Agency for Toxic Substances and Disease Registry

Division of Health Studies

Self-reported Disease and Symptom Prevalence Survey Wingate Road Municipal Incinerator and Landfill Ft. Lauderdale, Florida

Final Report

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U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ATLANTA, GA

SELF-REPORTED DISEASE AND SYMPTOM PREVALENCE SURVEY
WINGATE ROAD MUNICIPAL INCINERATOR AND LANDFILL
FT. LAUDERDALE, FLORIDA

SUBMITTED BY

FLORIDA DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL HEALTH

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ABSTRACT

From 1954 to 1978, the City of Ft. Lauderdale burned municipal solid waste at the Wingate Road Municipal Incinerator and Landfill. Nearby residents were concerned that during its operation, toxic chemicals from the incinerator made them ill. In response, the US Agency for Toxic Substances and Disease Registry provided funding for the Florida Department of Health (DOH) to conduct a disease and symptom prevalence survey.

Between August and December 2003, the Broward County Health Department interviewed 1,765 nearby residents. They asked about diseases and symptoms known from prior studies to be associated with exposure to arsenic and dioxins found in incinerator ash. The survey sought to answer the following questions: (1) Is the survey prevalence of self-reported diseases and symptoms before incineration ceased in 1978 different from the prevalence after 1978?, (2) Is the survey prevalence of self-reported diseases and symptoms different between ash deposition zones?, and (3) Is the survey prevalence of self-reported diseases and symptoms related to the reports of eating fish from nearby Rock Pit Lake?

Survey results indicate the prevalence of most self-reported diseases and symptoms before incineration ceased in 1978 was not statistically different from the prevalence after 1978. Results also indicate the prevalence of most self-reported diseases and symptoms was not statistically different between ash deposition zones. Associations between residency before/after incinerator operation and distance from the incinerator (ash deposition zone) were relatively few and inconsistent. Although there were a few statistically significant associations between reported diseases/symptoms and eating fish from nearby Rock Pit Lake, the percentage of respondents reporting eating fish from this lake (1%) was too small to judge their significance.

For those associations that were statistically significant (such as bronchitis, anemia, and high cholesterol), other factors such as age, gender, body mass index (BMI), and smoking played an equal or greater role in whether or not an individual reported a disease(s) or symptom(s).

The ability of this survey to answer the three main questions was limited by the number of participants, unaccounted out-migration, self-reported disease/symptoms not verified by medical records, lack of exposure documentation, and low number of participants reporting eating fish from Rock Pit Lake. Personal risk factors such as diet, physical activity, and socio-economic status are important in the development of the reported diseases and symptoms. Collection and analysis of these personal risk factors was, however, beyond the scope of this survey.

INTRODUCTION

In the fall of 2003, the Florida Department of Health, with the help of the Broward County Health Department, conducted a disease and symptom prevalence survey of people living near the former Wingate incinerator hazardous waste site. They conducted this survey to determine if the prevalence of self-reported disease and symptoms 1) changed after the incinerator shut down, 2) is related to distance from the incinerator or duration of exposure, or 3) is related to the amount of fish eaten from Rock Pit Lake.

Wingate Incinerator Site Background and History

The 60 acre Wingate Incinerator and Landfill Superfund National Priorities List (NPL) hazardous waste site (Wingate) is at 1300 Northwest 31st Avenue, Ft. Lauderdale, Broward County, Florida (Figures 1). It is approximately four miles west-northwest of downtown Ft. Lauderdale. It is bounded on the west by M.L. King Boulevard (formerly Wingate Rd.) on the northwest by an automotive junkyard, on the northeast by Rock Pit Lake, and on the east and south by single family homes (Figure 4 and 5).

When the City of Ft. Lauderdale (City) built the incinerator in 1954, the surrounding area was sparsely populated. In 1957, a few homes existed north, east, and south of the site (Figure 2). Unfortunately the 1960 census was not detailed enough to characterize the population around the incinerator. The 1970 census[1] counted about 18,500 mostly African-American residents in the census tracts approximately two miles northwest and one mile southeast of the incinerator most likely affected by ash deposition. A 1971 aerial photograph shows many more houses than in 1957 (Figure 3). According to the 2000 census[2] 14 percent of all housing units were built before 1960, while the majority of housing units, 70 percent, were built between 1960 and 1979. In 1980, two years after the City ceased incinerator operations, the population within approximately two miles northwest and one mile southeast of the incinerator was 27,763.[3] In addition, according to the 2000 census, the majority of the current population, (79%) moved into their home after 1979. (The specific geographic identifiers used in extracting census bureau data can be found in appendix B.)

Currently the area surrounding the Wingate site is a densely populated, low- to middle-income, African-American suburb of Ft. Lauderdale. In 2000, approximately 27,868 people lived within approximately two miles northwest and one mile southeast of the incinerator. The population is 87 percent African American, 7 percent Causation, and 6 percent other. The median annual income is $26,078 and the majority of the population (57%) completed all or part of high school.[4]

Neighborhood surrounding the Wingate site include:

Lake Aire,	Boulevard Gardens	Broward Estates
Broward Gardens	Dillard Park	Driftwood Terrace
Durrs	East Gate	Franklin Park
Golden Heights	Home Beautification Park	Lafayette Park

Lakeview	Lauderdale Manor	Rock Island
Roosevelt Gardens	St. George	Washington Park
West Ken Lark		

The City owed and operated the Wingate municipal solid waste incinerator. At its peak, the facility consisted of two incinerator buildings, a vehicle maintenance shop, an office building, and a 40-acre landfill (Figure 6). The City incinerated approximately 480 tons of household and industrial wastes daily. The City placed incinerator ash and other solid waste in the landfill on the northern portion of the site and discharged cooling water to a five-acre pond (Lake Stupid) in the southeast corner of the site. When this pond filled with ash and lost its permeability, the City routed cooling water along the eastern site boundary to adjacent 40-acre Rock Pit Lake, northeast of the site. Rock Pit Lake also received storm water runoff directly from the landfill. Rock Pit Lake resulted from rock mining sometime in the 1950s or 1960s.

Combustion of municipal solid waste generates two types of ash. Bottom ash is the coarser-grained bulk ash that remains in the furnace. Fly ash is the fine-grained ash that is carried to the smoke stack or emission control facility. Fly ash consists of 70 to 95 percent inorganic matter, primarily silicon, iron, aluminum, calcium, magnesium, and sodium. The remaining 5 to 30 percent of fly ash contains dioxins, furans, polynuclear aromatic hydrocarbons (PAHs); and metals such as arsenic, cadmium, chromium, nickel, and lead.[5] The City disposed of both kinds of ash in the on-site landfill.

In the only known air monitoring at the facility, the City collected one air sample from the incinerator smoke stack in 1975 but only measured the weight of particulates.[6]

Unable to meet new air emissions standards, the City ceased incinerator operations in 1978. In 1985 the US Environmental Protection Agency (EPA) began investigating the facility as a possible hazardous waste site. EPA found DDT and other pesticides in the landfill soil. EPA also found pesticide-contaminated sediments in adjacent Rock Pit Lake. In 1989, EPA added this site to its Superfund National Priorities List based on the threat of ground water contamination.

In a 1990 report, the Florida Department of Health (DOH) and the US Agency for Toxic Substances and Disease Registry (ATSDR) reviewed levels of polycyclic aromatic hydrocarbons (PAHs), DDT, and other pesticides in the landfill soil and Rock Pit Lake sediments. Based on the available environmental data, Florida DOH/ATSDR concluded the site was not a current public health hazard. Because of the lack of historical air testing, however, Florida DOH/ATSDR couldn't rule out exposures to air pollution when the incinerator was in operation.[7]

Between 1992 and 1994 the City, at EPA's direction, tested soil, sediment, surface water, ground water, incinerator ash, and Rock Pit Lake fish. In addition to ash in the landfill, the City found ash around the incinerator on the southern portion of the site. The City found arsenic, lead, and dioxins in soil and ash but were unable to identify a plume of contaminated ground water. The City also found antimony, arsenic, cadmium, and

dioxins in Rock Pit Lake sediments. Cooling water discharge and storm water run off transported ash and contaminated soil from Lake Stupid into Rock Pit Lake. Storm water runoff from the landfill may have also carried ash and contaminated soil into Rock Pit Lake.[8]

Although it is surrounded by private property, nearby residents reported that people occasionally ate fish caught in Rock Pit Lake. In 1993 EPA tested Rock Pit Lake bass, Tilapia, and catfish fillets for mercury and dioxins and concluded the public health threat was negligible. ATSDR reviewed the dioxin results and concurred that the maximum fish dioxin levels (0.07 parts per trillion TEQ) was not a health threat.[9] Two years later in 1995, the Florida DOH had Rock Pit Lake fish analyzed for heavy metals (arsenic, cadmium, chromium, copper, lead, selenium, and zinc). Although levels of heavy metal in the fish were low, to be on the safe side Florida DOH/ATSDR recommended people limit their consumption of fish from Rock Pit Lake to only fillets no more than once a week.[10] In 1997 Florida DOH and the Broward County Health Department distributed a fish consumption advisory to nearby residents. Also in 1997 the City, in cooperation with Florida DOH, posted fish consumption advisories around Rock Pit Lake.[11]

In 1996, EPA announced that demolition of the existing structures, placement of contaminated soils on the existing landfill, and capping the landfill was the best cleanup plan for the site.[8]

A 1996 preliminary review of area cancer data suggested that rates of some cancers (breast, prostate, pancreas, and eye) might be above state average. Florida DOH/ATSDR recommended additional analyses when more data became available.[12] Also in 1996, Florida DOH/ATSDR concluded incidental ingestion of metals and dioxins found in residential soil was not likely to cause illness.[13] In a 1999 report, Florida DOH/ATSDR concluded that eating homegrown vegetables and fruits grown in this same residential soil was not likely to cause illness.[14]

In 2001, the City and other responsible parties completed a site cleanup under EPA supervision. They demolished the incinerator and other site buildings, transferred contaminated soil and ash to the northern (landfill) portion of the site, and installed a cap over the landfill.[15] The site is now a fenced, raised, grass covered landfill with a lake for storm water runoff.

During the site cleanup, the City discovered low levels of dioxins (maximum 70 parts per trillion (ppt) TEQ) in residential surface soil along the eastern site boundary. Storm water run-off from Lake Stupid in the southeast corner of the site apparently carried contaminated sediments into nearby yards. Because the levels were below its cleanup goal of 600 ppt, EPA did not require remediation. These levels were, however, above the Florida Department of Environmental Protection's (DEP) soil target cleanup level of 7 ppt. In 2002, the Florida DEP removed dioxin-contaminated soil from 17 residential yards along the eastern site boundary.[16]

Health Survey Background and History

People living around the Wingate incinerator complained that fly ash and black smoke covered their homes in the late 1950s and 1960s. Their main health concern was that air pollution from the incinerator caused respiratory problems, circulatory problems, skin rashes, birth defects, cancer, and many other illnesses.

In 1997 as EPA was reconsidering the cleanup plan, community leader Leola McCoy, Legal Aid Services of Broward County Director Sharon Bourassa, and US Representative Alcee Hastings called for a health study. First Florida DOH/ATSDR explored the possibility of looking for arsenic and dioxin in the blood or urine of nearby residence but found it was not feasible because there were no current exposure to arsenic or dioxin and previous exposures had ceased 20 years prior in 1978.[17] At a September 1998 public meeting Florida DOH/ATSDR presented a plan for a disease and symptom prevalence survey to the Wingate community. The plan failed to gain community support because it would be unable to show causation.[18] Florida DOH/ATSDR also considered a dose reconstruction study but found it was not feasible due to inadequate exposure data.[19]

Between 1998 and 2002, Florida DOH, community leaders, and University of Alabama epidemiologist Jeff Roseman worked together on three different health study proposals. These proposals included a survey of cancer rates, testing blood dioxin levels, and a survey of hypertension and kidney function based on lead exposure.[20] These proposals, however, either exceeded available ATSDR funds (cancer rates/blood dioxin) or failed to gain community support because they would be unable to show causation (lead exposure).

In the Spring/Summer of 2002, Florida DOH, ATSDR, Broward County Health Department, City, and community representatives met three times in Ft. Lauderdale to discuss health study options. The community, represented by Legal Aid Services of Broward County, retained Boston University epidemiologist Richard Clapp who recommended a disease and symptom prevalence survey. At the third meeting, area homeowner association presidents voted to support a disease and symptom prevalence survey.

Between July 2002 and March 2003, Florida DOH worked with both community and City epidemiologists on the details of a disease and symptom prevalence survey. As a result of these discussions, Florida DOH decided to focus on symptoms and diseases associated with arsenic and dioxin. Arsenic and dioxin are contaminants associated with municipal incinerator ash. Arsenic is an inorganic contaminant and dioxins are organic contaminants. The toxicity of arsenic is fairly well known. Although the toxicity of dioxins are less well known, they are considered more toxic than arsenic. Also as a result of these discussions, Florida DOH decided to exclude diseases/symptoms associated with lead, mercury, and other contaminants in order to maintain a reasonable survey length. Three independent scientists then reviewed the survey plan and in June 2003 ATSDR approved/funded it. Florida DOH kept homeowner association presidents informed with five newsletters.

Potential Exposure Pathways

Florida DOH/ATSDR considered two exposure pathways for this survey: airborne fly ash from the incinerator and eating fish from nearby Rock Pit Lake.

To be able to detect health effects, surveys require hundreds of participants. Exposure to airborne particulates (fly ash) was the pathway that exposed the largest number of residents near the Wingate site. Nearby residents reported that fly ash from the incinerator frequently blanketed their home in the late 1950s and 1960s. This pathway takes into account inhalation, skin contact, and incidental ingestion of fly ash. The prevailing winds blew most of the ash to the northwest and some to the southeast (Figure 7.) In addition to having exposed the largest number of people, this is the pathway that most residents are concerned about.

Although fewer people ate fish from Rock Pit Lake than were exposed to airborne fly ash, because of community concerns the survey included fish consumption.

Compared to the large number of people exposed to contaminants through the air; the number of people exposed via contact with residential soil, ground water, home grown fruits/vegetables, and swimming in Rock Pit Lake was relatively small. Also Florida DOH/ATSDR found that exposure to the concentrations of contaminants currently in these media is unlikely to cause illness. Therefore in order to detect health effects and address community concerns, this survey focused on exposure to airborne incinerator ash and also included Rock Pit Lake fish consumption.

Possible Health Effects

Municipal incinerators such as Wingate release smoke and small particles known as "fly ash" into the air. On average, 5 to 30 percent of this fly ash consists of dioxins, furans, polynuclear aromatic hydrocarbons (PAHs), and metals such as arsenic, cadmium, chromium, nickel, and lead.[5] Since there was no air monitoring around Wingate, the exact levels of these contaminants nearby residents breathed is unknown.

Working with both Wingate community and City scientists, Florida DOH narrowed the survey to those diseases and symptoms associated with exposure to arsenic and dioxins. Both arsenic and dioxins are toxic chemicals present in the Wingate incinerator fly ash. The human toxicity of arsenic is well known.[21] The human toxicity of dioxins is less well known but potentially much more toxic than arsenic.[22] Diseases and symptoms associated with other fly ash contaminants such as PAHs and lead were considered but not included in order to keep the survey questionnaire a reasonable length.

Studies at other municipal incinerators found, on average, about 0.003 grams of arsenic were emitted into the air per ton of refuse burned.[23] At this rate, the 480 ton/day Wingate incinerator would have emitted about 1.4 grams of arsenic into the air per day. A paper

clip weighs a little less than one gram. For dioxins, studies found emissions from municipal incinerators typically result in air concentrations of about 2 nanograms of dioxins (TEF) per cubic meter.[23] A nanogram is one billionth (10^{-9} or 1/1,000,000,000) of a gram.

Older incinerators like the Wingate incinerator, however, likely emitted higher than average contaminant concentrations. The lack of information on the Wingate incinerator operation and the lack of air monitoring prevent an accurate estimate of the actual arsenic and dioxin air emissions. It is likely, however, that nearby residents were exposed to low levels of these contaminants for a number of years.

Because the levels of arsenic and dioxin that residents around Wingate were exposed to are unknown, this survey looked for all associated diseases and symptoms, regardless of exposure level. Most of the symptoms and diseases associated with arsenic and dioxin discussed below, however, are only known to occur at high exposure levels. Because of the uncertainty in past Wingate exposure levels, this survey errs on the side of including all of the diseases and symptoms associated with exposure to arsenic and dioxin.

