (III) DAR-1 "equivalent" one-hour and annual air quality standards.

[2] California Office of Environmental Health Risk Assessment, 2010 Approved Risk Assessment Health Values.

[3] CREG ATSDR Cancer Risk Evaluation Guide for one in a million excess cancer risk

[4] Agency for Toxic Substances and Disease Registry 2010 Air Comparison Values , acute (1-14 days of exposure) minimal risk level (MRL) intermediate (14-364 days of exposure) MRL, or chronic (365 or more days of exposure) MRL.

[5] NYS DEC and NYS DOH 2006. New York State Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document http://www.dec.ny.gov/docs/remediation.

Table 3b. AERMOD Modeling Results for Estimated Maximum Ground-level Air Concentrations of Polycyclic Aromatic Hydrocarbons (PAH) from Kiln Stack Emissions Using Appropriate Averaging Times for Short- and Long-Term Air Comparison Values (CV).

PAH	2004 Test			Air Comparison Value		Conclusion
	Emissions grams / second	Maximum Ground level Concentration (mcg/m^3) and averaging time		Value mcg/m^3	Source of Air Comparison Value	
Acenaphthene	0.000844	0.000015	annual	210	NYS DEC/DOH[1]	Ground-level concentrations are below levels of public health concern
Acenaphthylene	0.00151	0.000275	annual	210	NYS DEC/DOH	
Anthracene	0.000832	0.000015	annual	0.02	AGC[2]	
Benzo(a) Anthracene	0.000112	0.000002	annual	0.02	AGC	
Benzo(a) Pyrene	0.0000318	<0.000001	annual	100	NYS DEC/DOH	
Benzo(b) Fluoranthrene	0.000123	0.000002	annual	100	NYS DEC/DOH	
Benzo(g,h,i)Perylene	0.0000286	0.000001	annual	100	NYS DEC/DOH	
Benzo(k)Fluoranthene	0.0000181	<0.000001	annual	100	NYS DEC/DOH	
Chrysene	0.000238	0.000004	annual	0.02	AGC	
Dibenzo(a,h)Anthracene	0.00000829	<0.000001	annual	100	NYS DEC/DOH	
Fluoranthene	0.0193	0.000038	annual	140	NYS DEC/DOH	
Fluorene	0.00239	0.000044	annual	140	NYS DEC/DOH	
Indeno(1,2,3-cd)Pyrene	0.0000116	<0.000001	annual	100	NYS DEC/DOH	
2-Methylnaphthalene	0.0367	0.000667	annual	7.1	AGC	
Naphthalene	0.00799	0.012062 0.000145	1- hour annual	7900 3	SGC[2] AGC	
Phenanthrene	0.0193	0.000351	annual	0.02	AGC	
Pyrene	0.000597	0.000011	annual	0.02	AGC	

[1] NYS DEC and NYS DOH 2006. New York State Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf.

[2] New York State Department of Environmental Conservation 2010 DAR-1 AGC/SGC tables. The AGC/SGC tables list all the short term (one-hour) and Annual Guideline Concentrations (AGCs & SGCs), (II) Federal and State one-hour and annual air quality standards and (III) DAR-1 "equivalent" one-hour and annual air quality standards.

Table 3c. AERMOD Modeling Results for Estimated Maximum Ground-level Air Concentrations of Other Chemicals from Kiln Stack Emissions Using Appropriate Averaging Times for Short- and Long-Term Air Comparison Values (CV).

Chemical	2004 Test		Air Comparison Value		Conclusion
	Emissions grams / second	Maximum Ground level Concentration (mcg/m^3) and averaging time	Value mcg/m^3	Reference for CV	
Total Polychlorinated Biphenyls (PCBs)	0.000000393	<0.000001 annual	0.002 0.01	AGC[1] CREG[2]	Ground-level concentrations are below levels of public health concern
Dioxins/ Furans	0.00000000934	<0.00000001 annual	0.00000003	AGC	
Acetaldehyde	0.0117	0.018 1-hour 0.00021 annual	4500 0.45 0.5	SGC[1] AGC CREG	
Acrolein	0.471	0.71 1-hour 0.0086 annual	2.5 0.35	SGC AGC	
Ammonia	2.17	3.27 1-hour 0.039 annual	1000 70	ATSDR acute ATSDR[3] chronic	
Benzene	0.330	0.50 1-hour 0.00060 annual	1300 0.13 0.1	SGC AGC CREG	
Fluoride	0.0136	0.021 1-hour 0.00025 annual	5.3 0.067	SGC AGC	
Formaldehyde	0.0606	0.092 1-hour 0.0011 annual	30 0.06 0.08	SGC AGC CREG	
Hydrogen Chloride	1.97	3.0 1-hour 0.036 annual	2100 20	SGC AGC	
Vinyl Chloride	0.180	0.27 1-hour 0.0033 annual	1000 0.11 0.1	ATSDR acute AGC CREG	

[1] New York State Department of Environmental Conservation 2010 DAR-1 AGC/SGC tables. The AGC/SGC tables list all the short term (one-hour) and Annual Guideline Concentrations (AGCs & SGCs), (II) Federal and State one-hour and annual air quality standards and (III) DAR-1 "equivalent" one-hour and annual air quality standards.

[2] CREG ATSDR Cancer Risk Evaluation Guide for one in a million excess cancer risk

[3] Agency for Toxic Substances and Disease Registry 2010 Air Comparison Values , acute (1-14 days of exposure) minimal risk level (MRL) intermediate (14-364 days of exposure) MRL, or chronic (365 or more days of exposure) MRL.

Table 3d. AERMOD Modeling Results for Estimated Maximum Ground-level Air Concentrations of Criteria Pollutants from Kiln Stack Emissions Using Appropriate Averaging Times for Short- and Long-Term Air Comparison Values (CV).