Human diseases and symptoms associated with exposure to sufficiently high levels of arsenic are: [21]

1. Darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.
2. Irritation of the stomach and intestines: stomachache, nausea, vomiting, and diarrhea.
3. Decreased red and white blood cell production leading to fatigue, anemia, abnormal heart rhythm, bruising, and "pins and needles" sensation in the hands and feet.
4. Increased risk of skin, liver, bladder, kidney, and lung cancer.
5. Breathing arsenic-containing dust can cause a sore throat and irritated lungs.
6. Skin contact may cause irritation, redness, and swelling of the skin. .

Human diseases and symptoms associated with exposure to sufficiently high levels of dioxins are: [22]

1. Chloracne
2. Red skin rashes, darkened patches of skin (hyperpigmentation), and excessive body hair.
3. Lassitude, weakness of the lower limbs, muscular pains, sleepiness or sleeplessness, increased perspiration, loss of appetite, headaches, sudden onset/short-lived seizures, and accumulation of fluid in the brain.
4. Abnormal skin sensation (burning, prickling, itching, or tingling), pain, loss of sensation, and weakness.
5. Diabetes mellitus
6. An excess of cholesterol in the blood and cells.

STUDY QUESTIONS

The survey attempts to answer three questions:

1. Is the survey prevalence of self-reported disease and symptoms among residents who reported living in the ash deposition zone when the incinerator operated (1954-1978) statistically different from the prevalence of those who reported moving in after 1978?

2. Is the modeled ash deposition zone of current residence and length of reported residence in this zone statistically related to the survey prevalence of self-reported disease and symptoms?

3. Is the amount of fish reported retrospectively by residents to be consumed from Rock Pit Lake over time statistically related to the survey prevalence of self-reported disease and symptoms?

METHODS

Environmental Exposures

The survey assumes nearby residents were exposed to arsenic and dioxins in air-borne fly ash from the Wingate incinerator. The survey assumes residents living closest to the incinerator where exposed to more fly ash that more distant residents. The survey assumes that nearby residents were exposed to fly ash from the time the incinerator began operation in 1954 until it ceased operation in 1978. The survey assumes the longer residents lived near the incinerator the greater their exposure to fly ash. The survey assumes that residents that moved into the area near the incinerator after 1978 were not exposed to fly ash.

The survey assumes that some nearby residents were exposed to arsenic and dioxins by eating fish from Rock Pit Lake.

The exposure variables were:

1. Exposure to fly ash: lived nearby 1954-1978 or after 1978
2. Amount of fly ash exposure: residential distance from incinerator
3. Duration of fly ash exposure: how long lived in area 1954-1978
4. Rock Pit Lake fish consumption

In 2002, the Florida Department of Environmental Protection (DEP) modeled the pattern of dry particulate deposition (fly ash) from the Wingate incinerator stacks when they were in operation. The model took into account the prevailing winds, incinerator stack heights, smoke temperature, and smoke exit velocity. The model predicted a pattern of decreasing ash deposition with increasing distance from the incinerator (Appendix E).

Estimating ash deposition from a model was necessary because actual measurements were not taken when the incinerator was in operation.

Using the Florida DEP ash deposition model map, Florida DOH selected ash deposition contours that extended about two miles to the west-northwest and about one mile to the southeast (Figures 7). The area within these contours had the highest rate of ash deposition and, according to our sample size/power calculations, contained sufficient numbers of residents for a survey. Using ash deposition contours, Florida DOH subdivided this ash deposition area into three ash deposition "zones." Each of these ash deposition zones contained about the same number of residents. Using GIS software and DEP's ash deposition map, Florida DOH geographically superimposed three ash deposition zones (A, B, and C) on to the 2000 census blocks (Appendix B).[2] Ash deposition zone A is the closest to the former incinerator; ash deposition zone C was the most distant. Ash deposition zone B was in the middle. Zone A had the most ash deposition; zone C had the least. Zones are a surrogate for exposure. Dividing the overall ash deposition area into three zones allowed a comparison of disease and symptoms between different ash deposition rates.

Study Population and Participant Selection

The survey only included adults 25 years or older. When the survey was conducted in 2003 (25 years after the incinerator ceased operations), the exposed population would have been at least 25 years old. For individuals who moved into the area after 1978, we also limited our survey to adult 25 years or older. We did this to have a comparable age distribution in both groups.

For individuals living in the area between 1954 and 1978, selection was limited to those with at least one year residency. Individual who lived in the area for less than one year may not have been exposed to incinerator fly ash. Inclusion of individuals who lived in the area for less than one year would have diluted the power of the study to detect an association between exposure and disease/symptom.

Florida DOH obtained Wingate area (Figure 7) telephone numbers from Survey Sampling International, a private telephone number supplier. Table 2 details the distribution of the 4,758 available Wingate area telephones and the population in ash deposition zones A, B, and C. From the available telephone pool, we randomly selected a number of telephone numbers in each zone proportional to the number of people (25 or older) in each zone (Table 2.). There were only 1,253 telephones in zone A. We estimated a 70 percent response rate which required at least 1,243 telephones from zone A. Therefore we selected all telephones in zone A and calculated the number of telephones in zone B and C necessary to maintain the same population proportion between zones. We conducted one interview for each telephone number selected.

Study Diseases and Symptoms

The survey asked nearby residents about diseases and symptoms associated with exposure to both arsenic and dioxins. Florida DOH, in consultation with City and community epidemiologist decided to focus on symptoms and diseases associated with exposure to arsenic and dioxin. Arsenic and dioxin are contaminants associated with municipal incinerator ash. Arsenic is an inorganic contaminant and dioxins are organic contaminants. The toxicity of arsenic is fairly well known. Although the toxicity of dioxins are less well known, they are considered more toxic than arsenic. Florida DOH decided to exclude diseases/symptoms associated with lead, mercury, and other contaminants in order to maintain a reasonable survey length.

For arsenic, the survey asked about:

1. Darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.
2. Irritation of the stomach and intestines: stomachache, nausea, vomiting, and diarrhea.
3. Decreased red and white blood cell production leading to fatigue, anemia, abnormal heart rhythm, bruising, and "pins and needles" sensation in the hands and feet.
4. Increased risk of skin, liver, bladder, kidney, and lung cancer.
5. Breathing arsenic-containing dust can cause a sore throat and irritated lungs.
6. Skin contact may cause irritation, redness, and swelling of the skin. .

For dioxins, the survey asked about:

1. Chloracne
2. Red skin rashes, darkened patches of skin (hyperpigmentation), and excessive body hair.
3. Lassitude, weakness of the lower limbs, muscular pains, sleepiness or sleeplessness, increased perspiration, loss of appetite, headaches, sudden onset/short-lived seizures, and accumulation of fluid in the brain.
4. Abnormal skin sensation (burning, prickling, itching, or tingling), pain, loss of sensation, and weakness.
5. Diabetes mellitus
6. An excess of cholesterol in the blood and cells.

Sample Size and Power Analysis[24]

To maximize the power of the study, Florida DOH attempted to administer the survey questionnaire to as many Wingate area residents as possible (within the study budget). We attempted to survey as many residents as possible to ensure an adequate number of residents in each ash deposition zone and to increase the power of the survey to detect small effects.

Florida DOH estimated it could survey 2,963 individuals within the study budget. Our target was 870 individuals in zone A, 1,093 in zone B, and 1,000 in zone C. This target survey size was based on the background prevalence rates of skin rash in the United States. Except for cancer, skin rash was the only disease/symptom associated with arsenic or dioxin exposure with an available national prevalence rate.[25] This rate was used to create varying scenarios for sample size.

Based on prevalence data from the National Health Interview Survey[25] we assumed that residents in ash deposition zone C had a prevalence of skin rash of 70 per 1,000. Table 1 shows the effect on sample size of various plausible effects across ash deposition zones, ranging from small effects (a 40 percent increase in prevalence for subjects in zone B compared to zone C and 80 percent increase in prevalence for subjects in zone A compared to zone C) to large effects (a 100 percent increase in prevalence for subjects in zone B compared to zone C and a 200 percent increase in prevalence for subjects in zone A compared to subjects in zone C)[26]. We also show how the required sample size is affected by treating the ash deposition zone as an ordinal variable compared to modeling it in unordered categories, i.e., nominal (the latter being more conservative, less powerful for detecting true linear associations between deposition zone and outcome, but more appropriate when the underlying relationships are not linear).

Thus, an overall sample size of 1,300-1,700 was required to detect small effects, 600-700 to detect small-to-moderate effects, 400-550 to detect moderate-to-large effects, and 300 to detect large effects. Considering that prevalence rates of cancer are 100 fold smaller than the prevalence for skin rash, we would have liked a sample size of over 50,000 to detect small effects (over 26,000 to detect small-to-moderate effects). However, study funding only allowed for a total of 3,000 interviews. In the end, we maximized the overall sample size (2,963) according to the available funding and proportion of the population age 25 or older by ash deposition zone to 1) increase the likelihood of an adequate number of residents that lived in one of the ash deposition zones between 1954 and 1978 and 2) increase the power of the survey to detect small effects (Table 2).

Survey Preparation

The Broward County Health Department (CHD), in cooperation with the Florida DOH, hired four interviewers to conduct the health interviews. The Broward CHD trained the interviewers to conduct the interviews in a consistent, unbiased, and professional manner. Broward CHD housed and coordinated the interviewers' work with Florida DOH. The Broward CHD Environmental Health Director supervised and randomly monitored interviews for quality control. Florida DOH/Broward CHD required the interviewers to follow department security policy and maintain strict confidentiality of the participant's responses.

Survey Implementation

For each of the four Broward CHD interviewers, a sub-sample was created by dividing the already selected sample from zone A into four equal parts. The same was done for the

sample from zone B and zone C. The estimate obtained from combining these stratified proportional samples is equivalent to an estimate obtained using a simple random sample of the entire population (individuals 25 and older) of the three zones combined (Table 2).

The interviewers administered the survey questionnaire primarily via telephone. They attempted to interview the first person at least 25 years old who answered the phone. The interviewers tried to call the selected residence five times on different workdays. If unsuccessful, they then tried to call the selected residences five times on weeknights or on Saturday. The survey questionnaire is in Appendix F.

If unable to complete the survey after ten attempts over the telephone, that resident was added to a list for an "in-person" interview attempt. Interviewers attempted to conduct an "in-person" interview on three different workdays or Saturdays. The interviewers confirmed the location of each "in-person" interview using a hand-held global positioning system (GPS) unit.

To minimize "interviewer bias" interviewers were assigned telephone interviewees randomly from the three ash deposition zones and were provided only with the name, telephone number and interviewee code. Follow-up "in person" interviews were also assigned to interviewers randomly.

DATA ANALYSIS

Data Entry and Management

During the interview, interviewers entered responses to the survey questions directly into an Access database form created for this project. Florida DOH epidemiologists had direct access to the database and so it was possible to review collected data on a daily basis. They monitored the collected data for completeness and accuracy and worked with the Broward CHD environmental health director and the survey interviewers on a weekly basis to discuss and resolve data quality problems.

Using addresses given during each interview, Florida DOH used geocoding software to accurately locate each respondent within the appropriate ash deposition zone. Zone location was done by hand for address the software could not correctly place.

Outcome and Exposure Variables

Florida DOH analyzed whether distance from the incinerator (zones A, B, C), living there before 1978, or eating Rock Pit Lake fish (exposure variables) was associated with increased reporting of 10 different medical diagnoses (Asthma, Bronchitis, Chloracne, Hyperkeratosis, Hyperpigmentation, Anemia, Other blood disorders w/ low cell count, Hypercholesterolemia, Glucose Intolerance, and Cardiac Arrhythmias) and 15 different symptoms (outcome variables, see appendix C). Each reported medical diagnosis and reported symptom was treated as a dichotomous outcome variable (answered yes or no).

Statistical analysis was performed as to whether distance from the former incinerator site, living there before 1978, or eating fish from Rock Pit Lake (exposure variables) were associated with an increased reporting of being diagnosed with any of the cancers associated with dioxin or arsenic. As the frequency for individual types of cancers was too low to perform an analysis on each type separately, a dichotomous variable labeled *cancers of concern* (outcome variable) was created by combining all cancers previously known to be associated with exposure to arsenic and dioxin.[22, 21] The *cancers of concern* are melanoma, lung, kidney, bladder, prostate, and liver cancers. *Cancers of concern* was treated as a dichotomous outcome variable (answered yes or no).

The following variables were found in literature reviews to be possible covariates of afore mentioned disease and symptoms and as such were adjusted for in differing combinations in all of the models: age-group, body mass index (BMI), race, and gender (Appendix C).

Survey participants may have also been exposed at work to hazardous chemicals, toxins or activities that may have affected their health. Question number eight of the survey asked "At any place you ever worked (job), do you recall being exposed to any of these potentially toxic substances?" Participants were then asked to choose from a list of chemicals, toxins, particulates and/or activities that could have affected their health (Appendix F). Four dichotomous variables were created from this question, job exposure to dioxin, job exposure to arsenic, asthma job hazard and cancer job hazard. Combinations of the reported exposures to chemicals, toxins, particulates and activities that could have been associated with a survey participants' reported asthma or cancer were used to define the cancer or asthma job hazard variables (Appendix C).

Model Analysis

All outcome variables, reported diseases[27], reported cancers of concern[28] and reported symptoms, were analyzed as dichotomous data (yes/no). The exposure variables; reported time of residence (before 1978 vs. after 1978) and ate Rock Pit Lake fish (yes vs. no) were also treated as dichotomous. The third exposure variable was discrete with zone A, zone B, and zone C. A forth exposure variable was to be examined: the effect of zone of residence (A, B, and C) for individuals living in the area between 1954 and 1978. However, due to the small number of respondents expected to have lived in each of the three areas considered, the responses from zones A, B and C were combined to perform the analysis of people who reported living in the area before 1978 vs. after 1978. Further information about the variables used in the analysis can be found in Appendix C. Analysis was not conducted where the reported number of respondents within a cell was less than five: the disease Other Low Blood Cell Count vs. all exposure variables, and the disease hyperkeratosis vs. ate Rock Pit Lake fish.

Descriptive and Bivariate Analysis:
Initially, to characterize the distributions of demographic survey questions, frequencies and percentiles were calculated subdivided by zone of residence. Frequencies and

percentiles were also calculated for an aggregated number of reported symptoms vs. each exposure variable (Appendix C). Crude odd ratios were calculated for each exposure variable vs. each outcome variable. A correlation analysis using Pearson's correlation coefficient was done for all potential covariates vs. all outcome variables (reported diseases, reported cancers of concern and reported symptoms). Similarly, analysis using Row Means Score difference was performed for all exposure variable (before/after 1978, zone of residence, eating Rock Pit Lake fish) vs. all potential covariates. The results from the correlation analysis among predictors were utilized in determining potential interaction terms.

Multivariate Analysis:
Literature search in analysis models determined that a binary regression model would provide more reliable models for the analysis than would a Poisson model. For the ten reported medical diagnoses cancers of concern and reported symptoms, dichotomous variables were created and binary regression models were applied using SAS (proc genmod) with *binary* distribution and *logit* link

All testing was reported at a significance level of 0.05. For each disease analysis the best explanatory model(s) was created using the variables that were relevant for that particular disease using the survey data (Appendix D contains information on the variables selected for the initial models). Potential covariates were chosen for inclusion in the original model dependent on previous literature review. Once the variables were selected for the initial model, stepwise (backward elimination) regression was conducted to determine a reduced model. The backward elimination procedure involves removing variables from the model one by one dependent on statistical significance of each remaining variable (alpha level of ~ 0.05) and overall fit of the model which was defined by the goodness-of-fit statistic. The models were evaluated after each variable was deleted.

There was the possibility that a covariate was not statistically significant at an alpha level of 0.05 but the covariate added to the overall fit of the model as defined by the goodness-of-fit statistic and the overall model p-value, in which case, the covariate was not excluded from the model. An interaction term was added to the model when a potential covariate modified the relationship between the exposure variable (before/after 1978, zone of residence, eating Rock Pit Lake fish) and the outcome variable. When this occurred a separate analysis for each covariate stratum was presented. An interaction term among covariates was added to the model if the coefficient was not zero. The effect of these two combined covariates on the outcome variable was more or less than the effect of each of these covariates alone. The inclusion of the interaction term (or stratification of the model) was based on statistical significance and the overall fit of the model.

The exposure variables (before/after 1978, zone of residence, eating Rock Pit Lake fish) were forced into their respective models since the explanatory variables were the focus of the analysis. In some cases, it was found that a model without the exposure variable was a better explanation of the disease being analyzed.

Upper and lower confidence limits were also calculated for each odds ratio in the multivariate analyses. Confidence limits were used to estimate the variability and statistical significance of the results. The upper-to-lower confidence limit ratio (CLR) was used to determine the precision of the confidence interval. A confidence interval was precise if the CLR was less than four[29].

Adjustments to Survey Analysis

On the job exposure to arsenic or dioxin were to be included as potential covariates in the multivariate analysis phase. The variables, job exposure to dioxin or job exposure to arsenic, were to be included in models were existing literature regarding dioxin or arsenic supported potential association between the odds of having the disease or symptom and exposure to the chemical. However, there were a total of five respondents reportedly exposed to arsenic while working on the job and a total of ten respondents reportedly exposed to dioxins while working on the job, as assessed by survey question number eight. Since these numbers were small, respondents reportedly having exposure to these chemicals on the job were excluded from particular disease or symptom models. The exclusion occurred only in the models which would have included the potential covariate. For instance, arsenic was only excluded from models which would have included the variable, job exposure to arsenic (Appendix D).

Among the survey respondents a total of 13 people reported having been diagnosed with sickle cell disease, 5 of the 13 respondents also reported having been diagnosed with anemia. Studies have shown that individuals with sickle cell disease a more likely than the general population to be diagnosed with anemia[30]. Due to this reasoning, all respondents diagnosed with sickle cell disease were removed from the anemia analyses.

Analysis was not performed when the number of respondents who reported having a disease or symptom stratified by the exposure variable was too low. This occurred when the count in at least one of the cells was less then five for a 2x2 table of disease (or symptom) vs. one of the three exposure variables.

In some of the models quasi-complete separation was a problem. Quasi-complete separation occurs in regression models when some linear combination of the exposure variable perfectly predicts the outcome variable except for a single value of the exposure variable for which both values of the outcome variable occur. For instance, individuals were asked if they had ever been diagnosed with leukemia (yes/no) and their age group (25 to 29, 30 to 34, 35 to 39, and 40 to 44). If everyone in the group age 25 to 29 answered yes to leukemia, everyone older than 35 answered no to leukemia and exactly half the people age 30 to 34 answered no and exactly half answered yes, then the true maximum likelihood estimate for age group would be infinite and the fit of the model would be highly questionable producing inaccurate results. Combining age groups may correct this problem. Individuals age 25 to 34 answered both yes and no to leukemia while individuals age 35 plus still only answered no, however the true maximum likelihood estimate can now be calculated. In our analysis all models initially utilized six age-group categories. However, to avoid the problem of quasi-complete separation

caused by age groups with no respondents, the six age-group categories were condensed into four or five categories when necessary (Appendix C and Appendix D). Categories were combined when the parameter estimates produced by proc genmod were unusually high and the standard errors were zero. Age-groups were first condensed into five categories and if this still did not produce a valid model then age-groups were condensed into four categories.

The information from the survey question related to education (question #6) was found to be negatively correlated with age group and was not included in any analyses to prevent multicollinearity (Pearson Correlation Coefficient = -0.23, p-value = <0.0001). It was also determined that older survey participants (age 55+) were more likely then younger survey participants to have a high school education or less (OR 2.03; 95% CI 1.64, 2.5). In general individuals older than age 55 started in the work force when college degrees were not the determinate of a middle class (or higher) income bracket. For younger individuals, education is a stronger determinate of income level. Due to this reasoning, we decided that education alone, varying significantly among age groups is not an accurate measure of socio-economic status and was, therefore, not included in any of the analyses.[31]

RESULTS

Examination of Bias

In order to estimate bias, Florida DOH epidemiologists searched the Florida Cancer Data System (FCDS) to verify reports of cancers associated with exposure to arsenic. (FCDS does not collect data on basal and squamous skin cancers.) Limited resources did not allow for review of medical records to verify other diseases or symptoms. Of the 130 reported diagnoses of cancer, only 54 of the cases could be confirmed in the Florida Cancer Registry (FCDS)[32]. The other 76 reports of cancer diagnosis could not be found in the FCDS and therefore could not be confirmed. We found after confirmation with FCDS that 24 percent of the 54 confirmed cancer cases were incorrectly reported by survey participants. For instance, one survey participant reported having Colon cancer where as FCDS reports the individual had Lung and Bronchial cancer.

The survey included questions about 13 different symptoms associated with exposure to arsenic or dioxins (Appendix F). In addition, the survey included two symptoms (neck pain and difficulty urinating) not associated with exposure to arsenic or dioxins. These two symptoms were included to estimate the response bias of survey participants. We wanted to test if respondents reported a varying frequency of all 15 symptoms or only a varying frequency of the 13 symptoms related to arsenic or dioxin exposure. Towards this end, 2x2 tables were created to see if there were differences by the three exposure variables in the frequency of reported symptoms. Reported symptoms were either the frequency of all 15 symptoms or the frequency of symptoms without neck pain and difficulty urinating and was stratified as follows; zero reported symptoms, 1 to 4 reported symptoms, 5 to 8 reported symptoms and 9 or more reported symptoms. Four 2x2 tables

were created for the exposure variables, time of residence and ate Rock Pit Lake fish while eight tables were created for zone of residence. No statistically significant difference was found between the 14 symptom frequency group and the 12 symptom frequency group for: time of residence (living in the area before 1978 or after 1978); area of residence (zone A, B or C); and eating fish from Rock Pit. This indicates there was little to no response bias among respondents' reporting of symptoms (results not shown.)

Previous knowledge or hearsay of a potential health hazard may have affected the recall and reporting of diseases and symptoms in this survey. Therefore, two control questions were included in the survey to estimate recall bias of survey participants (see questions 9 and 10 in appendix F). Both questions allowed the respondent to don't know. We considered *don't know* as a non-analyzable answer and all records with this response were considered unusable for all analyses. A smaller number of participants (33%) answered *don't know* for question #10 then for question #9 (43%). Due to the similarity between these two questions and the large *don't know* response to both questions, only question number 10 was analyzed. A correlation analysis using Pearson's correlation coefficient was done for all diseases and symptoms vs. survey question #10. Only responses from survey participants who answered yes or no to survey question #10 were utilized in analysis for this study (n = 1054). For all disease, except glucose intolerance and the cancers of concern, there was a statistically significant correlation between survey participants who answered yes to question #10 and those who reported having been diagnosed with a disease (Pearson Correlation Coefficient ranged from 0.10 to 0.24, $p < 0.0008$.) For all symptoms there was a statistically significant correlation between survey participants who answered yes to question #10 and those who reported having experience one of the symptoms (Pearson Correlation Coefficient ranged from 0.11 to 0.40, $p < 0.0003$.)

Participation Results

The population within two miles of the Wingate site is predominately African-American. The average age is between 30 and 35, the average educational level is high school, and the average household income is about $30,000 per year[33]. In 2000, zone A (nearest to the incinerator) contained 4,772 people age 25 or older, zone B contained 5,990 people age 25 or older, and zone C contained 5,480 people age 25 or older. Table 2 shows the population distribution for the study area. Although 1960, 1970, and 1980 census data were not detailed enough to determine the exact number of people in these zones, historical maps and aerial photographs show residential development in each area.

Respondents were removed from the overall survey population if they were under the age of 25, lived in the study area less than 1 year, were found to currently live outside of the study area, or did not answer any of the disease/symptom related survey questions. Incomplete surveys were also removed from the database. Surveys were considered incomplete if the respondent did not answer any of the disease or symptom questions. Duplicate records were also removed from the database. Duplicate records occurred when a household had more than one phone line or were called for an interview more than once.

Out of a total of 1,767 surveys completed, 1,627 meet the study eligibility criteria and were included in the analysis. 582 eligible survey participants were from zone A, 523 were from zone B, and 522 were from zone C. Of the 140 ineligible surveys, two were under the age of 25 and 138 were outside the study area. Zone A had a 67 percent response rate while zone B had a 48 percent response rate and zone C had a 52 percent response rate.

Demographic Characteristics

Approximately one-third of all study respondents were from each of the three ash deposition zones (Table 3). A majority of survey participants in each area of residence were; female, black, non-Hispanic, had moved into the area after 1978, had not eaten fish from Rock Pit Lake, and had a high school (twelfth grade) education or less. The majority of study participants in zone A were 45-74 years of age while in both zones B and C the majority of study participants were 35-64 years of age. Study participants who smoked more than 5 packs of cigarettes in their life-time were in the minority for all zones.

When asked how much pollution they thought was in their community compared to other similar communities, survey participants in all zones believed their community had higher levels of pollution. The majority of respondents in zone A reported that they believed their health had had been affected by toxic chemicals in the environment. The majority of respondents in zone B and zone C reported that they did not feel that their health had been affected by toxic chemicals in the environment.

Crude Analysis

Crude odds ratios (OR) and 95 percent confidence intervals (CI) were calculated for self-reported diseases (Tables 4-6) and self- reported symptoms (Tables 6-8) by time of residence in area (i.e. moved into the area before or after 1978), by zone of residence and by whether the respondent ate fish from Rock Pit Lake.

Self-Reported Diseases

When examining self-reported diseases by time of residence in area (before 1978 or after 1978), 9 of the 11 diseases had odds ratios greater than 1.0, indicting a higher occurrence in the group residing in the area before 1978 (Table 4). Of these, six were found to be higher with statistical significance in the group residing in the area before 1978 (hyper-pigmentation, anemia, hypercholesterolemia, glucose intolerance, cardiac arrhythmias, and cancers of concern). One self-reported disease (asthma) resulted in an odds ratio less than 1.0 indicating a lower occurrence in the groups residing in the area before 1978. "Other low blood cell count" could not be evaluated since the number of individuals reporting this condition was less than 5.

Self-reported diseases were also examined by zone of residence (Tables 5a and 5b). When comparing residents in zone A vs. zone C (Table 5a), all self-reported diseases resulted in odds ratios greater than 1.0. One disease (other low blood cell count) was not examined since less than five respondents in both zone A and zone C reported having the condition. The self-reporting of three diseases was higher with statistical significance in zone A (asthma, anemia and hypercholesterolemia). When comparing residents in zone B vs. zone C (Table 5b), six of the self-reported diseases resulted in odds ratios greater than 1.0 and four of the self-reported diseases resulted in odds ratios less than 1.0. None were statistically significant. One disease (other low blood cell count) was not examined since less than five respondents in both zone B and zone C reported having the condition.

Odds ratios and 95 percent confidence intervals for individuals who reported eating fish from Rock Pit Lake were based on much smaller numbers and resulted in less precise estimates (Table 6). All nine diseases that were evaluated resulted in odds ratios greater than 1.0 with all but one being statistically significant (anemia). Two self-reported diseases were not evaluated (hyperkeratosis and other low blood cell count) since less than five respondents reporting having the condition.

Self-Reported Symptoms

For respondents who reported living in the area before 1978 compared to those respondents who moved into the area after 1978 (Table 7), all 15 self-reported symptoms had ORs ≥1.0, indicating higher occurrence in individuals who reported moving into the area before 1978. Of these, two were found not to be significantly higher statistically: extreme sleepiness; and severe (strong) headaches.

Tables 8a and 8b compares numbers of reported symptoms between ash deposition zones. All 15 symptoms had ORs ≥ 1.0, indicating higher occurrence in individuals who lived in zone A compared to zone C. Of theses, three were found not to be statistically significantly higher: neck pain; difficulty in urination (passing water); and anxiety, nervousness or depression. All symptoms except one (severe headaches) had ORs ≥ 1.0, indicating higher occurrence in individuals who lived in zone B compared to zone C. Of theses, only two were found to be statistically significantly higher: numbness, tingling, or weakness in arms or legs; and irritation, redness & swelling of skin.

Table 9 compares numbers of reported symptoms between respondents who reported eating Rock Pit Lake Fish to respondents who reported not eating Rock Pit Lake Fish. All symptoms had ORs ≥1.0, indicating higher occurrence in individuals who reported eating fish from Rock Pit Lake. All symptoms were found to be statistically significantly higher.

Multivariate Analysis

Controlling for the effect of potential confounders and effect modifiers, logistic regression was used to assess the relationship between self-reported diseases and symptoms with potential exposure to contaminants as indicated by:

1. time of residence (living in the area before 1978 or after 1978)
2. area of residence (zone A, B or C)
3. eating fish from Rock Pit Lake

Self-reported diseases used for logistic modeling did not include *other low blood cell count* and for the reported fish consumption did not include *hyperkaratosis*. Diseases and symptoms to be analyzed were selected because they were (1) possibly associated etiologically with the primary chemicals of concern (arsenic and dioxin), and (2) had sufficient sample size for modeling. Potential confounders and effect modifiers include: sex, age, race, body mass index (BMI), smoking, asthma job hazard, and cancer job hazard. Appendix C and D contains detailed information regarding covariate selection and the initial modeling strategy (information on final model selection is not included).

Self-Reported Diseases

After adjusting for confounding and interaction, statistically significant differences remained in individuals who reported living in the survey area before 1978 compared to those who reported moving into the area after 1978 for 3 of the 10 diseases: bronchitis, anemia and hypercholesterolemia (Table 10). Odds ratios ranged from 1.35 to 1.98 and all three estimates were precise (CLR < 4).

Of the ten self-reported diseases examined, two (asthma and anemia) were statistically more prevalent in zone A than in zone C after adjusting for confounding and interaction (Table 11a). The odds ratios ranged from 1.44 to 1.52 and both estimates were precise (CLR < 4). The model with hypercholestrolemia included an interaction between age group and the exposure variable (zone A vs. zone C) – stratified analysis was conducted. Individuals age 25-54 who resided in zone A were more likely to have reported hypercholesterolemia than individuals of the same age group who resided in zone C (OR 1.52; 95% CI 1.02, 2.27.) Individuals age 55 plus who resided in zone A were also more likely to have reported hypercholesterolemia than individuals in the same age group who resided in zone C, these results were not statistically significant (OR 1.14; 95% CI 0.79, 1.63.)

One self-reported disease (glucose intolerance) was statistically more prevalent among individuals with a normal BMI in zone B (Table 11b) than in zone C (OR 1.97; 95% CI 1.21, 3.19) and statistically less prevalent among individuals who had a higher BMI in zone B than in zone C (OR 0.5; 95% CI 0.27, 0.93)

The odds of reporting 5 of the 10 diseases (hyperpigmentation, hypercholesterolemia, glucose intolerance, cardiac arrhythmias, and cancers of concern) was higher among participants who reported eating fish from Rock Pit Lake even after adjusting for confounding and effect measure modification (Table 12). The odds ratios ranged from 2.47 to 3.03 and all estimates were precise (CLR < 4). Two of the models included an interaction between age group and the exposure variable (ate Rock Pit Lake fish) – stratified analyses were conducted for asthma and chloracne. Individuals who were 55

years or older and reported eating fish from Rock Pit Lake were more likely to report having asthma than individuals of the same age group who did not report eating fish (OR = 2.5, 95% CI 1.09, 4.64). Individuals who were 25-54 years of age and reported eating fish from Rock Pit Lake were also more likely to report having asthma than individuals of the same age group who did not report eating fish, although this effect was not statistically significant (OR = 1.82, 95% CI 0.85, 3.87). Individuals who were 25-54 years of age and reported eating fish from Rock Pit Lake were more likely to report having chloracne than individuals of the same age group who did not report eating fish (OR = 5.91, 95% CI 1.16, 30.22). Individuals who were 55 years or older and reported eating fish from Rock Pit Lake were also more likely to report having chloracne than individuals of the same age group who did not report eating fish, although this effect was barely statistically significant (OR = 3.60, 95% CI 1.01, 12.82).

Self-Reported Symptoms

After adjusting for confounding and interaction, statistically significant differences remained in individuals who reported living in the survey area before 1978 compared to those who reported moving into the area after 1978 for 5 of the 15 symptoms: heavy perspiration not related to heat or exercise; bruising easily; extreme sleeplessness; difficulty in urination (passing water); and nausea, vomiting or diarrhea (Table 13). The odds ratios ranged from 1.40 to 2.00 and all five estimates were precise (CLR < 3). Four of the 15 self-reported symptoms: anxiety, nervousness or depression; ringing in ears; numbness, tingling, or weakness in arms or legs; and inability to move arms or legs without known cause were statistically more prevalent among individuals who reportedly lived in the study area before 1978 and who smoked less than 5 packs of cigarettes in their lifetime compared to those who reported moving into the study area after 1978 and smoked less than 5 packs of cigarettes in their lifetime. The odds ratios ranged from 1.56 to 1.87 and all three estimates were precise (CLR < 2). Two of the 15 self-reported symptoms; irritation, redness and swelling of skin; and irritation or burning in the eyes or nose or throat were statistically more prevalent among females who reported living in the study area before 1978 compared to females who reported moving into the area after 1978, the results were precise with an odds ratio of 1.89 for each reported symptom (CLR < 2). For individuals who smoked less than 5 packs of cigarettes in their lifetime, extreme sleepiness was statistically more prevalent for those who reported living in the area before 1978 compared to those who reported moving into the area after 1978 who smoked less than 5 packs of cigarettes in their lifetime (OR 1.70, 95% CI 1.20, 2.40) and statistically less prevalent for individuals who smoked more than 5 packs of cigarettes in their lifetime (OR 0.47, 95% CI 0.25, 0.92). Severe (strong) headaches were statistically more prevalent for individuals who reported living in the area before 1978 and who were under-weight or had normal weight compared to respondents who reported moving in the area after 1978 and who were under-weight or had normal weight (OR 2.21, 95% CI 1.35, 3.62).