Criteria Pollutant	2004 Kiln Stack Test		Air Comparison Value		Conclusion
	Emissions grams / second	Maximum Ground level Concentration (mcg/m^3) and averaging time	Value mcg/ m^3	Source of Air Comparison Value	
Carbon Monoxide	32	48.02 1-hour	14,000 40,000	SGC[1] 1-hour NAAQS[2] 1-hour	Ground-level concentrations are below levels of concern
Lead	5.09E-03	0.000093 annual	0.038	AGC[1] annual	
Nitrogen Dioxide	187[3]	281.8 1-hour 3.4 annual	188 100	NAAQS, SGC 1-hour NAAQS, AGC annual	**1-hour ground-level concentration may exceed comparison value[3]**
PM_{10}	3.69	5.6 1-hour 0.5 24-hour	380 150	SGC 1-hour NAAQS 24-hour	Ground-level concentrations are below levels of concern
$PM_{2.5}$ (assumes all PM_{10} emitted is $PM_{2.5}$)	3.69	5.6 1-hour 0.5 24-hour 0.07 annual	88 35 15	SGC 1-hour NAAQS 24-hour NAAQS, AGC annual	
Sulfur dioxide	387	584.7 1-hour 54.2 annual	196 80	NAAQS, SGC 1-hour NAAQS, AGC annual	**1-hour ground-level concentration exceeds comparison value**

[1] New York State Department of Environmental Conservation 2010 DAR-1 AGC/SGC tables. The AGC/SGC tables list all the short- term (one-hour) and Annual Guideline Concentrations (AGCs & SGCs), (II) Federal and State one-hour and annual air quality standards and (III) DAR-1 "equivalent" one-hour and annual air quality standards.

[2] Primary National Ambient Air Quality Standard established to be protective of public health.

[3] Emissions reported as NO_x which includes NO_2 and other oxides of nitrogen.

Table 4. Descriptions and Definitions of Health Outcomes Examined.

Respiratory Diseases	**ICD-9 codes (International Classification of Disease, Ninth Edition)**
Asthma total (493)	493.00 - 493.92 Asthma hospitalizations - all ages
Asthma childhood (493) (<15)	493.00 - 493.92 Asthma hospitalizations - among children less than 15 years old
Chronic Bronchitis (491)	491.0 - 491.9 Chronic bronchitis hospitalizations
COPD (490-492, 496)	490 Bronchitis not specified as acute or chronic 491.0 - 491.9 Chronic bronchitis hospitalizations 492.0, 492.8 Emphysema hospitalizations 496 COPD not otherwise specified
Cardiovascular Diseases (CVD)	**ICD-9 codes**
Myocardial Infarction (410)	410.00-410.99 Acute Myocardial Infarction (heart attack) hospitalizations
Cardiovascular Disease and other Circulatory Diseases (390-459)	390-392 Acute rheumatic fever 393-398 Chronic rheumatic heart disease 401-405 Hypertensive disease 410-414 Ischemic heart disease (includes acute myocardial infarction) 415-417 Diseases of pulmonary circulation 420-429 Other forms of heart disease 430-438 Cerebrovascular disease 440-448 Diseases of the arteries, arterioles and capillaries 451-459 Diseases of the veins, lymphatics and other diseases of the circulatory system
Perinatal Health	
Low Birthweight	Singleton birth weighing less than 2500 g (about 5.5 lbs)
Preterm Birth	Singleton birth occurring before 37 weeks gestation
Term LBW	Low birth weight birth occurring among full term singleton births
Sex Ratio	Ratio of male to female births among full term singleton births
Birth Defects	Total of 45 birth defects combined which are tracked by the NYS DOH Environmental Public Health Tracking Network (EPHT). These include, but are not limited to, certain neural tube defects (NTDs), eye and ear deformities, heart defects, cleft lip/cleft palate, gastrointestinal and genitourinary tract defects, limb deficiencies, abdominal wall defects and chromosomal abnormalities. For details see link below. https://apps.nyhealth.gov/statistics/environmental/public_health_tracking/tracker/birth_defects/about/glossary.jsp

Table 4 (Continued).

Cancer	**ICD-O-3 (International Classification of Disease for Oncology, Third Edition)**
Female Breast all ages	C500:C509 (Excl. M-9050:9055, 9140, 9590:9989)
Female Breast 0-50	Same as above limited to women 0-50 years of age
Female Breast 50+	Same as above limited to women over 50 years of age
Lung and Bronchus	C340:C349 (Excl. M-9050-9055, 9140, 9590:9989)
Urinary Bladder (including in situ)	C670:C679 (Excl. M-9050:9055, 9140, 9590:9989)
Brain (and other Nervous System)	C710:C719 (Excl. M-9050:9055, 9140, 9530:9539, 9590:9989) C700:C709 C720:C729
Thyroid	C739 (Excl. M-9050:9055, 9140, 9590:9989)
Non-Hodgkin's Lymphoma	M-9590:9596, 9670:9671, 9673, 9675, 9678:9680, 9684, 9687, 9689:9691, 9695, 9698:9702, 9705, 9708:9709, 9714:9719, 9727:9729 (9823, 9827) all sites except C420, C421, C424
Leukemia combined	M-9826, 9835:9837, 9823, 9820, 9832-9834, 9940 M-9840, 9861, 9866, 9867, 9871:9874, 9895:9897, 9910, 9920, 9891, 9863, 9875, 9876, 9945, 9946, 9860, 9930, 9801, 9805, 9931,9733, 9742, 9800, 9831, 9870, 9948, 9963, 9964 ,8927
Chronic Lymphocytic Leukemia	M-9823
Acute Myeloid Leukemia	M-9840, 9861, 9866, 9867, 9871:9874, 9895:9897, 9910, 9920

Table 4 (Continued).

Developmental Disabilities	Regulations of the Commissioner of Education – 8NYCRR Part 200.1 - Definitions
Autism	Autism means a developmental disability significantly affecting verbal and nonverbal communication and social interaction, generally evident before age 3 that adversely affects a student's educational performance. Other characteristics often associated with autism are engagement in repetitive activities and stereotyped movements, resistance to environmental change or change in daily routines, and unusual responses to sensory experiences. The term does not apply if a student's educational performance is adversely affected primarily because the student has an emotional disturbance as below. A student who manifests the characteristics of autism after age 3 could be diagnosed as having autism if the criteria in this paragraph are otherwise satisfied.
Emotional Disturbance	Emotional disturbance means a condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affects a student's educational performance: (i) an inability to learn that cannot be explained by intellectual, sensory, or health factors; (ii) an inability to build or maintain satisfactory interpersonal relationships with peers and teachers; (iii) inappropriate types of behavior or feelings under normal circumstances; (iv) a generally pervasive mood of unhappiness or depression; or (v) a tendency to develop physical symptoms or fears associated with personal or school problems. The term includes schizophrenia. The term does not apply to students who are socially maladjusted, unless it is determined that they have an emotional disturbance.
Learning Disability	Learning disability means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which manifests itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations, as determined in accordance with section 200.4(j) of this Part. The term includes such conditions as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia and developmental aphasia. The term does not include learning problems that are primarily the result of visual, hearing or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural or economic disadvantage.
Mental Retardation	Mental retardation means significantly sub-average general intellectual functioning, existing concurrently with deficits in adaptive behavior and manifested during the developmental period that adversely affects a student's educational performance.
Other Health	Other health-impairment means having limited strength, vitality or alertness, including a heightened alertness to environmental stimuli, that results in limited alertness with respect to the educational environment, that is due to chronic or acute health problems, including but not limited to a heart condition, tuberculosis, rheumatic fever, nephritis, asthma, sickle cell anemia, hemophilia, epilepsy, lead poisoning, leukemia, diabetes, attention deficit disorder or attention deficit hyperactivity disorder or Tourette syndrome, which adversely affects a student's educational performance.