In table 14a, 5 of the 15 self-reported symptoms (numbness, tingling or weakness in arms or legs; irritation, redness and swelling of skin; heavy perspiration not related to heat or exercise; unexpected short seizures not related to epilepsy; and extreme sleeplessness)

were statistically more prevalent in zone A than in zone C after adjusting for confounding and interaction. The odds ratios ranged from 1.38 to 2.40 and all but one estimate (unexpected short seizures not related to epilepsy, CLR < 5) was precise (CLR < 3). After adjusting for confounding and interaction, male respondents in zone A reported two symptoms (neck pain; and nausea, vomiting or diarrhea) more frequently then male respondents in zone C. The odds were 2.06 for neck pain and 2.33 for nausea, vomiting or diarrhea, both estimates were precise (CLR < 4). Two symptoms (irritation or burning in the eyes or nose or throat; and inability to move arms or legs without known cause) were reported more often for respondents who were age 55 or older and reported living in zone A compared to respondents of the same age in zone C after adjusting for confounding and interaction. The odds were 1.81 for irritation or burning in the eyes or nose or throat and 1.76 for inability to move arms or legs without known cause, both estimates were precise (CLR < 3.)

In table 14b, only one self-reported symptom (irritation, redness and swelling of skin) was statistically more prevalent in zone B than in zone C (OR 1.80; 95% CI 1.17, 2.77). In addition, irritation or burning in the eyes or nose or throat was reported more often for respondents who were age 55 or older and reported living in zone B compared to respondents of the same age in zone C after adjusting for confounding and interaction (OR 1.78, 95% CI 1.15, 2.73.)

After adjusting for confounding and interaction, statistically significant differences remained in individuals who reported eating fish from Rock Pit Lake compared to those who did not eat the fish for 10 of the 15 symptoms: numbness, tingling, or weakness in arms or legs; irritation, redness and swelling of skin; bruising easily; unexpected short seizures not related to epilepsy; extreme sleepiness; extreme sleeplessness; neck pain; difficulty in urination (passing water); nausea, vomiting or diarrhea; and anxiety, nervousness or depression (Table 15). The odds ratios ranged from 1.73 to 4.49. All but one (unexpected short seizures not related to epilepsy, CLR < 6) of the ten symptoms estimates were precise (CLR < 4). Two of the 15 symptoms: inability to move arms or legs without known cause and severe (strong) headaches were statistically more prevalent among individuals who ate fish from Rock Pit Lake and who were under-weight or had normal weight compared to individuals who reported not eating fish from Rock Pit Lake and who were under-weight or had normal weight. The odds ratios were imprecise at 17.47 and 3.79 respectively (CLR >13.) For over-weight individuals who reported eating fish from Rock Pit Lake compared to over-weight individuals who did not report eating Rock Pit Lake fish, the an inability to move arms or legs was statistically more prevalent (OR 5.3, 95% CI 1.80, 15.65). Reporting severe (strong) headaches was statistically more prevalent among obese individuals who ate fish from Rock Pit Lake compared to obese individuals who reported not eating Rock Pit Lake fish (OR 3.83, 95% CI 2.01, 7.31).

Individuals who reportedly smoked less than 5 packs of cigarettes in their lifetime had a statistically greater prevalence of reporting irritation or burning in the eyes or nose or throat if they had also reported eating fish from Rock Pit Lake compared to those who had reported not eating the fish and who smoked less than 5 packs of cigarettes (OR 8.51, 95% CI 3.80, 19.02). Individuals who were between the ages of 25 and 54 had a

statistically greater prevalence of reporting heavy perspiration not related to heat or exercise if they had also reported eating fish from Rock Pit Lake compared to those who reported not eating fish from Rock Pit Lake and were in the same age range (OR 5.58, 95% CI 2.67, 11.67).

DISCUSSION

Crude odds ratio analysis showed that both self-reported diseases and symptoms were reported more often by study participants who lived in the area before 1978 compared to those who moved in after 1978, by study participants who lived in zone A compared to those who lived in zone C, by study participants who lived in zone B compared to those who lived in zone C, and by study participants who reported eating fish from Rock Pit Lake compared to participants who did not report eating fish from the lake. However, when other factors that can affect disease or symptom onset such as age, smoking, BMI are taken into consideration, the results did not show a clear pattern of reporting among study participants.

Diseases - Review of self reported diseases from the final regression models, which controlled for confounding and interaction, indicated that bronchitis, anemia and hypercholesterolemia were reported more frequently among individuals who lived in the area before 1978 when compared to the individuals who moved into the area after 1978. Asthma and anemia were reported more frequently among individuals who lived in zone A than among individuals who lived in zone C. Glucose intolerance was reported more frequently among individuals with normal BMI and among those with overweight BMI, who lived in zone B than among individuals in the same BMI group who lived in zone C. The odds of reporting chloracne, hyperpigmentation, hypercholesterolemia, glucose intolerance, cardiac arrhythmias, and cancers of concern was higher among participants who reported eating fish from Rock Pit Lake compared to participants who did not report of eating fish from the lake.

Symptoms - Review of self reported symptoms from the final regression models, which controlled for confounding and interaction, indicated that statistically significant differences remained in individuals who reported living in the survey area before 1978 compared to those who reported moving into the area after 1978 for 5 of the 15 symptoms: heavy perspiration not related to heat or exercise; bruising easily; extreme sleeplessness; difficulty in urination (passing water); and nausea, vomiting or diarrhea. Statistically significant differences remained in individuals who reported living in zone A versus zone C for 5 of the 15 symptoms: numbness, tingling or weakness in arms or legs; irritation, redness and swelling of skin; heavy perspiration not related to heat or exercise; unexpected short seizures not related to epilepsy; and extreme sleeplessness. Only one self-reported symptom (irritation, redness and swelling of skin) was statistically more prevalent in zone B than in zone C.

After review of the final regression models, which controlled for confounding and interaction, statistically significant differences remained in individuals who reported eating fish from Rock Pit Lake compared to those who did not eat the fish for 10 of the

15 symptoms: numbness, tingling, or weakness in arms or legs; irritation, redness and swelling of skin; bruising easily; unexpected short seizures not related to epilepsy; extreme sleepiness; extreme sleeplessness; neck pain; difficulty in urination (passing water); nausea, vomiting or diarrhea; and anxiety, nervousness or depression.

Even though the multivariate analysis using regression models provides a better understanding of the dependent variable(s) (reported disease/symptoms) than the initial crude odds ratio analysis, it still does not provide the clearest or most accurate picture of what is associated with the disease or symptom in question. The exposure variables (time group, zones, or ate Rock Pit Lake fish) do not explain the increase or decrease in self-reported disease/symptoms as well as some of the other variables in the model. For instance, in examining hypercholesterolemia in zone B vs. zone C; the zone of residence was not significantly associated with the disease, but BMI, age group and smoking were all significantly associated with hypercholesterolemia. Typically, zone of residence would be removed from the model since it was not statistically significant. The final model would then have indicated that the age and lifestyle choices of the individual are associated with whether or not an individual is diagnosed with hypercholesterolemia. However, since this project was designed to measure the impact of the exposure variables (i.e. zone of residence) they were left as predictors.

The overall sample size of the study did not allow for the detection of small or moderate increases in diagnoses of the cancers of concern. In addition, the sample size may not have allowed for the detection of a large increase in individuals diagnosed with one of the cancers of concern. So, while not statistically significant, it is concerning that the odds of an individual reporting having been diagnosed with one of the cancers of concern were higher among individuals who lived in zone A compared to individuals who lived in zone C. It is impossible to say with this study whether or not the results are significant because the sample size was not large enough to detect a difference or if there truly is no difference in the frequency of diagnosis between zone A and zone C.

Of the 130 reported diagnoses of cancer, only 54 of the cases could be confirmed in the Florida Cancer Registry (FCDS)[32]. The other 76 reports of cancer diagnosis could not be found in the FCDS and therefore could not be confirmed. The reasons for persons who reported having been diagnosed with a cancer but were not found in FCDS include: 1) the respondent may have been diagnosed with cancer before moving to the state of Florida; or 2) the respondent may have been diagnosed in a VA Hospital which do not report to the FCDS. There is also the possibility of recall bias and because of that inaccurate or incomplete cancer diagnoses information could have been provided to the interviewer by the respondent. Similar limitations may affect the reporting of other diseases and symptoms in the survey.

The positive responses to the bias question: "Do you think your health has been affected by toxic chemicals in the environment?" were correlated to the diseases and symptoms reported by the survey participants, which indicates that the findings of health survey are affected by knowledge or hearsay about an environmental issue in the community. Due to

the fact that so many survey participants answered *don't know* to this question it is impossible to quantify the extent of the bias.

STRENGTHS AND LIMITATIONS

One of the strengths of this survey was it helped open communication between residents and the state/county health departments. By participating in the survey, residents were able to express their environmental concerns and their worries about illnesses. Collaboration and partnerships between various agencies and their representatives in planning and conducting the survey brought the community together to identify and mitigate issues related to public health.

One of the strengths of this survey was the cross-sectional design. This design made it possible to complete the survey in a relatively short time with limited resources.

Another of the strengths of this survey is that bias introduced by the study itself was minimized by use of trained interviewers, a standardized interview process, and strict survey quality control procedures. [34,35]

One limitation is self-selection bias. It has been shown that individuals who have more to gain from a study or investigation are more likely to participate.[34,35] For instance, individuals who live closer to a hazardous waste site are more likely to participate than those who live farther away. In the same manner those who are ill are more likely to participate than those who are not ill. In this manner an accurate representation of the study population (i.e. zone A) or the control population (i.e. zone C) would not be collected leading to distorted results.

This survey collected subjective information that reflects individuals' perceived concerns and illnesses which were not verified by medical record review. Due to this fact, it is important to consider the limitation of recall bias and differential misclassification. As can be seen in the literature, knowledge or hearsay of a potential health hazard can affect the recall and reporting of diseases and symptoms.[36,37,38] Individuals who are worried about their health may over-report their symptoms or diseases while individuals who are not concerned may under-report diseases or symptoms. In addition, the concern over environmental exposures may cause adverse affects, such as increased anxiety of depression. Differential misclassification occurs when individuals report having disease A when in fact they have disease X. I this survey 54 self-reported cancer cases were verified in FCDS, 24 percent of those cases were incorrectly reported. The bias due to differential misclassification, depending on age, race, gender and type of disease, can significantly decrease the validity of study results.[38,39,40,41] In a study done by Kaye et al., the misclassification of neoplasms (a type of cancer), due to self-reporting, inflated the resulting odds ratio by 15 percent.

A limitation of this study was present in the selection of respondents. Interviewers initially telephoned respondents during the day and interviewed the first individual over the age of twenty five. There are a number of individuals who are more likely to be at

home during the day and therefore more likely to participate in the survey. These individuals are usually retired, ill, or stay at home mothers. For this reason the selection of survey respondents within households was not completely random and may not be truly representative of the Wingate area residents.

Another limitation of the survey is that it did not include residents who once lived in the area but moved away. This form of out-migration may impact the findings, but the extent cannot be determined. Individuals who became sick and died before the study was conducted may also impact the findings.

A lack of measured exposures to hazardous chemicals at the community or individual level is a survey limitation. Exposure was classified based on reported time of residence, reported area of residence, and reportedly eating fish from a nearby contaminated lake. The lack of exposure data and the inability of cross-sectional studies to establish temporal relationships make it impossible to use the results of this study to establish a causal association between possible exposures to hazardous substances and adverse health effect.

Another survey limitation is that diseases and symptoms can be affected by many other factors like genetic inheritance, dietary habits, physical activity, lifestyle, and substance abuse (e.g. tobacco or alcohol). For example, when comparing respondents who reported living in the area before 1978 to those who reported moving in after 1978, age played a highly significant role in the occurrence of hypercholesterolemia followed closely by weight (as measured by body mass index or BMI). Respondents who smoked had higher odds of reporting having been diagnosed with hypercholesterolemia than those who had not smoked. Social factors such as education and socio-economic status also impact an individual's knowledge and practice of disease prevention and health maintenance measures. Collection of personal/social information and analysis of its effect was, however, beyond the scope of this survey.

Although the sample size and power of this survey were limited by the available funds, a larger sample size/power would not have overcome some of these limitations.

CONCLUSIONS

For most reported diseases and symptoms, neither time lived in the study area (before or after 1978 incinerator shutdown) nor residency in different ash deposition zones was statistically significant. Associations between residency before/after incinerator operation and distance from the incinerator (ash deposition zone) were relatively few and inconsistent. For those associations that were statistically significant (bronchitis, anemia, and high cholesterol), other factors such as age, gender, body mass index (BMI), and smoking played an equal or greater role in whether or not an individual reported a disease(s) or symptom(s).

1. For most reported diseases and symptoms, the prevalence of self-reported diseases and symptoms before incineration ceased in 1978 was not statistically different from the prevalence after 1978.
2. For most reported diseases and symptoms, the prevalence of self-reported diseases and symptoms was not statistically different between ash deposition zones. The reported diagnosis of asthma, however, was higher for individuals in zone A compared to zone C.
3. Although there were a few statistically significant associations between reported diseases/symptoms and eating fish from nearby Rock Pit Lake, the percentage of respondents reporting eating fish from this lake (1%) was too small to judge the importance of the association.
4. This survey was limited by the number of participants, unaccounted out-migration, self-reported disease/symptoms not verified by medical records, lack of exposure documentation, and low number of participants reporting eating fish from Rock Pit Lake.
5. Further study would be necessary to determine if there is an increase in cancers related to arsenic and/or dioxin exposure among the residents of zone A.

RECOMMENDATIONS

1. Increase awareness of the existing Rock Pit Lake fish consumption advisory. Although in 1995 the levels of heavy metal in Rock Pit Lake fish were low, to be on the safe side Florida DOH/ATSDR recommended people limit their consumption of fish from Rock Pit Lake to only fillets no more than once a week. Individuals who ate fish from Rock Pit Lake should tell their doctors they may have been exposed to arsenic and/or dioxins.
2. Promote healthy lifestyles in the Wingate community including awareness of asthma, anemia, hypercholesterolemia, glucose intolerance, and cardiac arrhythmias. Residents should be aware of the signs and symptoms of asthma and consult their doctors if treatment becomes necessary.

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TABLES

Table 1. Sample size per zone required to detect specified effects on prevalence of skin rash with 80% power and alpha of 0.05.

Increase in prevalence per unit of potential exposure category	Rate ratio (Zone B vs. Zone C)	Rate ratio (Zone A vs. Zone C)	Prevalence, Ash Deposition Zone C	Prevalence, Ash Deposition Zone B	Prevalence, Ash Deposition Zone A	Sample size per ash deposition zone, ordinal exposure	Sample size per ash deposition zone, nominal exposure
40%	1.4	1.8	0.070	0.098	0.126	442	544
60%	1.6	2.2	0.070	0.112	0.154	221	227
80%	1.8	2.6	0.070	0.126	0.182	137	170
100%	2.0	3.0	0.070	0.140	0.210	96	119

Table 2. Telephone Distribution and Population by Ash Deposition Zone

Zone	No. Phones	Ratio of Phones/ Population	2000 Census Population	2000 Census Population (25 years and older)	Survey Sample Size (proportional to 25 years and older)	No. Phones Selected (proportional to 25 years and older)	Completed Survey Responses
A	1,253	1/7	8,928	4,772	870	1,253	582
B	1,833	1/5	9,382	5,990	1,093	1,571	523
C	1,672	1/6	9,558	5,480	1,000	1,439	522
Total	4758	1/6	27,242	18,242	2,963	4,246	1,627

Note: The 'stratified proportional' equation referenced in the text for survey sample size: $\frac{870}{4772} = \frac{1093}{5990} = \frac{1000}{5480}$ and the equation for number of selected phones: $\frac{1253}{4772} = \frac{1571}{5990} = \frac{1439}{5480}$

Table 3. Demographic characteristics of survey participants

Characteristics		Zone A (n = 582)		Zone B (n = 523)		Zone C (n = 522)		Total for all zones (n = 1627)	
		Count	% total	Count	% total	Count	% total	Count	% total
Reported Time of Residence	After 1978	316	54%	392	75%	386	74%	1094	67%
	Before 1978	265	46%	131	25%	134	26%	530	33%
	Missing	1	0.002%	0	0%	2	0.004%	3	0.002%
Reported Ate Rock Pit Lake Fish	no	538	92%	502	96%	514	98%	1554	96%
	yes	44	8%	21	4%	8	2%	73	4%
	Missing	0	0%	0	0%	0	0%	0	0%
Gender	male	144	25%	190	36%	168	32%	502	31%
	female	438	75%	333	64%	352	67%	1123	69%
	Missing	0	0%	0	0%	2	0.004%	2	0.001%
Age Group	yrs 25-34	82	14%	59	11%	75	14%	216	13%
	yrs 35-44	79	14%	109	21%	106	20%	294	18%
	yrs 45-54	128	22%	107	20%	111	21%	346	21%
	yrs 55-64	132	23%	115	22%	102	20%	349	21%
	yrs 65-74	119	20%	81	15%	72	14%	272	17%
	yrs 75+	41	7%	50	10%	54	10%	145	9%
	Missing	1	0.002%	2	0.004%	2	0.004%	5	0.003%
Race	Black	553	95%	449	86%	452	87%	1454	89%
	White	7	1%	53	10%	43	8%	103	6%
	Other	8	1%	5	1%	9	2%	22	1%
	Unknown/ refused	4	1%	5	1%	6	1%	15	1%
	Missing	10	2%	11	2%	12	2%	33	2%
Hispanic	no	579	99%	514	98%	508	97%	1601	98%
	yes	2	0%	9	2%	13	2%	24	1%
	Missing	1	0.002%	0	0%	1	0.002%	2	0.001%
Smoked more than 5 packs of cigarettes in lifetime	no	438	75%	358	68%	390	75%	1186	73%
	yes	144	25%	165	32%	132	25%	441	27%
	Missing	0	0%	0	0%	0	0%	0	0%
Education	No schooling	9	2%	2	0%	1	0%	12	1%

Characteristics		Zone A (n = 582)		Zone B (n = 523)		Zone C (n = 522)		Total for all zones (n = 1627)	
		Count	% total	Count	% total	Count	% total	Count	% total
Education (cont.)	Grades 1-8	138	24%	95	18%	99	19%	332	20%
	Grades 9-12	245	42%	237	45%	207	40%	689	42%
	College	157	27%	144	28%	157	30%	458	28%
	Graduate/ professorial	24	4%	30	6%	44	8%	98	6%
	Missing	9	2%	15	3%	14	3%	38	2%
Survey Question #9†	lower	52	9%	73	14%	54	10%	*179*	*11%*
	same	66	11%	101	19%	112	21%	*279*	*17%*
	higher	196	34%	135	26%	125	24%	*456*	*28%*
	don't know	267	46%	211	41%	225	43%	*703*	*43%*
	missing	1	0%	3	0%	6	1%	*10*	*0%*
Survey Question #10‡	no	150	26%	186	36%	202	39%	*538*	*33%*
	yes	221	38%	153	29%	142	27%	*516*	*32%*
	don't know	200	34%	173	33%	160	31%	*533*	*33%*
	missing	11	2%	11	2%	18	3%	*40*	*2%*
Worked at Wingate	no	556	96%	495	95%	489	94%	*1540*	*95%*
	yes	0	0%	2	0%	1	0%	*3*	0%
	don't know	1	0%	0	0%	0	0%	*1*	0%
	missing	25	4%	26	5%	32	6%	*83*	*5%*

†Survey Question #9: Compared to other communities like this one, how much pollution do you think there is in this community?

‡Survey Question #10: Do you think your health has been affected by toxic chemicals in the environment?

Table 3a. Demographic characteristics of survey participants by time group

Characteristics		**Before 1978 (n = 530)**		**After 1978 (n = 1094)**		***Total for all Time Groups***	
		Count	% total	Count	% total	*Count*	*% total*
Zone of Residence	zone A	265	50%	316	29%	*581*	*36%*
	zone B	131	25%	392	36%	*523*	*32%*
	zone C	134	25%	386	35%	*520*	*32%*
	Missing	0	0%	0	0%	*0*	*0%*
Reported Ate Rock Pit Lake Fish	no	503	95%	1048	96%	*1551*	*96%*
	yes	27	5%	46	4%	*73*	*4%*
	Missing	0	0%	0	0%	*0*	*0%*
Gender	male	160	30%	341	31%	*501*	*31%*
	female	369	70%	752	69%	*1121*	*69%*
	Missing	1	0%	1	0%	*2*	*0%*
Age Group	yrs 25-34	32	6%	184	17%	*216*	*13%*
	yrs 35-44	36	7%	257	23%	*293*	*18%*
	yrs 45-54	77	15%	268	24%	*345*	*21%*
	yrs 55-64	157	30%	192	18%	*349*	*21%*
	yrs 65-74	163	31%	108	10%	*271*	*17%*
	yrs 75+	65	12%	80	7%	*145*	*9%*
	Missing	0	0%	5	0%	*5*	*0%*
Race	Black	477	90%	974	89%	*1451*	*89%*
	White	36	7%	67	6%	*103*	*6%*
	Other	4	1%	18	2%	*22*	*1%*
	Unknown/ refused	3	1%	12	1%	*15*	*1%*
	Missing	10	2%	23	2%	*33*	*2%*
Hispanic	no	527	99%	1071	98%	*1598*	*98%*
	yes	2	0%	22	2%	*24*	*1%*
	Missing	1	0%	1	0%	*2*	*0%*
Smoked more than 5 packs of cigarettes in lifetime	no	375	71%	808	74%	*1183*	*73%*
	yes	155	29%	286	26%	*441*	*27%*
	Missing	0	0%	0	0%	*0*	*0%*
Education	No schooling	6	1%	6	1%	*12*	*1%*
	Grades 1-8	121	23%	211	19%	*332*	*20%*

	Grades 9-12	224	42%	464	42%	*688*	*42%*
	College	127	24%	330	30%	*457*	*28%*
	Graduate/ professorial	38	7%	60	5%	*98*	*6%*
	Missing	14	3%	23	2%	*37*	*2%*
Survey Question #9†	lower	41	8%	138	13%	*179*	*11%*
	same	79	15%	199	18%	*278*	*17%*
	higher	186	35%	268	24%	*454*	*28%*
	don't know	220	42%	483	44%	*703*	*43%*
	Missing	4	1%	6	1%	*10*	*1%*
Survey Question #10‡	no	135	25%	403	37%	*538*	*33%*
	yes	197	37%	318	29%	*515*	*32%*
	don't know	182	34%	350	32%	*532*	*33%*
	Missing	16	3%	23	2%	*39*	*2%*
Worked at Wingate	no	495	93%	1043	95%	*1538*	*95%*
	yes	1	0%	2	0%	*3*	*0%*
	don't know	1	0%	0	0%	*1*	*0%*
	Missing	33	6%	49	4%	*82*	*5%*

†Survey Question #9: Compared to other communities like this one, how much pollution do you think there is in this community?

‡Survey Question #10: Do you think your health has been affected by toxic chemicals in the environment?

Table 4. Crude odds ratios for self-reported diseases by time of reported residence†

Type of Disease		Before 1978 (n = 530)	After 1978 (n = 1094)	Crude Odds Ratios	(95% CI)
Asthma	Yes	71	157	0.93	0.68, 1.25
	No	458	937		
Bronchitis	Yes	114	194	1.27	0.98, 1.65
	No	416	900		
Chloracne	Yes	20	35	1.19	0.68, 2.08
	No	510	1059		
Hyperkeratosis	Yes	12	14	1.79	0.82, 3.89
	No	518	1080		
Hyper-pigmentation	Yes	25	29	**1.82**	**1.05, 3.14**
	No	505	1065		
Anemia‡	Yes	162	238	**1.59**	**1.26, 2.01**
	No	363	848		
Other Low Blood Cell Count	Yes	3	4	---	---
	No	527	1090		
Hypercholesterolemia	Yes	260	345	**2.09**	**1.69, 2.59**
	No	270	749		
Glucose Intolerance	Yes	135	192	**1.61**	**1.25, 2.06**
	No	395	902		
Cardiac Arrhythmias	Yes	106	160	**1.46**	**1.11, 1.91**
	No	424	934		
Cancers of Concern	Yes	19	17	**2.36**	**1.21, 4.57**
	No	511	1077		

†Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
‡Individuals who reported having been diagnosed with Sickle Cell disease and Anemia were removed from the Anemia calculations.

Table 5a. Crude odds ratios for self-reported diseases by zone of reported residence: zone A vs. zone C†

Type of Disease		Zone A (n = 582)	Zone C (n = 522)	Crude Odds Ratios	(95% CI)
Asthma	Yes	99	66	**1.41**	**1.01, 1.98**
	No	483	455		
Bronchitis	Yes	126	96	1.22	0.91, 1.65
	No	456	426		
Chloracne	Yes	25	12	1.91	0.95, 3.84
	No	557	510		
Hyperkeratosis	Yes	11	8	1.24	0.49, 3.10
	No	571	514		
Hyper-pigmentation	Yes	22	13	1.54	0.77, 3.09
	No	560	509		
Anemia‡	Yes	179	111	**1.65**	**1.25, 2.17**
	No	398	407		
Other Low Blood Cell Count	Yes	2	2	---	---
	No	580	520		
Hypercholesterolemia	Yes	241	173	**1.43**	**1.12, 1.82**
	No	341	349		
Glucose Intolerance	Yes	120	94	1.18	0.88, 1.60
	No	462	428		
Cardiac Arrhythmias	Yes	109	77	1.33	0.97, 1.83
	No	473	445		
Cancers of Concern	Yes	19	9	1.92	0.86, 4.29
	No	563	513		

†Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type

‡Individuals who reported having been diagnosed with Sickle Cell disease and Anemia were removed from the Anemia calculations.

Table 5b. Crude odds ratios for self-reported diseases by zone of reported residence: zone B vs. zone C†

Type of Disease		Zone B (n = 523)	Zone C (n = 522)	Crude Odds Ratios	(95% CI)
Asthma	Yes	64	66	0.96	0.67, 1.39
	No	459	455		
Bronchitis	Yes	87	96	0.89	0.64, 1.22
	No	436	426		
Chloracne	Yes	18	12	1.52	0.72, 3.18
	No	505	510		
Hyperkeratosis	Yes	8	8	1.24	0.49, 3.10
	No	515	514		
Hyper-pigmentation	Yes	19	13	1.48	0.72, 3.02
	No	504	509		
Anemia‡	Yes	110	111	0.99	0.73, 1.33
	No	409	407		
Other Low Blood Cell Count	Yes	4	2	---	---
	No	519	520		
Hypercholesterolemia	Yes	191	173	1.16	0.90, 1.50
	No	332	349		
Glucose Intolerance	Yes	113	94	1.26	0.92,1.70
	No	410	428		
Cardiac Arrhythmias	Yes	81	77	1.06	0.76, 1.49
	No	442	445		
Cancers of Concern	Yes	8	9	0.89	0.34, 2.31
	No	515	513		

†Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
‡Individuals who reported having been diagnosed with Sickle Cell disease and Anemia were removed from the Anemia calculations.

Table 6. Crude odds ratios for self-reported diseases by individuals who ate/did not eat Fish from Rock Pit Lake†

Type of Disease		Ate Fish (n = 73)	Did Not Eat Fish (n= 1554)	Crude Odds Ratios	(95% CI)
Asthma	Yes	18	211	**2.08**	**1.20, 3.61**
	No	55	1342		
Bronchitis	Yes	22	287	**1.9**	**1.14, 3.19**
	No	51	1267		
Chloracne	Yes	9	46	**4.61**	**2.16, 9.83**
	No	64	1508		
Hyperkeratosis	Yes	3	24	---	---
	No	70	1530		
Hyper-pigmentation	Yes	7	47	**3.4**	**1.48, 7.81**
	No	66	1507		
Anemia‡	Yes	22	378	1.38	0.83, 2.32
	No	49	1165		
Other Low Blood Cell Count	Yes	1	7	---	---
	No	72	1547		
Hypercholesterolemia	Yes	45	560	**2.85**	**1.76, 4.62**
	No	28	994		
Glucose Intolerance	Yes	28	299	**2.61**	**1.60, 4.26**
	No	45	1255		
Cardiac Arrhythmias	Yes	28	239	**3.42**	**2.09, 5.60**
	No	45	1315		
Cancers of Concern	Yes	5	31	**3.61**	**1.36, 9.58**
	No	68	1523		

†Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type

‡Individuals who reported having been diagnosed with Sickle Cell disease and Anemia were removed from the Anemia calculations.

Table 7. Crude odds ratios for self-reported symptoms by time of reported residence†

Type of Symptom		Before 1978 (n = 530)	After 1978 (n = 1094)	Crude Odds Ratios	(95% CI)
Irritation or burning in your eyes or nose or throat	Yes	237	344	**1.76**	**1.42, 2.18**
	No	293	750		
Numbness, tingling, or weakness in arms or legs	Yes	269	354	**2.15**	**1.74, 2.66**
	No	261	740		
Inability to move arms or legs without known cause	Yes	66	90	**1.59**	**1.13, 2.22**
	No	464	1004		
Irritation, redness & swelling of skin	Yes	76	101	**1.65**	**1.20, 2.26**
	No	454	993		
Heavy perspiration not related to heat or exercise	Yes	136	142	**2.31**	**1.78, 3.01**
	No	394	952		
Bruising easily	Yes	139	229	**1.34**	**1.05, 1.71**
	No	391	865		
Unexpected short seizures not related to epilepsy	Yes	20	21	**2.00**	**1.08, 3.73**
	No	510	1073		
Extreme sleepiness	Yes	72	133	1.14	0.84, 1.55
	No	458	961		
Extreme sleeplessness	Yes	154	231	**1.53**	**1.21, 1.94**
	No	376	863		
Ringing in ears	Yes	173	237	**1.75**	**1.39, 2.21**
	No	357	857		
Neck pain	Yes	126	187	**1.51**	**1.17, 1.95**
	No	404	907		
Difficulty in urination (passing water)	Yes	53	51	**2.27**	**1.52, 3.39**
	No	477	1043		
Nausea, vomiting or diarrhea	Yes	127	172	**1.69**	**1.31, 2.19**
	No	403	922		
Severe (strong) headaches	Yes	153	306	1.05	0.83, 1.31
	No	377	788		
Anxiety, nervousness or depression	Yes	150	254	**1.31**	**1.03, 1.65**
	No	380	840		

† Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type

Table 8a. Crude odds ratios for self-reported diseases by zone of reported residence: zone A vs. zone C†

Type of Symptom		Zone A (n = 582)	Zone C (n = 522)	Crude Odds Ratios	(95% CI)
Irritation or burning in your eyes or nose or throat	Yes	240	157	**1.63**	**1.27 2.09**
	No	342	365		
Numbness, tingling, or weakness in arms or legs	Yes	274	160	**2.01**	**1.57, 2.58**
	No	308	362		
Inability to move arms or legs without known cause	Yes	76	38	**1.91**	**1.27, 2.88**
	No	506	484		
Irritation, redness & swelling of skin	Yes	75	37	**1.94**	**1.28, 2.93**
	No	507	485		
Heavy perspiration not related to heat or exercise	Yes	135	65	**2.12**	**1.54, 2.93**
	No	447	457		
Bruising easily	Yes	148	107	**1.32**	**1.00, 1.75**
	No	434	415		
Unexpected short seizures not related to epilepsy	Yes	20	7	**2.62**	**1.10, 6.24**
	No	562	515		
Extreme sleepiness	Yes	84	55	**1.43**	**1.00, 2.06**
	No	498	467		
Extreme sleeplessness	Yes	160	106	**1.49**	**1.12, 1.97**
	No	422	416		
Ringing in ears	Yes	170	115	**1.46**	**1.11, 1.92**
	No	412	407		
Neck pain	Yes	120	93	1.20	0.89, 1.62
	No	462	429		
Difficulty in urination (passing water)	Yes	43	30	1.31	0.81, 2.12
	No	539	492		
Nausea, vomiting or diarrhea	Yes	126	85	**1.42**	**1.05, 1.93**
	No	456	437		
Severe (strong) headaches	Yes	190	136	**1.38**	**1.06, 1.79**
	No	392	386		
Anxiety, nervousness or depression	Yes	155	118	1.24	0.94, 1.64
	No	427	404		

†Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type

Table 8b. Crude odds ratios for self-reported diseases by zone of reported residence: zone B vs. zone C†