Table 5. Numbers and Estimated Rates of Respiratory and Cardiovascular Disease Hospitalizations for Residents of the Six Ravena-Area ZIP Codes Compared to Albany County; the Four Area Counties (Albany, Rensselaer, Columbia, Greene); and New York State Excluding New York City from 1997-2006.

Disease (ICD-9-CM code)	12143 (Ravena) (including 12045 Coeymans)	12158 (Selkirk)	12046 (Coeymans Hollow)	12156 (Schodack Landing)	12087 (Hannacroix)	All ZIP codes	Albany County	Albany, Rensselaer, Columbia, Green Counties	NYS excluding NYC
	Number (Estimated Rate*)								Estimated Rate*
Respiratory Disease									
Asthma total (493)	63 (**9.8**^{x})	69 (11.0)	5 (6.7)	1 (**1.0**^{xyz})	11 (8.1)	149 (**9.6**^{xz})	3,603 (12.6)	6,145 (11.2)	12.4
Asthma childhood (493) (<15)	17 (**12.3**^{xz})	37 (**28.2**^{b})	3 (21.6)	0 (**0.0**^{xyz})	1 (3.7)	58 (17.9)	1,192 (22.7)	1,991 (19.5)	20
COPD (490-492, 496)	170 (**25.8**^{abc})	106 (18.1)	21 (**32.2**^{ac})	24 (**22.9**^{a})	13 (**10.7**^{xyz})	334 (**21.8**^{ac})	6,051 (18.1)	12,555 (19.6)	17.6
Chronic Bronchitis (491)	137 (**20.7**^{abc})	88 (15.1)	16 (25.2)	16 (15.1)	11 (**8.8**^{y})	268 (**17.5**^{ac})	4,785 (14.3)	10,029 (15.7)	14.4
Cardiovascular Disease (CVD)									
Myocardial Infarction (410)	115 (**17.8**^{z})	102 (**16.3**^{z})	7 (**9.8**^{z})	21 (23.8)	23 (16.6)	268 (**17.3**^{yz})	6,022 (17.9)	12,862 (20.1)	24.5
CVD and other circulatory diseases (390-459)	1087 (**167**^{z})	810 (**135.1**^{xyz})	89 (**131.6**^{yz})	145 (170.0)	195 (**149.2**^{z})	2,328 (**158.0**^{yz})	53,169 (157.6)	105,588 (164.4)	185.7

Data Sources – Number of hospitalizations from NYS DOH Statewide Planning and Research Reporting System (SPARCS)
Population data are from yearly Claritas ZIP code population estimates
*Hospitalization rates are per 10,000 person years and are standardized to the US Standard Million, 2000.
COPD=Chronic Obstructive Pulmonary Disorder
Bold indicates statistically different rate than either Albany County, the 4 county area, or New York State excluding New York City rates
a indicates statistically significantly **higher** than Albany County rates
b indicates statistically significantly **higher** than 4 county area rates
c indicates statistically significantly **higher** than NYS excluding NYC rates
x indicates statistically significantly **lower** than Albany County rates
y indicates statistically significantly **lower** than 4 county area rates
z indicates statistically significantly **lower** than NYS excluding NYC rates

Table 6. Observed and Expected Numbers of Cancer Cases for the Combined Six ZIP Codes area (12143 (Ravena), 12045 (Coeymans), 12158 (Selkirk), 12046 (Coeymans Hollow), 12156 (Schodack Landing), 12087 (Hannacroix)) from 2002-2006.

	Males					Females				
	Observed	**Expected***	**SIR**	**LCI**	**UCI**	**Observed**	**Expected***	**SIR**	**LCI**	**UCI**
Female breast (all ages)	-	-	-	-	-	69	58.7	1.18	0.91	1.49
female breast 0-50	-	-	-	-	-	18	14.8	1.22	0.72	1.92
Female breast 50+	-	-	-	-	-	51	43.9	1.16	0.86	1.53
Lung and bronchus	39	29.1	1.34	0.95	1.83	21	26.2	0.80	0.50	1.23
Urinary bladder	12	16.3	0.74	0.38	1.29	4	5.6	0.71	0.19	1.83
Brain	3	3.5	0.86	0.18	2.50	1	2.6	0.38	0.01	2.14
Thyroid	1	2.7	0.37	0.01	2.06	5	7.7	0.65	0.21	1.52
Non-Hodgkin's Lymphoma	5	9.3	0.54	0.17	1.25	14	7.9	1.77	0.97	2.97
Leukemia (all types combined)	2	6.4	0.31	0.04	1.13	5	4.7	1.06	0.35	2.48
Chronic lymphocytic leukemia	0	2.5	0.00	0.00	1.20	0	1.7	0.00	0.00	1.76
Acute myeloid leukemia	2	1.7	1.18	0.14	4.25	1	1.4	0.71	0.02	3.98

Data Source: New York State Cancer Registry. Data are provisional as of January 2009.
*Expected rates are age adjusted to the US standard million and calculated based on NYS rates excluding NYC.
SIR = Standardized Incidence Ratio
LCI/UCI = Lower / Upper 95% Confidence Interval

Table 7. Perinatal and Childhood Health Outcome Numbers and Estimated Rates in the Six ZIP Code Area Compared to Albany County; the 4 Area Counties (Albany, Rensselaer, Columbia, Greene); and New York State excluding New York City.