Type of Symptom		Zone B (n = 523)	Zone C (n = 522)	Crude Odds Ratios	(95% CI)
Irritation or burning in your eyes or nose or throat	Yes	185	157	1.27	0.98, 1.65
	No	338	365		
Numbness, tingling, or weakness in arms or legs	Yes	191	160	**1.3**	**1.01, 1.68**
	No	332	362		
Inability to move arms or legs without known cause	Yes	42	38	1.11	0.70, 1.76
	No	481	484		
Irritation, redness & swelling of skin	Yes	65	37	**1.86**	**1.21, 2.84**
	No	458	485		
Heavy perspiration not related to heat or exercise	Yes	79	65	1.25	0.88, 1.78
	No	444	457		
Bruising easily	Yes	114	107	1.08	0.80, 1.46
	No	409	415		
Unexpected short seizures not related to epilepsy	Yes	14	7	2.02	0.81, 5.06
	No	509	515		
Extreme sleepiness	Yes	67	55	1.25	0.85, 1.82
	No	456	467		
Extreme sleeplessness	Yes	119	106	1.16	0.86, 1.55
	No	404	416		
Ringing in ears	Yes	126	115	1.12	0.84, 1.50
	No	397	407		
Neck pain	Yes	101	93	1.10	0.81, 1.51
	No	422	429		
Difficulty in urination (passing water)	Yes	31	30	1.03	0.62, 1.73
	No	492	492		
Nausea, vomiting or diarrhea	Yes	89	85	1.05	0.76, 1.46
	No	434	437		
Severe (strong) headaches	Yes	134	136	0.98	0.74, 1.29
	No	389	386		
Anxiety, nervousness or depression	Yes	133	118	1.17	0.88, 1.55
	No	390	404		

†Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type

Table 9. Crude odds ratios for self-reported symptoms by individuals who ate/did not eat Fish from Rock Pit Lake†

Type of Symptom		Ate Fish (n = 73)	Did Not Eat Fish (n= 1554)	Crude Odds Ratios	(95% CI)
Irritation or burning in your eyes or nose or throat	Yes	53	529	**5.13**	**3.04, 8.68**
	No	20	1025		
Numbness, tingling, or weakness in arms or legs	Yes	49	576	**3.47**	**2.10, 5.71**
	No	24	978		
Inability to move arms or legs without known cause	Yes	21	135	**4.24**	**2.48, 7.26**
	No	52	1419		
Irritation, redness & swelling of skin	Yes	15	162	**2.22**	**1.23, 4.01**
	No	58	1392		
Heavy perspiration not related to heat or exercise	Yes	33	246	**4.39**	**2.71, 7.09**
	No	40	1308		
Bruising easily	Yes	37	332	**3.78**	**2.35, 6.08**
	No	36	1222		
Unexpected short seizures not related to epilepsy	Yes	7	34	**4.74**	**2.03, 11.09**
	No	66	1520		
Extreme sleepiness	Yes	23	183	**3.45**	**2.05, 5.78**
	No	50	1371		
Extreme sleeplessness	Yes	38	347	**3.78**	**2.35, 6.07**
	No	35	1207		
Ringing in ears	Yes	27	384	**1.79**	**1.10, 2.92**
	No	46	1170		
Neck pain	Yes	25	289	**2.28**	**1.38, 3.76**
	No	48	1265		
Difficulty in urination (passing water)	Yes	13	91	**3.48**	**1.84, 6.58**
	No	60	1463		
Nausea, vomiting or diarrhea	Yes	30	270	**3.32**	**2.04, 5.39**
	No	43	1284		
Severe (strong) headaches	Yes	35	425	**2.45**	**1.53, 3.92**
	No	38	1129		
Anxiety, nervousness or depression	Yes	37	369	**3.3**	**2.06, 5.30**
	No	36	1185		

†Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type

Table 10. Final models for the exposure variable - before/after 1978 †

Outcome Variable	Covariates	Odds Ratio	(95% CI)	p-value
Asthma	age, race, gender, BMI and smoking	0.13	0.68, 1.35	0.79
Bronchitis*	age, race, gender and smoking	**1.35**	**1.01, 1.80**	**0.04**
Chloracne**	age and race	1.02	0.54, 1.90	0.96
Hyperkeratosis*	age and race	1.52	0.66, 3.53	0.33
Hyperpigmentation**	age and gender	1.71	0.94, 3.10	0.08
Anemia	race, age and an age/gender interaction	**1.98**	**1.50, 2.60**	**<0.0001**
Other Blood Disorders with a Low RBC Count	Not enough information to run an analysis			
Hypercholesterolemia	age, BMI and smoking	**1.35**	**1.04, 1.74**	**0.02**
Glucose Intolerance**	age, race, gender and BMI	0.87	0.65, 1.16	0.33
Cardiac Arrhythmias*	age, race, gender and smoking	1.05	0.78, 1.42	0.75
Cancers of Concern	age (4 cat.), race gender and smoking	1.34	0.66, 2.73	0.42

† Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
*removed individuals with job exposure to arsenic
**removed individuals with job exposure to dioxins

Table 11a. Final models for the exposure variable - reported area of residence: zone A vs. zone C †

Outcome Variable	Stratification	Covariates	Odds Ratio	(95% CI)	p-value
Asthma	---	age and BMI	**1.44**	**1.01, 2.04**	**0.04**
Bronchitis*	---	gender and smoking	1.17	0.83, 1.65	0.36
Chloracne**	---	race and gender	1.74	0.84, 3.61	0.14
Hyperkeratosis*	---	race and gender	1.22	0.51, 2.91	0.66
Hyper-pigmentation**	---	age and gender	1.43	0.71, 2.89	0.32
Anemia *(w/out sickle cell disease)**	---	age, gender & age/gender interaction	**1.50**	**1.12, 1.99**	**0.006**
Other Blood Disorders with a Low RBC Count	Not enough information to run an analysis				
Hypercholesterolemia**	age 25-54	BMI, gender and smoking	**1.52**	**1.02, 2.27**	**0.04**
	age 55+		1.14	0.79, 1.63	0.49
Glucose Intolerance**	---	age, BMI, race and gender	0.92	0.66, 1.28	0.61
Cardiac Arrhythmias*	---	age, smoking and BMI	1.13	0.81, 1.59	0.47
Cancers of Concern	---	age (4 cat.), gender and race	2.32	0.97, 5.57	0.06

† Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
*removed individuals who reported workplace exposure to arsenic
**removed individuals who reported workplace exposure to dioxins

Table 11b. Final models for the exposure variable - reported area of residence: zone B vs. zone C †

Outcome Variable	Stratification	Covariates	Odds Ratio	(95% CI)	p-value
Asthma	---	age and BMI	1.00	0.68, 1.46	0.99
Bronchitis*	---	gender and smoking	0.86	0.60, 1.24	0.41
Chloracne**	---	race and gender	1.59	0.74, 3.44	0.24
Hyperkeratosis*	---	race and gender	0.98	0.38, 2.49	0.96
Hyper-pigmentation**	---	age and gender	1.42	0.68, 2.93	0.35
Anemia *(w/out sickle cell disease)**	---	age, gender & age/gender interaction	1.05	0.77, 1.43	0.79
Other Blood Disorders with a Low RBC Count	Not enough information to run an analysis				
Hypercholesterolemia**	---	age, BMI and smoking	1.04	0.77, 1.40	0.80
Glucose Intolerance**	BMI = normal/under weight	age, race and gender	**1.97**	**1.21, 3.19**	**0.006**
	BMI = over-weight		**0.50**	**0.27, 0.93**	**0.03**
	BMI = obese		1.54	0.71, 3.37	0.28
Cardiac Arrhythmias*	---	age, smoking and BMI	1.04	0.73, 1.48	0.84
Cancers of Concern	---	age (4 cat.), gender and race	0.77	0.28, 2.08	0.6

† Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
*removed individuals with job exposure to arsenic
**removed individuals with job exposure to dioxins

Table 12. Final models for the exposure variable - reported eating Rock Pit lake fish †

Outcome Variable	Stratification	Covariates	Odds Ratio	(95% CI)	p-value
Asthma	age = 25-54	BMI, gender, smoking	1.82	0.85, 3.87	0.12
	age = 55+		**2.5**	**1.09, 4.64**	**0.03**
Bronchitis*	---	age (5 cat.), gender and smoking	1.69	0.99, 2.90	0.06
Chloracne**	age = 25-54	gender and race	**5.91**	**1.16, 30.22**	**0.003**
	age = 55+	gender	**3.6**	**1.01, 12.82**	**0.05**
Hyperkeratosis*	---	Not enough information to run an analysis			
Hyperpigmentation**	---	age (4 cat.), gender and race	**2.47**	**1.00, 6.10**	**0.05**
Anemia (w/out sickle cell disease)*	---	age (4 cat.), gender and race	1.4	0.76, 2.58	0.28
Other Blood Disorders with a Low RBC Count	---	Not enough information to run an analysis			
Hypercholesterolemia	---	age (5 cat.), BMI and smoking	**2.5**	**1.48, 4.13**	**0.0005**
Glucose Intolerance**	---	age (4 cat.), BMI, and gender	**2.36**	**1.39, 3.99**	**0.001**
Cardiac Arrhythmias*	---	age (5 cat.) and race	**2.76**	**1.65, 4.61**	**0.0001**
Cancers of Concern	---	BMI, race and smoking	**3.03**	**1.09, 8.46**	**0.03**

† Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
*removed individuals with job exposure to arsenic
**removed individuals with job exposure to dioxins

Table 13. Final models for reported symptoms vs. the exposure variable - before/after 1978 †

Outcome Variable	Stratification	Covariates	Odds Ratio	(95% CI)	p-value
Irritation or burning in the eyes or nose or throat*	Males	age-group, race, BMI, smoked	1.10	0.71, 1.72	0.67
	Females	age-group, race, BMI	**1.89**	**1.41, 2.25**	**< 0.0001**
Numbness, tingling, or weakness in arms or legs***	Smoked = no	age-group, gender, race, BMI	**1.87**	**1.39, 2.52**	**< 0.0001**
	Smoked = yes		0.97	0.60, 1.57	0.89
Inability to move arms or legs without known cause**	Smoked = no	age-group, race	**1.56**	**1.01, 2.42**	**0.05**
	Smoked = yes	age-group, gender, race	0.57	0.30, 1.08	0.08
Irritation, redness and swelling of skin*	Males	age-group, BMI, smoked	0.71	0.34, 1.47	0.35
	Females	age-group, race, BMI, smoked	**1.89**	**1.25, 2.87**	**0.003**
Heavy perspiration not related to heat or exercise**	---	age-group, gender, race, BMI, smoked, BMI/gender interaction term	**2.00**	**1.48, 2.70**	**< 0.0001**
Bruising easily*	---	age-group, gender, BMI, smoked	**1.4**	**1.07, 1.84**	**0.016**
Unexpected short seizures not related to epilepsy**	---	age-group, gender, smoked	1.75	0.95, 3.25	0.07
Extreme sleepiness**	Smoked = no	age-group, race, BMI	**1.7**	**1.20, 2.40**	**0.003**
	Smoked = yes	gender, race, BMI	**0.47**	**0.25, 0.92**	**0.03**
Extreme sleeplessness**	---	age-group, gender, BMI, smoked	**1.43**	**1.10, 1.88**	**0.008**
Ringing in ears**	Smoked = no	age-group, gender, race, BMI	**1.80**	**1.31, 2.47**	**0.0003**
	Smoked = yes		0.94	0.59, 1.52	0.81
Neck pain	---	age-group, gender, race, BMI, smoked, BMI/gender interaction term	1.3	0.98, 1.73	0.07
Difficulty in urination (passing water)	---	age-group, gender, race, smoked	**1.81**	**1.16, 2.80**	**0.008**
Nausea, vomiting or diarrhea*	---	age-group, gender, race, BMI, BMI/gender interaction term	**1.73**	**1.29, 2.31**	**0.0002**

Outcome Variable	Stratification	Covariates	Odds Ratio	(95% CI)	p-value
Severe (strong) headaches**	BMI = normal/under-weight	age-group, gender, race, smoked	**2.21**	**1.35, 3.62**	**0.002**
	BMI = over-weight		1.47	0.87, 2.47	0.15
	BMI = obese		0.85	0.57, 1.25	0.40
Anxiety, nervousness or depression**	Smoked = no	age-group, gender, race, BMI	**1.63**	**1.18, 2.26**	**0.003**
	Smoked = yes	age-group, gender	0.8	0.54, 1.18	0.26

† Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
*removed individuals with job exposure to arsenic
**removed individuals with job exposure to dioxins
***removed individuals with job exposure to dioxins and individuals with job exposure to arsenic

Table 14a. Final models for reported symptoms vs. the exposure variable - reported zone of residence: zone A vs. zone C†

Outcome Variable	Stratification	Covariates	Odds Ratio	(95% CI)	p-value
Irritation or burning in the eyes or nose or throat*	age-group = 25-54	gender, BMI, smoked	1.15	0.80, 1.65	0.46
	age-group = 55+	gender, race, BMI, smoked	**1.81**	**1.20, 2.74**	**0.005**
Numbness, tingling, or weakness in arms or legs***	---	age-group, gender, race, BMI, smoked	**1.7**	**1.28, 2.24**	**0.0002**
Inability to move arms or legs without known cause**	age-group = 25-54	race, BMI, smoked	1.69	0.88, 3.23	0.11
	age-group = 55+	gender, race, BMI, smoked	**1.76**	**1.04, 2.98**	**0.04**
Irritation, redness and swelling of skin*	---	age-group, gender, race, smoked	**1.78**	**1.16, 2.72**	**0.008**
Heavy perspiration not related to heat or exercise**	---	age-group, gender, race, smoked	**1.75**	**1.24, 2.46**	**0.001**
Bruising easily*	---	age-group, gender, BMI, smoked	1.16	0.86, 1.56	0.33
Unexpected short seizures not related to epilepsy**	---	age-group, gender, smoked	**2.40**	**1.09, 5.25**	**0.03**
Extreme sleepiness**	---	age-group, gender, race, BMI, smoked	1.33	0.91, 1.94	0.14
Extreme sleeplessness**	---	age-group, gender, smoked	**1.38**	**1.03, 1.85**	**0.03**
Ringing in ears**	---	age-group, gender, race, BMI, smoked	1.23	0.91, 1.66	0.18
Neck pain	gender = male	age-group, race, smoked	**2.06**	**1.09, 3.91**	**0.03**
	gender = female	age-group, race	0.83	0.58, 1.21	0.34
Difficulty in urination (passing water)	---	age-group, gender, race	1.24	0.75, 2.05	0.40
Nausea, vomiting or diarrhea*	gender = male	age-group, BMI, smoked	**2.33**	**1.23, 4.40**	**0.009**
	gender = female	age-group, race, BMI	1.21	0.83, 1.77	0.32
Severe (strong) headaches**	---	age-group, gender, smoked	1.27	0.97, 1.67	0.08
Anxiety, nervousness or depression**	race = black	age-group, gender, smoked	1.33	0.98, 1.82	0.07
	race = white	gender, BMI, smoked	0.2	0.02, 2.07	0.18

† Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
*removed individuals with job exposure to arsenic
**removed individuals with job exposure to dioxins
***removed individuals with job exposure to dioxins and individuals with job exposure to arsenic

Table 14b. Final models for reported symptoms vs. the exposure variable - reported zone of residence: zone B vs. zone C†

Outcome Variable	Stratification	Covariates	Odds Ratio	(95% CI)	p-value
Irritation or burning in the eyes or nose or throat*	age-group = 25-54	gender, BMI, smoked	0.98	0.67, 1.43	0.92
	age-group = 55+	gender, race, BMI, smoked	**1.78**	**1.15, 2.73**	**0.009**
Numbness, tingling, or weakness in arms or legs***	---	age-group, gender, race, BMI, smoked	1.28	0.96, 1.71	0.09
Inability to move arms or legs without known cause**	---	age-group, gender, race, BMI, smoked	1.05	0.66, 1.69	0.83
Irritation, redness and swelling of skin*	---	age-group, gender, race, smoked	**1.80**	**1.17, 2.77**	**0.007**
Heavy perspiration not related to heat or exercise**	---	age-group, gender, race, smoked	1.17	0.81, 1.69	0.39
Bruising easily*	---	age-group, gender, BMI, smoked	1.11	0.82, 1.52	0.49
Unexpected short seizures not related to epilepsy**	---	age-group, gender, smoked	1.99	0.87, 4.53	0.10
Extreme sleepiness**	---	age-group, gender, race, BMI, smoked	1.26	0.84, 1.87	0.26
Extreme sleeplessness**	---	age-group, gender, smoked	1.17	0.87, 1.59	0.3
Ringing in ears**	---	age-group, gender, race, BMI, smoked	1.04	0.76, 1.42	0.82
Neck pain	---	age-group, race, BMI, smoked	1.06	0.77, 1.47	0.71
Difficulty in urination (passing water)	---	age-group, gender, race	1.00	0.59, 1.70	0.996
Nausea, vomiting or diarrhea*	---	age-group, gender, race, smoked	1.18	0.84, 1.65	0.34
Severe (strong) headaches**	---	age-group, gender, smoked	1.02	0.76, 1.35	0.92
Anxiety, nervousness or depression**	---	gender, BMI, smoked	1.15	0.84, 1.58	0.39

† Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
*removed individuals with job exposure to arsenic
**removed individuals with job exposure to dioxins
***removed individuals with job exposure to dioxins and individuals with job exposure to arsenic

Table 15. Final models for reported symptoms vs. the exposure variable - reported eating Rock Pit lake fish[†]

Outcome Variable	Stratification	Covariates	Odds Ratio	(95% CI)	p-value
Irritation or burning in the eyes or nose or throat*	Smoked = no	age-group, gender, race, BMI, BMI/gender interaction term	**8.51**	**3.80, 19.02**	**<0.0001**
	Smoked = yes	age-group, gender, race	2.12	0.97, 4.67	0.06
Numbness, tingling, or weakness in arms or legs***	---	age-group, gender, race, BMI, smoked	**2.41**	**1.42, 4.11**	**0.0012**
Inability to move arms or legs without known cause**	BMI = normal/under-weight	age-group, gender, race, smoked	**17.47**	**4.37, 69.87**	**<0.0001**
	BMI = over-weight	age-group, gender, race, smoked	**5.3**	**1.80, 15.65**	**0.003**
	BMI = obese	age-group, gender, race	1.76	0.86, 3.62	0.12
Irritation, redness and swelling of skin*	---	age-group, gender, race, BMI, BMI/age-group interaction term	**1.85**	**1.01, 3.41**	**0.05**
Heavy perspiration not related to heat or exercise**	age-group = 25-54	Gender, race, BMI, BMI/gender interaction term	**5.58**	**2.67, 11.67**	**<0.0001**
	age-group = 55+	gender, race, BMI	2.46	0.99, 6.10	0.05
Bruising easily*	---	age-group, gender, smoked	**4.49**	**2.69, 7.50**	**<0.0001**
Unexpected short seizures not related to epilepsy**	---	age-group, gender, smoked	**4.20**	**1.76, 10.05**	**0.001**
Extreme sleepiness**	---	age-group, gender, race, BMI	**3.10**	**1.79, 5.39**	**<0.0001**
Extreme sleeplessness**	---	age-group, gender	**3.45**	**2.31, 5.15**	**<0.0001**
Ringing in ears**	---	age-group, gender, race, BMI, smoked, BMI/age-group interaction term	1.63	0.98, 2.73	0.06
Neck pain	---	age-group, gender, race, BMI, smoked, smoked/age-group interaction term	**1.73**	**1.02, 2.94**	**0.04**

Outcome Variable	Stratification	Covariates	Odds Ratio	(95% CI)	p-value
Difficulty in urination (passing water)	---	age-group, gender, race, BMI smoked	**2.82**	**1.45, 5.49**	**0.002**
Nausea, vomiting or diarrhea*	---	age-group, gender, race, BMI, smoked, BMI/gender interaction term	**3.2**	**1.91, 5.34**	**<0.0001**
Severe (strong) headaches**	BMI = normal/under-weight	age-group, gender, race, smoked	**3.79**	**1.04, 13.75**	**0.04**
	BMI = over-weight	age-group, gender, race, smoked	0.33	0.07, 1.52	0.15
	BMI = obese	age-group, gender, race	**3.83**	**2.01, 7.31**	**<0.0001**
Anxiety, nervousness or depression**	---	age-group, gender, BMI, smoked	**2.88**	**1.69, 4.91**	**0.0001**

† Statistically significant odds ratios and accompanying confidence intervals are in boldfaced type
*removed individuals with job exposure to arsenic
**removed individuals with job exposure to dioxins
***removed individuals with job exposure to dioxins and individuals with job exposure to arsenic

FIGURES

Figure 1. Location of study site in Broward County, Florida

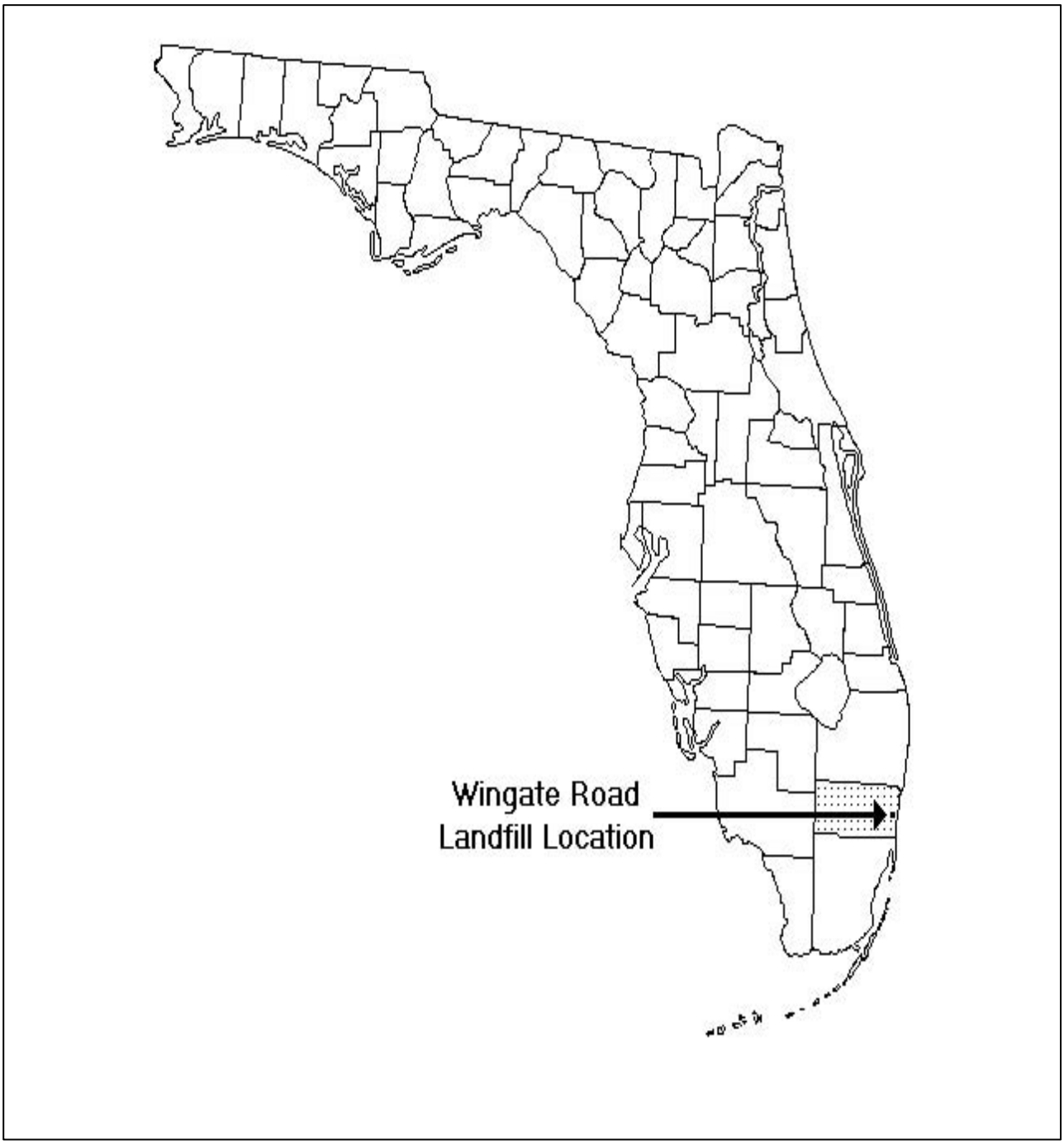


Figure 2. Arial photograph of Wingate study area (1957)

1:31,941

Figure 3. Arial photograph of Wingate study area (1971)

1:31,941

Figure 4. Arial photograph of Wingate study area (1999)

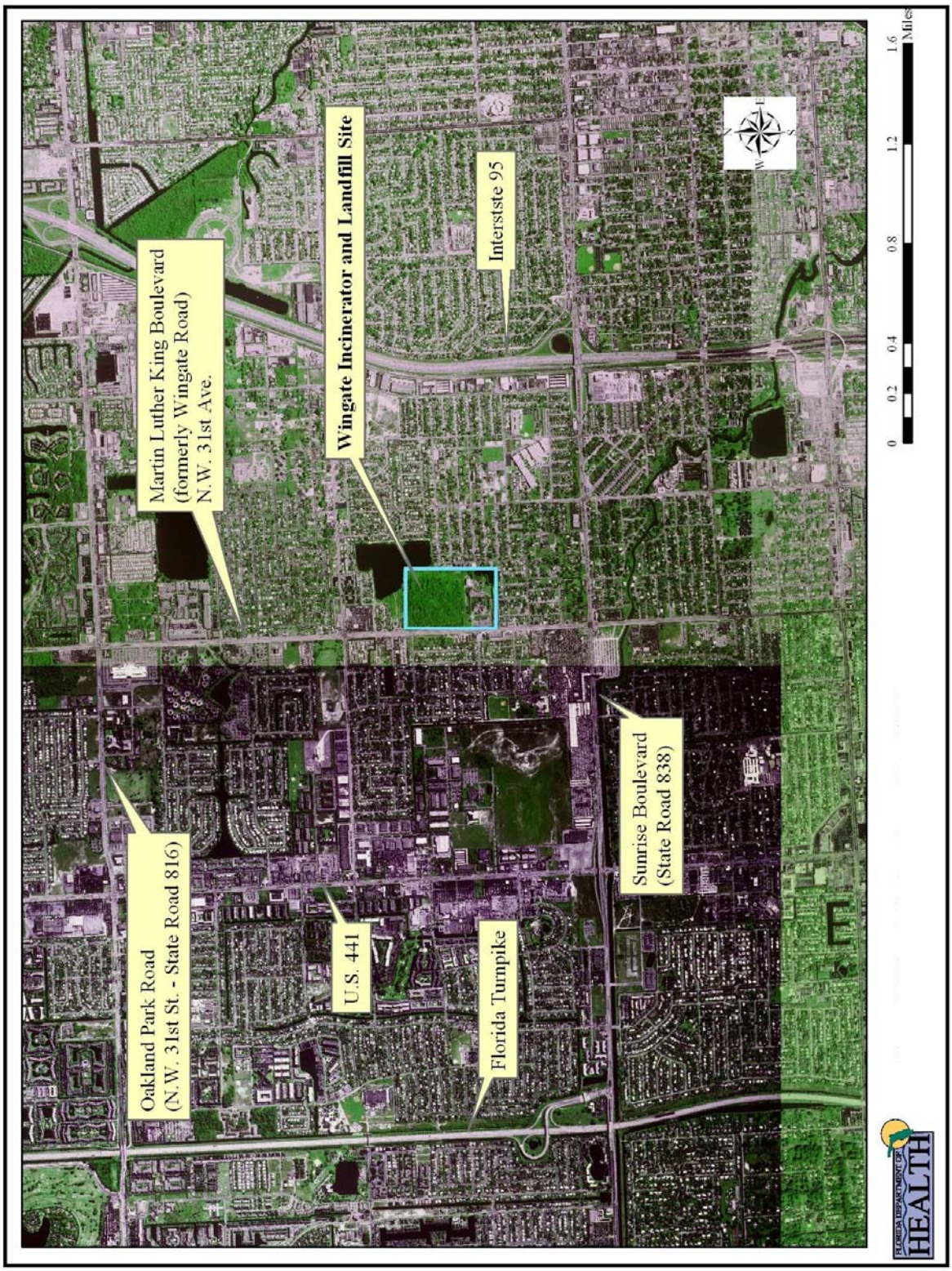


Figure 5. Area around the Wingate Road Incinerator and Landfill Site.

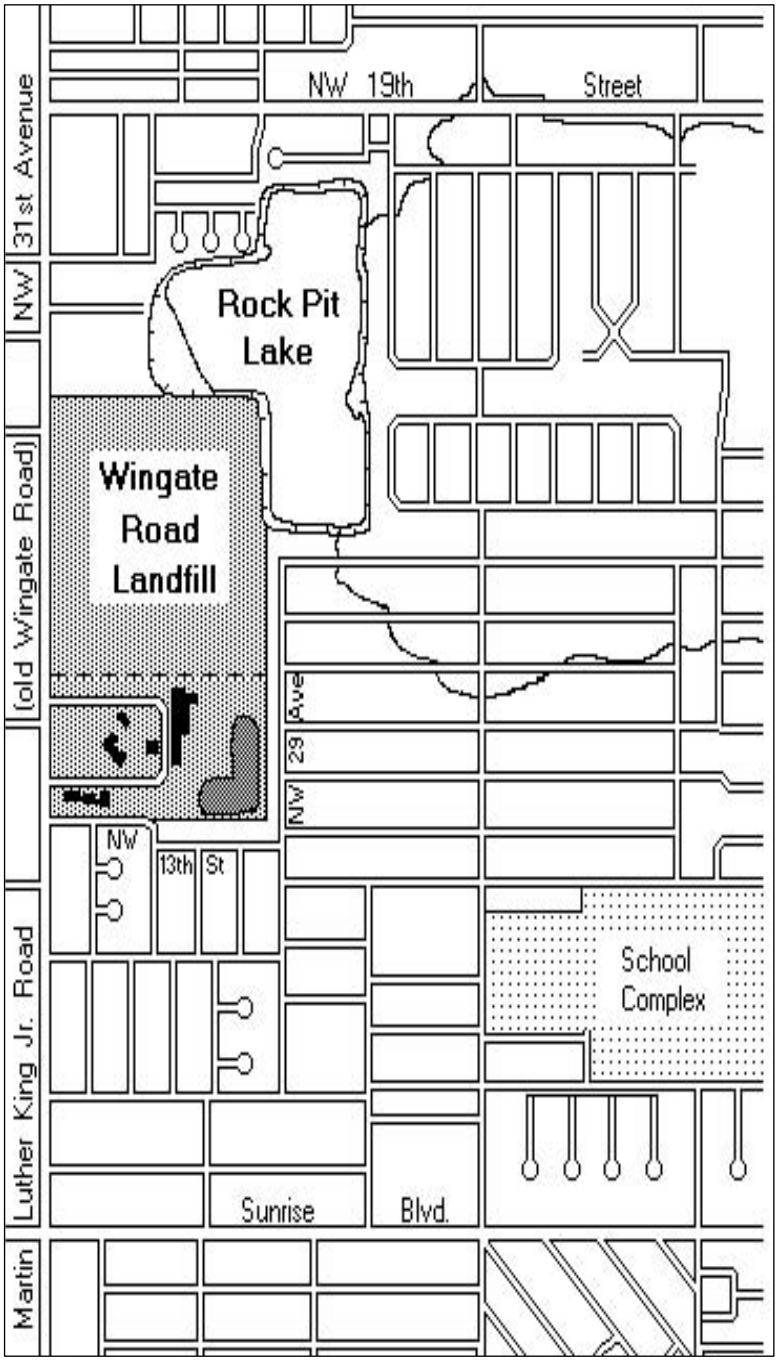


Figure 6. Wingate Road Incinerator and Landfill Site Map (1995).