	Data Years	**12143(Ravena) and 12045 (Coeymans)**	**12158 (Selkirk)**	**12046 (Coeymans Hollow)**	**12156 (Schodack Landing)**	**12087 (Hannacroix)**	**All ZIP codes**	**Albany County**	**Albany, Rensselaer, Columbia, Green Counties**	**NYS excluding NYC**
Perinatal Health		Number (Estimated Rate or Ratio)								Estimated Rate
Low Birthweight[1]	1998-2007	40 (5.8)	35 (4.7)	0 (**0.0^{xyz}**)	3 (4.9)	7 (6.3)	85 (5.1)	1,806 (5.9)	3,340 (5.8)	5.5
Preterm birth[1]	1998-2007	54 (7.9)	59 (8.0)	6 (9.7)	4 (6.6)	10 (8.9)	133 (8.0)	2,838 (9.2)	5,126 (8.9)	9.2
Term LBW[2]	1998-2007	15 (2.4)	8 (1.2)	0 (0.0)	1 (1.8)	5 (4.9)	29 (1.9)	615 (2.2)	1,186 (2.3)	2.1
Sex Ratio[3]	1998-2007	324 (1.1)	356 (1.1)	37 (**1.9^{abc}**)	26 (0.8)	56 (1.2)	799 (1.1)	14,210 (1.0)	9652 (1.0)	1.0
Birth defects (all EPHT)[4]	2000-2004	4 (1.33)	8 (1.97)	0 (0.0)	2 (5.13)	0 (0.0)	14 (1.61)	267 (1.67)	530 (1.78)	1.82

Data sources: NYS DOH Vital Statistics; NYS DOH Congenital Malformations Registry; NYS DOH Lead Reporting

1 Rate per 100 singleton births

2 Rate per 100 singleton full term births

3 Number is the number of singleton full term male births, ratio is the number of male to the number of female births among singleton full term births.

4 Prevalence per 100 Live Births. List of all birth defects examined can be found in NYS DOH's Environmental Public Health Tracker – See Table 20

Bold indicates statistically different rate than either Albany County or New York State excluding New York City rates

a indicates statistically significantly **higher** than Albany County rates

b indicates statistically significantly **higher** than 4 county area rates

c indicates statistically significantly **higher** than NYS excluding NYC rates

x indicates statistically significantly **lower** than Albany county rates

y indicates statistically significantly **lower** than 4 county area rates

z indicates statistically significantly **lower** than NYS excluding NYC rates

Table 8. Average Annual Number and Rates of Students Receiving Services for Select Disabilities in RCS School District for 2003-2008 Compared to Albany County. Average Total Enrollment at RCS School District for these 5 Years was Approximately 2260 Students per Year.

Disability	RCS		Albany County	
	Number	Percent	Number	Percent
Autism	15.4	0.68	306	0.80
Emotional Disturbance	43.0	1.90[a]	589	1.54
Learning Disability	149.4	6.60[a]	2287.8	5.72
Mental Retardation	8.2	0.36[b]	144.4	0.57
Other Health	66.2	2.93	1061.4	2.66
All Disabilities	409.8	18.11[a]	6126	15.31

Source NYS ED SEDCAR

a indicates rate of students with disabilities in RCS is statistically higher than the rate in other Albany County school districts

b indicates rate of students with disabilities in RCS is statistically lower than the rate in other Albany County school districts

Table 9. Percent of Children Receiving Services for Select Disabilities in the 2007-2008 School Year by School District in the Four County Area (School districts with fewer than 1000 enrolled students and specialized school districts are not included*).

District	N/RC**	Enrollment	Autism	Emotional Disturbance	Learning Disability	Mental Retardation	Other Health	All Disabilities
			%	%	%	%	%	%
Albany County								
Albany City School District	3	8653	1.10	3.81	8.19	0.90	2.74	22.12
Cohoes City School District	3	2105	0.57	1.85	5.56	1.19	2.28	13.49
Watervliet City School District	3	1393	0.57	1.65	4.95	0.36	4.95	18.23
Berne-Knox-Westerlo Central School District	5	1073	1.03	0.75	7.08	0.00	2.33	16.87
Ravena-Coeymans-Selkirk Central School District	5	2183	0.82	1.97	5.73	0.46	3.16	17.73
South Colonie Central School District	5	5592	0.88	0.77	5.53	0.25	2.25	12.46
Bethlehem Central School District	6	5112	0.86	0.43	2.33	0.00	3.83	12.28
North Colonie Central School District	6	5646	1.38	0.80	3.13	0.00	3.26	12.47
Guilderland Central School District	6	5365	1.17	0.48	5.27	0.00	3.30	14.13
Voorheesville Central School District	6	1227	0.65	0.00	4.40	0.00	2.36	11.25
Columbia County								
Hudson City School District	4	2048	0.73	3.47	8.84	0.59	2.64	19.73
Taconic Hills Central School District	5	1718	0.58	1.28	6.58	0.87	2.27	13.21
Chatham Central School District	5	1314	0.61	0.91	4.95	0.00	0.00	10.81
Kinderhook Central School District	5	2140	0.93	1.40	7.06	0.00	2.34	15.84
Greene County								
Cairo-Durham Central School District	5	1666	0.48	0.84	7.38	0.00	1.98	13.33
Catskill Central School District	5	1781	1.01	2.41	6.46	0.73	1.68	14.88
Coxsackie-Athens Central School District	5	1555	0.96	0.96	2.70	0.58	1.54	8.75
Greenville Central School District	5	1363	0.44	1.25	6.38	0.00	2.64	15.04

Table 9 (Continued).

District	N/RC**	Enrollment	Autism	Emotional Disturbance	Learning Disability	Mental Retardation	Other Health	All Disabilities
			%	%	%	%	%	%
Rensselaer County								
Lansingburgh Central School District	3	2559	0.51	1.80	6.60	1.95	2.58	18.37
Rensselaer City School District	3	1066	0.00	2.16	7.97	0.84	2.06	16.04
Troy City School District	3	4171	0.53	1.99	6.86	1.29	4.34	18.13
Brunswick Central School District (Brittonkill)	5	1363	0.59	0.73	5.06	0.00	2.05	10.86
East Greenbush Central School District	5	4555	1.19	1.05	4.98	0.00	2.92	15.52
Hoosick Falls Central School District	5	1273	0.00	0.47	7.23	0.00	2.99	15.63
Averill Park Central School District	5	3408	0.73	1.20	6.72	0.15	2.85	15.70
Hoosic Valley Central School District	5	1226	0.41	1.79	8.81	0.00	2.61	17.46
Schodack Central School District	5	1118	0.98	1.25	3.85	0.00	2.86	14.04

*Districts not included:
Albany: Green Island Union Free School District; Menands Union Free School District; Maplewood Common School District
Columbia: Germantown Central School District; New Lebanon Central School District
Greene: Hunter-Tannersville Central School District; Windham-Ashland-Jewett Central School District
Rensselaer: Berlin Central School District; North Greenbush Common School District (Williams); Wynantskill Union Free School District
** N/RC Needs/Resource Capacity, RCS District is an Average Need District, a school district with average student needs in relation to district resource capacity.
Numbers are suppressed for confidentiality if fewer than 5 children were receiving services for a specific disability in a school district, thus a rate of 0.00 could indicate that no children in a district were receiving services for a disability or that data have been suppressed for confidentiality reasons.

APPENDIX A. AIR MODELING

Various types of pollutants (particulates and chemicals) have been released to air from the Ravena cement plant. Contaminants in air might harm health if their concentrations approach or exceed concentrations that might harm health at ground-level where exposure might occur, i.e., at points of exposure. To evaluate whether contaminant concentrations exceed concentrations that might harm health, modeled maximum ground-level air concentrations at ground-level are determined and first compared to appropriate guidance or health-based air comparison values. If maximum ground-level contaminant concentrations in air do not exceed their air comparison values, then these contaminants are considered unlikely to harm health. If maximum ground-level contaminant concentrations in air exceed comparison values, then they are further evaluated to better characterize whether and how they might harm health and to determine whether further studies or actions to reduce or mitigate exposure are needed.

The Phase One HC concluded that the cement plant kiln stack emissions data collected in 2004 are the most comprehensive data available for use in an air dispersion model. Therefore, the 2004 measured stack emission rate data are used in this Phase Two PHA in an air dispersion model to estimate maximum ground-level contaminant concentrations off-site.

NYS DEC modeled maximum ground-level peak 1-hour, 24-hour, and annual concentrations of contaminants released from the cement kiln stack using AERMOD, a US EPA air dispersion model. These values are compared to applicable short- and long-term air comparison values. Shorter averaging times (1-hour, 24-hour) almost always result in higher estimated maximum ground-level concentrations than longer averaging times and are used to assess the possibility of adverse health effects from short-term exposures (hours to days). AERMOD is a steady-state plume model which incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. Aside from the source stack information, meteorology, building locations and heights for downwash and terrain data are input into AERMOD to calculate impacts. The modeling analysis considered stack-tip downwash and rural dispersion coefficients. The modeling did not account for any degradation or deposition mechanisms. NYS DEC assumed that the cement plant was operating at full capacity, which overestimates actual operations (operations may be reduced from full capacity due to holidays, maintenance, or decreased demand for product). Five years of representative meteorological data are used in the modeling analysis, so that impacts due to a variety of weather patterns are evaluated. Concentrations are calculated within AERMOD for every hour at each modeled location and then averaged for the appropriate averaging time. This accounts for the differences seen in the contour plots of maximum impacts for the different averaging times.

Because the stack and building dimensions are such that building downwash of released effluent may cause the plumes to be influenced (which will tend to bring the plume closer to the ground), these effects were included in the analysis. Building locations and heights were input to Building Profile Input Program (BPIP) -Prime to develop direction-specific building dimensions to be input to AERMOD in order to calculate effects from downwash.

The emission rates and modeled concentrations at the point of maximum impact for the three averaging times are presented in Appendix A, Table 1. Values for some emissions were not

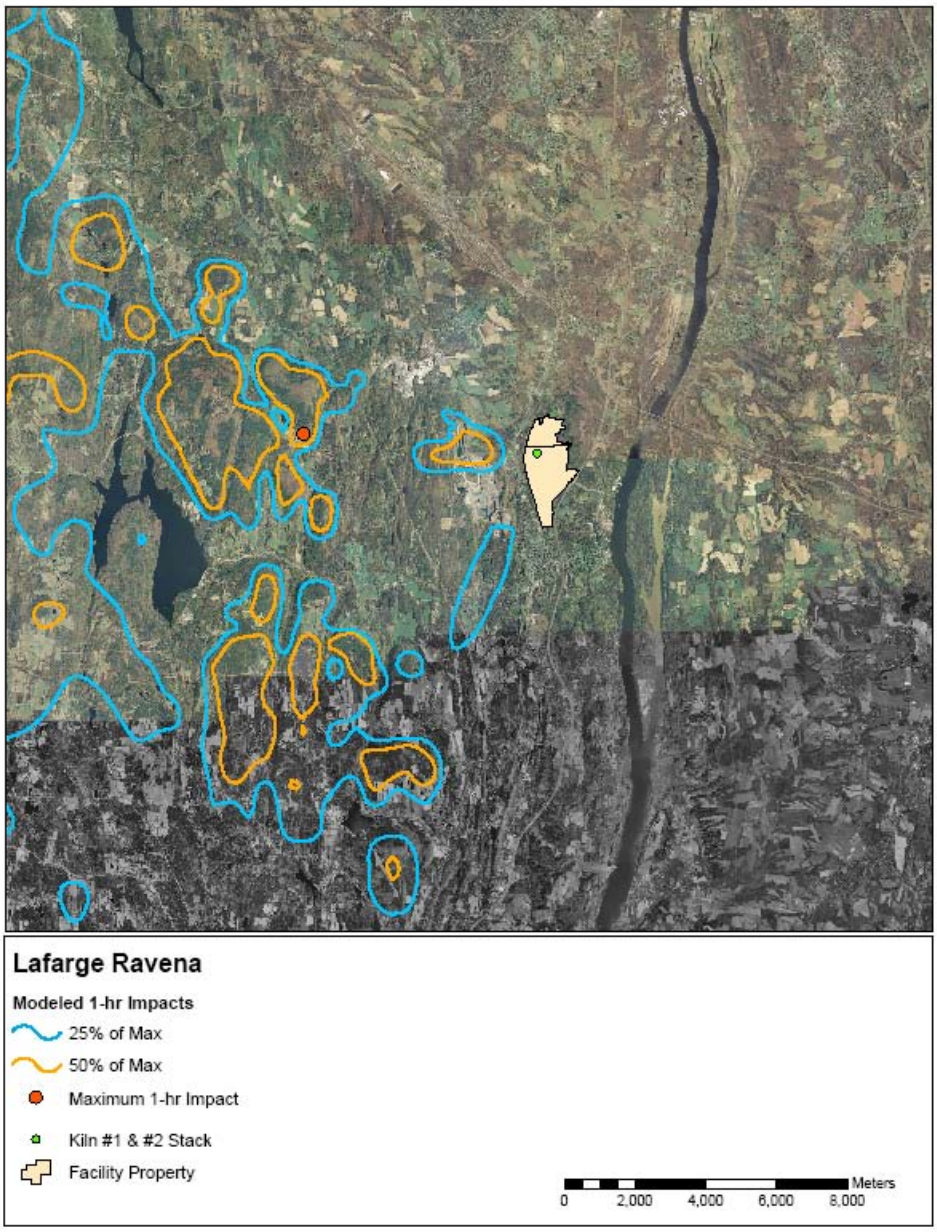
reported as exact emissions but as either "<"(less than) some value, or "≈" (similar to) some value. In those cases, the ground level concentrations were estimated using the reported values and the entries in Table 3a-d in Appendix A, Table 1 are in italic font.

Appendix A, Figures 1-3 are aerial maps showing the point of maximum impact, with contour lines illustrating areas that have ground level concentrations that are 50 or 25 percent of the maximum ground level concentration for each of the three averaging times. Contour lines illustrate where facility impacts are predicted to occur and characterize how concentrations change over geographic areas extending outward from the source(s). Contour lines indicate changes in pollutant concentrations across an area in the same way contour lines on a topographic map indicate changes in elevation. Contour lines can illustrate chemical-specific concentrations or concentration relative to some measure (e.g., relative to the concentration at the point of maximum impact) as is done in Figures 1-3. Using the relative impact approach, we can generalize the expected areas of impact, regardless of the specific chemical and the amount emitted.

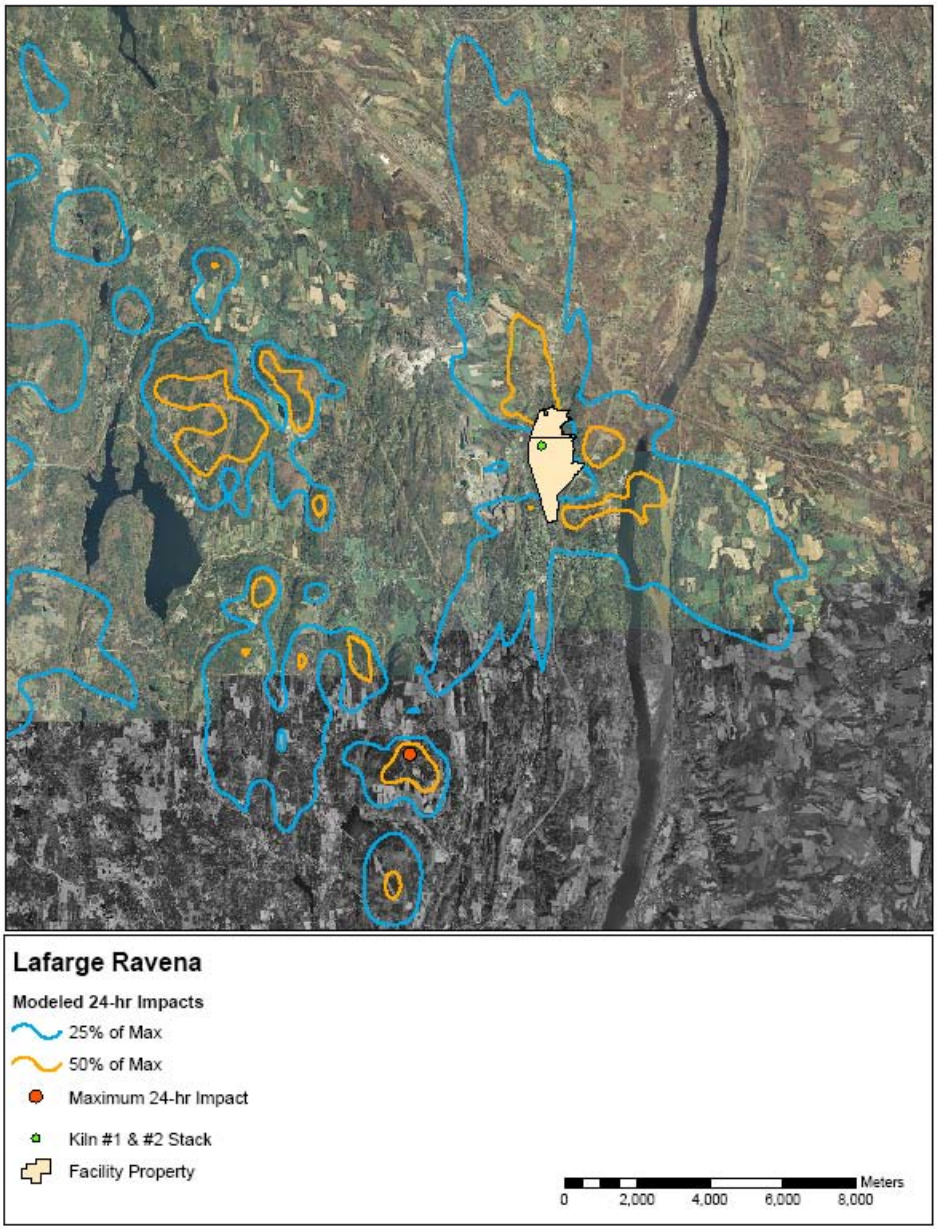
For this modeling application, Meteorological (MET) data from Albany International Airport for the years 2003–2007 were used. The Albany International Airport is located approximately 15 miles (24 kilometers) north of the Ravena cement plant. The representativeness of the Albany International Airport data to the Ravena plant site is reasonable, considering the general similar valley orientations for the two areas and the same mesoscale MET conditions affecting each area, as well as earlier data. (See Final Phase One HC Appendix B Ravena New York Area Wind Roses (NYS DOH, 2011).)

Note that the contour plots here differ from those presented in the Final Phase One HC. In the Final Phase One HC we presented the results from combined modeling of the particulate emissions from the kiln and clinker cooler stacks (see Final Phase One HC. Appendix E – Air Modeling). That modeling showed a different off-site location for the point of maximum impact than AERMOD modeling of only the kiln stack emissions, because it looked at the combined particulate impacts from kiln and the much shorter clinker cooler stacks. The inclusion of emissions from the shorter clinker cooler stacks brought the modeled point of maximum impact closer to the facility. The $PM_{2.5}$ modeling presented in the Phase One HC (combined particulate emissions from the kiln and the shorter clinker cooler stacks were assumed to be entirely $PM_{2.5}$) predicted that the maximum, 24-hour, ground-level average, $PM_{2.5}$ concentration off-site was 4.5 micrograms of $PM_{2.5}$ per cubic meter of air (mcg/m^3), also well below short and long-term air comparison values (see Table 3d for comparison values for PM).

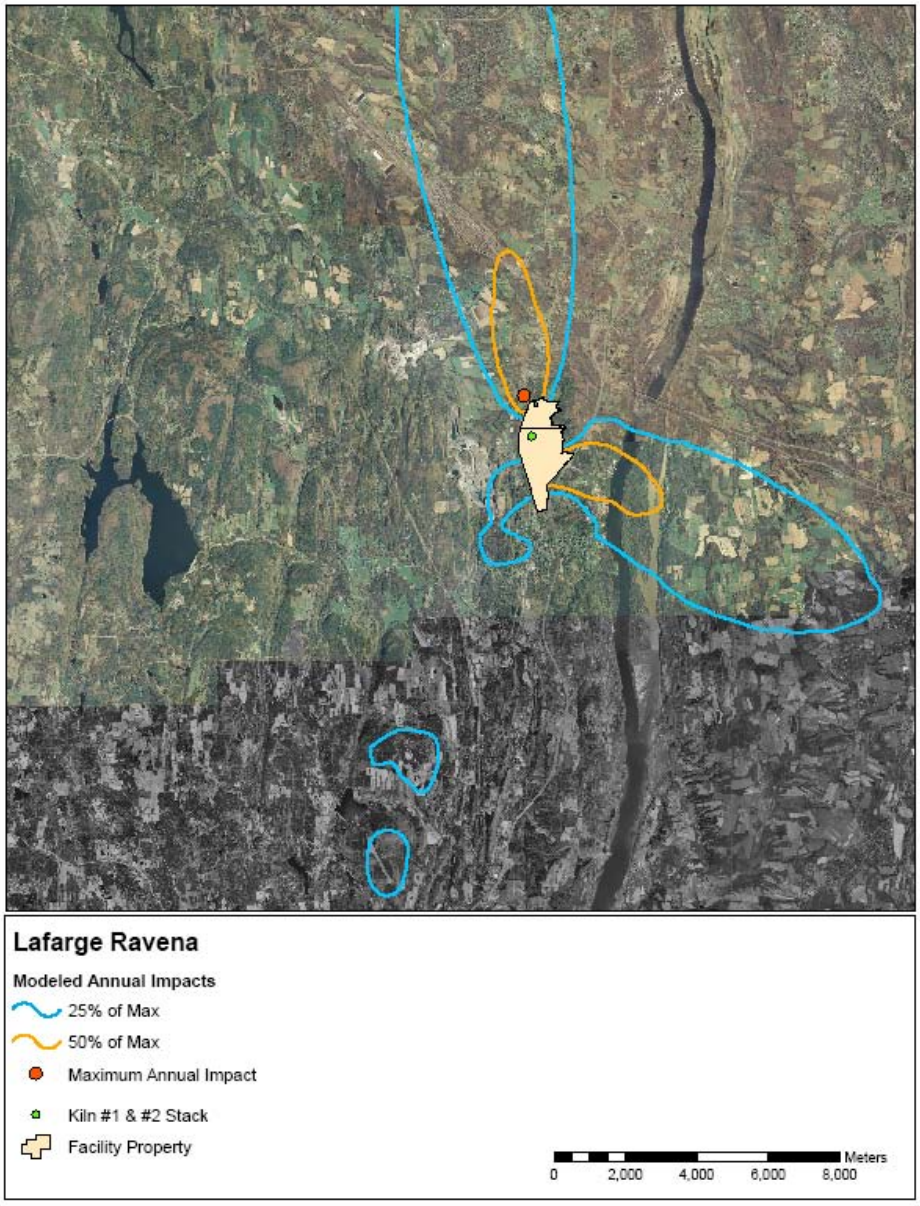
APPENDIX A, Figure 1. One-Hour Modeled Air Impact Contours for 2004 Kiln Stack Emissions at the Lafarge Cement Plant, Ravena, New York.



APPENDIX A, Figure 2. 24-Hour Modeled Air Impact Contours for 2004 Kiln Stack Emissions at the Lafarge Cement Plant, Ravena, New York.



APPENDIX A, Figure 3. Annual Modeled Air Impact Contours for 2004 Kiln Stack Emissions at the Lafarge Cement Plant, Ravena, New York.



APPENDIX A, Table 1. AERMOD Modeling Results for 2004 Kiln Stack Emissions and Availability of Health Comparison Values.

	Emission Rate g/sec	Highest Estimated Off-site Air Concentration at Ground Level (mcg/m3)			Is an Air Comparison Value Available?	
		1-Hour Averaging Time	24-Hour Averaging Time	Annual Averaging Time	Short-Term (hours, days)	Long term (yearly, lifetime)
Criteria Pollutants						
Carbon Monoxide	32	48.020819	4.452261	0.578794	Yes	No
Lead	0.0051	0.007686	0.000713	0.000093	No	Yes
Nitrogen Dioxide (assumes all NO_x emitted is NO_2)	190	281.770339	26.124402	3.396172	Yes	Yes
Particulate Matter						
PM_{10}	3.7	5.574525	0.516843	0.06719	Yes	Yes
$PM_{2.5}$ (assumes all PM_{10} is $PM_{2.5}$)	3.7	5.574525	0.516843	0.06719	Yes	Yes
Sulfur Dioxide	390	584.659184	54.206812	7.046886	Yes	Yes
Metals						
Antimony	0.0003	0.000457	0.000042	0.000006	No	Yes
Arsenic	0.0031	0.004642	0.00043	0.000056	Yes	Yes
Barium	0.00058	0.000875	0.000081	0.000011	No	Yes
Beryllium[1]	*0.0000042*	*0.000006*	*<0.000001*	*<0.000001*	No	Yes
Cadmium	0.00024	0.000369	0.000034	0.000004	Yes	Yes
Chromium	0.00044	0.00066	0.000061	0.000008	No	Yes
Hexavalent Chromium	*0.000016*	*0.000024*	*0.000002*	*<0.000001*	Yes	Yes
Cobalt	*0.000035*	*0.000052*	*0.000005*	*<0.000001*	No	Yes
Copper	0.00051	0.000763	0.000071	0.000009	Yes	Yes
Manganese	0.0014	0.002055	0.000191	0.000025	No	Yes
Mercury	0.0067	0.010084	0.000935	0.000122	Yes	Yes
Nickel	0.00034	0.000514	0.000048	0.000006	Yes	Yes
Selenium	0.011	0.016762	0.001554	0.000202	No	Yes
Silver	0.000057	0.000086	0.000008	0.000001	No	Yes
Thallium	0.0021	0.003196	0.000296	0.000039	No	Yes
Vanadium	0.00031	0.00047	0.000044	0.000006	Yes	Yes
Zinc	0.009	0.013546	0.001256	0.000163	No	Yes

[1] Values for some emissions were not reported as exact emissions but as either "<"(less than) some value, or "≈" (similar to) some value. In those cases, the ground level concentrations were estimated using the reported values and the entries in the table are displayed in italic font.

APPENDIX A, Table 1 (Continued).

	Emission Rate g/sec	Highest Estimated Off-site Air Concentration at Ground Level (mcg/m3)			Is an Air Comparison Value Available?	
		1-Hour Averaging Time	24-Hour Averaging Time	Annual Averaging Time	Short-Term (hours, days)	Long term (yearly, lifetime)
Polycyclic Aromatic Hydrocarbons (PAH)						
Acenaphthene	0.00084	0.001275	0.000118	0.000015	No	Yes
Acenaphthylene	0.015	0.022831	0.002117	0.000275	No	Yes
Anthracene	0.00083	0.001256	0.000116	0.000015	No	Yes
Benzo(a) Anthracene	0.00011	0.000169	0.000016	0.000002	No	Yes
Benzo(a) Pyrene	0.000032	0.000048	0.000004	<0.000001	No	Yes
Benzo(b) Fluoranthrene	0.00012	0.000186	0.000017	0.000002	No	Yes
Benzo(e)Pyrene	0.0002	0.000299	0.000028	0.000004	No	No
Benzo(g,h,i)Perylene	0.000029	0.000043	0.000004	0.000001	No	Yes
Benzo(k)Fluoranthene	0.000018	0.000027	0.000003	<0.000001	No	Yes
Chrysene	0.00024	0.00036	0.000033	0.000004	No	Yes
Dibenzo(a,h)Anthracene	0.0000083	0.000013	0.000001	<0.000001	No	Yes
Fluoranthene	0.019	0.003177	0.000295	0.000038	No	Yes
Fluorene	0.0024	0.003615	0.000335	0.000044	No	Yes
Indeno(1,2,3-cd)Pyrene	0.000012	0.000018	0.000002	<0.000001	No	Yes
2-Methylnaphthalene	0.037	0.055365	0.005133	0.000667	No	Yes
Naphthalene	0.008	0.012062	0.001118	0.000145	Yes	Yes
Perylene	0.0000044	0.000007	0.000001	<0.000001	No	No
Phenanthrene	0.019	0.029109	0.002699	0.000351	No	Yes
Pyrene	0.0006	0.000902	0.000084	0.000011	No	Yes
Volatile Organic Chemicals (VOC)						
Acetaldehyde	*0.012*	*0.017694*	*0.00164*	*0.000213*	Yes	Yes
Acrolein	*0.47*	*0.71156*	*0.065972*	*0.008576*	Yes	Yes
Benzene	*0.33*	*0.498473*	*0.046216*	*0.006008*	Yes	Yes
Formaldehyde	*0.061*	*0.091514*	*0.008485*	*0.001103*	Yes	Yes
Methane	1.1	1.723727	0.159816	0.020776	No	No
Non-methane Hydrocarbons	7.0	10.502176	0.973712	0.126583	No	No
Total Hydrocarbons	8.1	12.225903	1.133527	0.147359	No	No
Vinyl Chloride	*0.18*	*0.272067*	*0.025225*	*0.003279*	Yes	Yes

APPENDIX A, Table 1 (Continued).

	Emission Rate g/sec	Highest Estimated Off-site Air Concentration at Ground Level (mcg/m^3)			Is an Air Comparison Value Available?	
		1-Hour Averaging Time	24-Hour Averaging Time	Annual Averaging Time	Short-Term (hours, days)	Long term (yearly, lifetime)
Polychlorinated Biphenyls (PCB)						
PCB-77	*2.6E-08*[2]	*<0.000001*	*<0.000001*	*<0.000001*	No	No
PCB-81	*1.8E-09*	*<0.000001*	*<0.000001*	*<0.000001*	No	No
PCB-105	5.7E-08	<0.000001	<0.000001	<0.000001	No	No
PCB-114	*4.2E-09*	*<0.000001*	*<0.000001*	*<0.000001*	No	No
PCB-118	2.1E-07	<0.000001	<0.000001	<0.000001	No	No
PCB-123	2.2E-09	<0.000001	<0.000001	<0.000001	No	No
PCB-126	*4.2E-09*	*<0.000001*	*<0.000001*	*<0.000001*	No	No
PCB156/157	4.7E-08	<0.000001	<0.000001	<0.000001	No	No
PCB-167	2.8E-08	<0.000001	<0.000001	<0.000001	No	No
PCB-169	*3.4E-09*	*<0.000001*	*<0.000001*	*<0.000001*	No	No
PCB-189	7.1E-09	<0.000001	<0.000001	<0.000001	No	No
Total		<0.000001	<0.000001	<0.000001	No	Yes
Other						
Ammonia	2.2	3.272417	0.303403	0.039442	Yes	Yes
Dioxins/Furans	9.34E-09	<0.000001	<0.000001	<0.000001	No	Yes
Filterable PM	3.7	5.117908	0.474508	0.061686	No	No
Fluoride	0.014	0.020548	0.001905	0.000248	Yes	Yes
Hydrogen Chloride	2.0	2.968006	0.275179	0.035773	Yes	Yes

[2] For ease of reading some numbers appear in scientific notation. The following are some samples of how numbers are represented in scientific notation. For numbers that are

less than one,

one-one hundredth	=	1.0E-02
one-tenth	=	1.0E-01

equal to or greater than one,

one	=	1.0E00
ten	=	1.0E+01
one hundred	=	1.0E+02
one million	=	1.0E+06

APPENDIX B. CONCLUSION CATEGORIES AND HAZARD STATEMENTS

ATSDR has five distinct descriptive conclusion categories that convey the overall public health conclusion about a site or release, or some specific pathway by which the public may encounter site-related contamination. These defined categories help ensure a consistent approach in drawing conclusions across sites and assist the public health agencies in determining the type of follow-up actions that might be warranted. The conclusions are based on the information available to the author(s) at the time they are written.

1. Short-term Exposure, Acute Hazard "ATSDR concludes that...could harm people's health."

This category is used for sites where short-term exposures (e.g., < 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid public health intervention.

2. Long-term Exposure, Chronic Hazard "ATSDR concludes that...could harm people's health."

This category is used for sites that pose a public health hazard due to the existence of long-term exposures (e.g., > 1 yr) to hazardous substance or conditions that could result in adverse health effects.

3. Lack of Data or Information "ATSDR cannot currently conclude whether...could harm people's health."

This category is used for sites in which data are insufficient with regard to extent of exposure and/or toxicologic properties at estimated exposure levels to support a public health decision.

4. Exposure, No Harm Expected "ATSDR concludes that ... is not expected to harm people's health."

This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.

5. No Exposure, No Harm Expected "ATSDR concludes that ...will not harm people's health."

This category is used for sites that, because of the absence of exposure, are not expected to cause any adverse health effects.