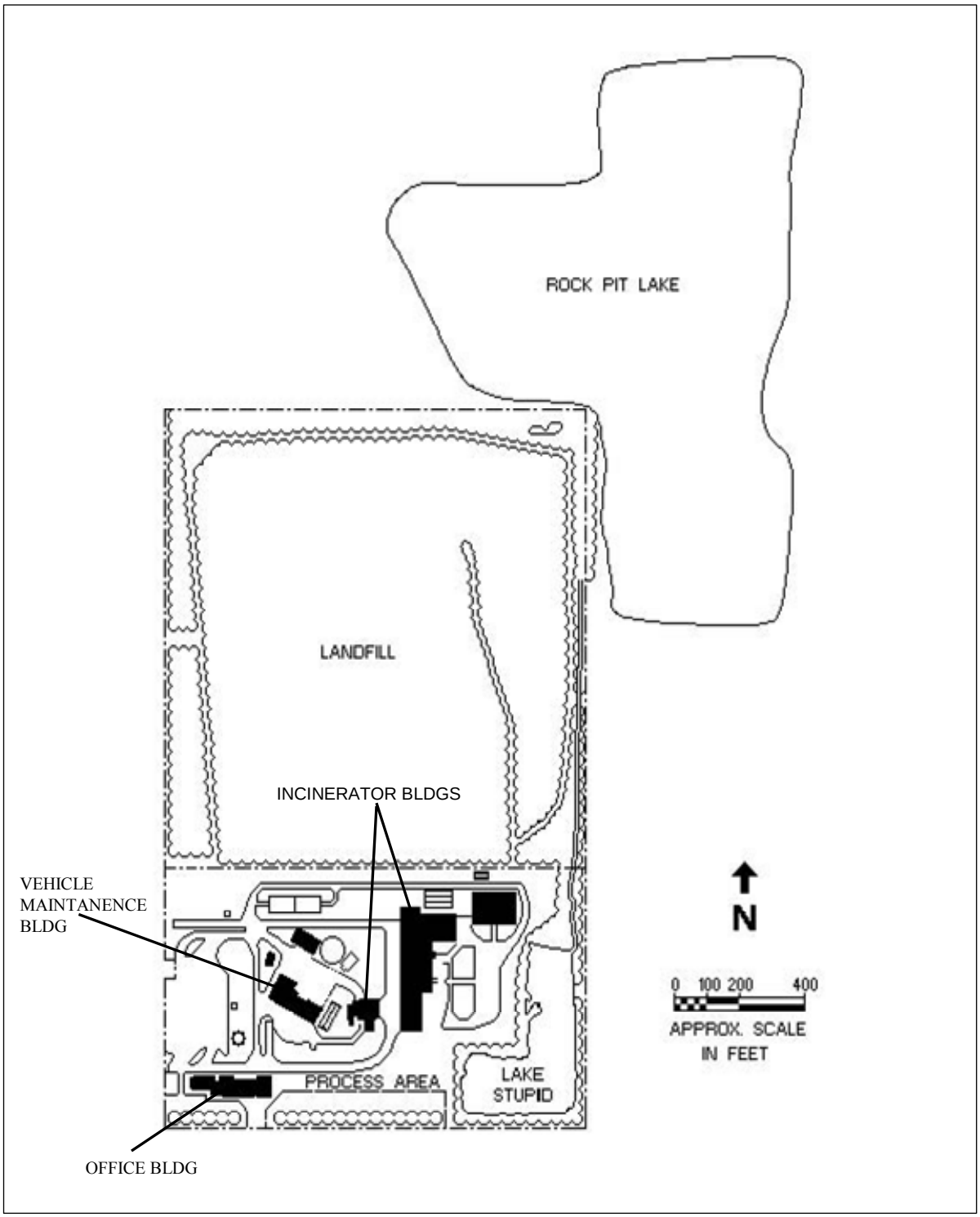
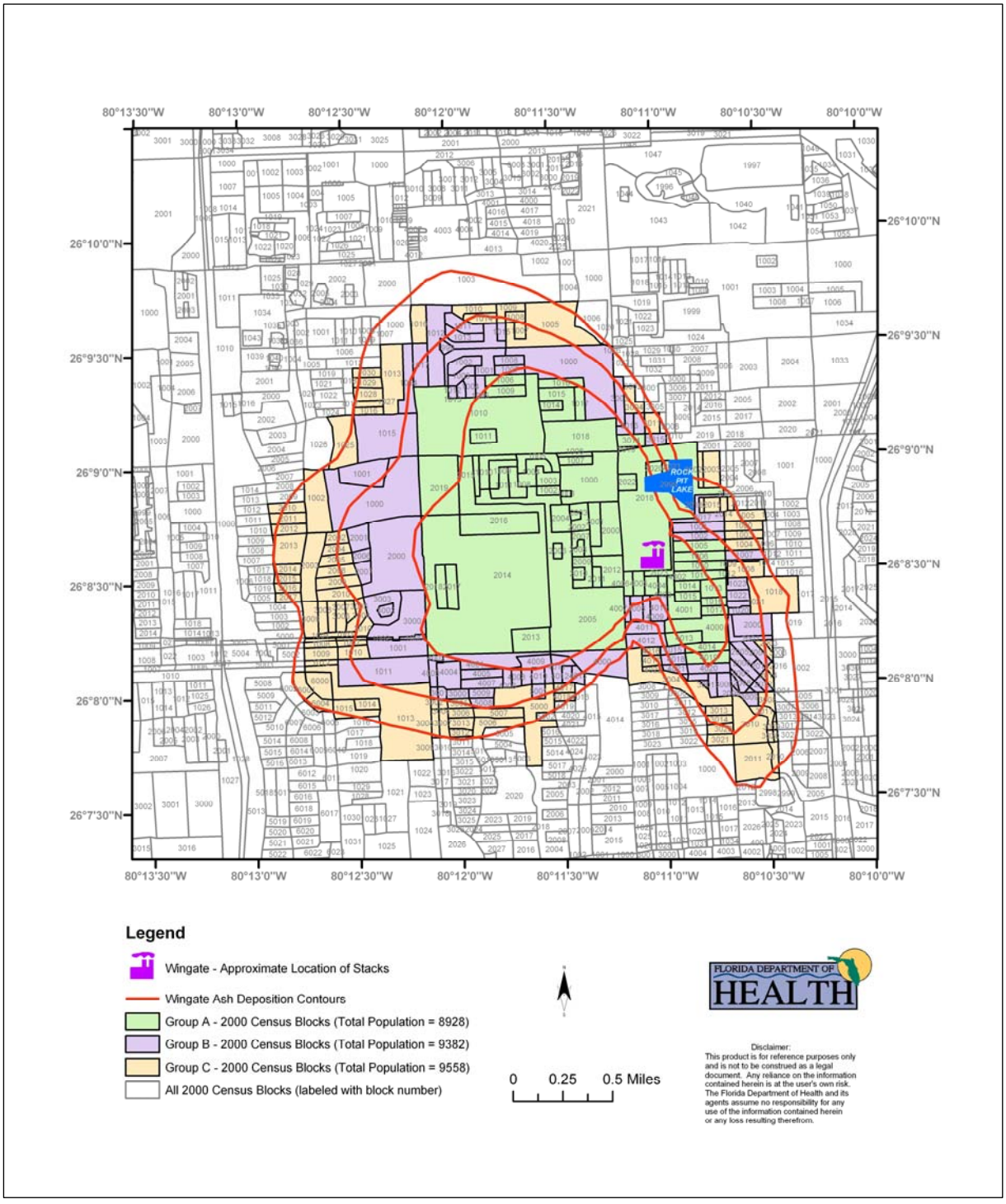


Figure 7. Wingate Incinerator Ash Deposition Contours and Surrounding Populations



APPENDICES

APPENDIX A: Terminology

Anemia: A condition in which the concentration of the oxygen-carrying pigment, hemoglobin (carried inside red blood cells), in the blood is below normal, usually reported as a low red blood cell count.

Asthma: Recurrent attacks of breathlessness, typically accompanied by wheezing that can vary in severity from day to day and from hour to hour.

Bronchitis: Inflammation of the windpipe, which may result in a persistent, productive cough (that may produce considerable quantities of phlegm), sometimes with fever and sore throat.

Cardiac Arrhythmias: an abnormal rate of muscle contractions in the heart.

Chloracne: An acne-like skin disorder with predominance of dry open blackheads and straw colored pimples distributed on the cheek bone area of face, behind ears, armpits and scrotum, but absent around nose. This can be caused by prolonged exposure to chlorinated hydrocarbons

Confounders: This occurs when the measure of association (for instance odds ratios) changes in comparing the measure without adjustment vs. with adjustment. For example the odds of lung cancer is higher in community A than in community B, however, when we take into account the number of people who smoke in community A (20%), compared to the number of people who smoke in community B (60%), then the odds of lung cancer in community A is now lower than in community B.

Glucose Intolerance: High blood sugar levels

Hypercholesterolemia: An excess of cholesterol in the blood and cells

Hyperkeratosis: Thickening of the outer layer of the skin due to an increased amount of keratin. The most common forms are planter warts and corns/calluses on the palms of the hands, soles of the feet or trunk of the body caused by prolonged pressure or friction.

Hyper-pigmentation: Excess pigment in a tissue or body part, i.e. darkening of skin or patches of darker colored skin than the individual's normal skin color.

Other blood disorders w/low blood cell count: This is a catch-all-category for survey participants' who had a blood disorder with low blood cell count other than sickle-cell-anemia or anemia. Examples of such disorders/diseases are; adult leukemia, thrombocytes, and leucopenia.

Reported/reporting/reportedly: answers to survey questions were self reported by survey participants.

APPENDIX B: Census Geographic Identifiers for the Wingate Study Area

Wingate area population data extracted from the 1970 and 1980 census used the following geographic identifiers: Broward County; census tract 410, 411, 412 and 604. It was not possible for the researchers to obtain information at the block or block group level. For the 2000 census the census tract 604 was split into three new census tracts: 604.01, 604.02 and 604.03.

Housing data for the 2000 census was not published at the block level. Wingate area housing data extracted from the 2000 census used the following geographic identifiers:

- Broward County; census tract 410; block groups 1 and 2
- Broward County; census tract 411; block groups 1, 2, 3, and 4
- Broward County; census tract 412; block groups 1 and 2
- Broward County; census tract 413; block groups 3, 4 and 5
- Broward County; census tract 414; block groups 2 and 3
- Broward County; census tract 503.07; block group 1
- Broward County; census tract 503.08; block group 1
- Broward County; census tract 508; block group 3
- Broward County; census tract 604.01; block group 2
- Broward County; census tract 604.02; block group 1
- Broward County; census tract 604.03; block groups 1, 2, and 3
- Broward County; census tract 608; block groups 1 and 6

Wingate area population data extracted from the 2000 census used the following geographic identifiers for zone A:

- Broward County; census tract 410; block group 2; blocks 2018, 2019, 2020, 2021, 2022, 2023, and 2999
- Broward County; census tract 411; block group 1; blocks 1005, 1006, 1010, 1011, 1013, 1014, 1015, 1016, and 1017
- Broward County; census tract 411; block group 4; blocks 4000, 4001, 4002, 4003, 4004, 4005, 4006, 4013, 4014, and 4019
- Broward County; census tract 412; block group 1; blocks 1000, 1001, 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1009, 1010, and 1011
- Broward County; census tract 412; block group 2; blocks 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, and 2019
- Broward County; census tract 503.08; block group 1; blocks 1006, 1009, 1010, 1011, 1014, 1015, 1016, 1017, and 1018
- Broward County; census tract 508; block group 3; block 3014

Wingate area population data extracted from the 2000 census used the following geographic identifiers for zone B:

- Broward County; census tract 410; block group 1; blocks 1020, 1021, 1022, 1023, and 1024

- Broward County; census tract 410; block group 2; block 2017
- Broward County; census tract 411; block group 1; blocks 1001, 1002, 1007, 1009, and 1012
- Broward County; census tract 411; block group 2; blocks 2000, 2001, 2004, 2005, 2006, 2007,2008, 2009, 2010, 2011, 2012, and 2015
- Broward County; census tract 411; block group 3; blocks 3000, 3001, 3002, 3003, and 3005
- Broward County; census tract 411; block group 4; blocks 4007, 4008, 4009, 4010, 4011, 4012,4015, 4018, 4020, and 4021
- Broward County; census tract 413; block group 3; blocks 3000, 3001, and 3002
- Broward County; census tract 413; block group 4; blocks 4000, 4001, 4002, 4003, 4004, 4005,4006, 4007, 4008, 4009, 4010, 4011, 4012, and 4013
- Broward County; census tract 413; block group 5; blocks 5001, 5008, and 5009
- Broward County; census tract 414; block group 3; block 3009
- Broward County; census tract 503.07; block group 1; blocks 1011, 1012, 1013, 1015, 1017, and 1999
- Broward County; census tract 503.08; block group 1; blocks 1000, 1001, 1002, 1003, 1004, 1005,1007, 1008, 1012, and 1013
- Broward County; census tract 508; block group 3; blocks 3003, 3012, 3013, and 3015
- Broward County; census tract 604.02; block group 1; blocks 1014 and 1015
- Broward County; census tract 604.03; block group 1; blocks 1000 and 1001
- Broward County; census tract 604.03; block group 2; blocks 2000, 2001, 2006, and 2007
- Broward County; census tract 604.03; block group 3; blocks 3000, 3001, 3002, and 3003
- Broward County; census tract 608; block group 1; blocks 1000, 1001, 1002, and 1011

Wingate area population data extracted from the 2000 census used the following geographic identifiers for zone C:

- Broward County; census tract 410; block group 1; blocks 1005 and 1018
- Broward County; census tract 410; block group 2; blocks 2002, 2003, 2013, 2014, 2015, and 2016
- Broward County; census tract 411; block group 1; blocks 1000, 1003, 1004, and 1008
- Broward County; census tract 411; block group 2; blocks 2002, 2003, 2013, 2014, and 2016
- Broward County; census tract 411; block group 3; blocks 3004, 3013, 3014, 3020, and 3021
- Broward County; census tract 411; block group 4; blocks 4016, 4017, and 4022
- Broward County; census tract 413; block group 3; blocks 3003, 3004, 3005, 3006, 3007, 3008,3012, and 3013
- Broward County; census tract 413; block group 4; blocks 4017 and 4018
- Broward County; census tract 413; block group 5; blocks 5000, 5006, and 5007
- Broward County; census tract 414; block group 2; blocks 2010 and 2011
- Broward County; census tract 414; block group 3; blocks 3008, 3010, 3011, 3012, 3018, 3019, and 3020

- Broward County; census tract 503.07; block group 1; blocks 1005, 1007, 1008, 1009, 1010, 1014, and 1016
- Broward County; census tract 508; block group 3; blocks 3004 and 3011
- Broward County; census tract 604.01; block group 2; blocks 2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2017
- Broward County; census tract 604.02; block group 1; blocks 1013, 1016, 1025, 1027, 1028, 1029,1030, and 1002
- Broward County; census tract 604.03; block group 2; blocks 2002, 2003, 2004, 2005, 2008, 2009, and 2010
- Broward County; census tract 604.03; block group 3; blocks 3004, 3005, 3006, 3007, 3008, 3009, and 3010
- Broward County; census tract 608; block group 1; blocks 1003, 1004, 1005, 1006, 1007, 1008,1009, 1010, 1012, 1013, 1014, and 1015
- Broward County; census tract 608; block group 6; blocks 6000, 6001, and 6004

- **APPENDIX C: Model Variables**

Exposure Variables

- Distance from the incinerator: zone A, zone B vs. zone C
- Living in the Wingate area before 1978 vs. after 1978
- Ate Rock Pit Lake fish: yes vs. no

Outcome Variables

Reported Diseases

- Asthma
- Bronchitis
- Chloracne
- Hyperkeratosis
- Hyperpigmentation
- Anemia
- Other blood disorders w/ low blood cell count
- Hypercholesterolemia
- Glucose Intolerance
- Cardiac Arrhythmias

Reported Symptoms

- Irritation or burning in the eyes or nose or throat
- Numbness, tingling, or weakness in arms or legs
- Inability to move arms or legs without known cause
- Irritation, redness and swelling of skin
- Heavy perspiration not related to heat or exercise
- Bruising easily
- Unexpected short seizures not related to epilepsy
- Extreme sleepiness
- Extreme sleeplessness
- Ringing in ears
- Neck pain (not associated with arsenic or dioxin)
- Difficulty in urination - passing water (not associated with arsenic or dioxin)
- Nausea, vomitting or diarrhea
- Severe (strong) headaches
- Anxiety, nervousness or depression

Potential Covariates

The following variables were found in literature reviews to be possible covariates of afore mentioned disease and symptoms (outcomes/exposure variables) and as such were adjusted for in differing combinations in all of the models.

- Smoked: Yes *vs.* No (defined as smoking more than five packs of cigarettes in a lifetime)
- Age-group: 35-44, 45-54, 55-64, 65-74, 75+ vs. 25-34
    - To prevent quasi-complete separation is some of the analysis (Allison, 1999) age-group as collapsed into 5 categories: 45-54, 55-64, 65-74, 75+ vs. 25-44 (Table 9-11)
    - To prevent quasi-complete separation is some of the analysis (Allison, 1999) age-group as collapsed into 4 categories: 45-54, 55-64, 65-75+ vs. 25-44 (Table 9-11)
- Body Mass Index: obese, overweight *vs.* underweight/normal (calculated according to the National Institute for Health as $BMI = \left(\frac{weight\ in\ pounds}{height\ in\ inches^2} \right) \times 703$)
- Race: Black *vs*. Not Black (according to the U.S. Census bureau the majority of the population in the study area was/is black)
- Gender: Male *vs.* Female
- Self-reported Workplace Exposure to Dioxin: Yes *vs.* No
- Self-reported Workplace Exposure to Arsenic: Yes *vs.* No
- Asthma Job Hazard: Yes *vs.* No (defined below)
- Cancer Job Hazard: Yes *vs.* No (defined below)

Potential cancer job hazard was defined by exposure at work to the following known occupational categories of carcinogens:

- Pesticides or Herbicides (Hans-Olov, et. al. 2002)
- Paint strippers
- Solvents or degreasers such as turpentine, gasoline, perchlorates, or trichloroethylene
- Other metals such as cadmium
- Asbestos
- Arsenic
- Dioxin

Potential asthma job hazard was defined as exposure at work to any of the following categories of chemicals and particulates or activities:

- Pesticides or Herbicides (Hans-Olov, et. al. 2002)
- Smoke, fumes or vapors
- Paint strippers
- Solvents or degreasers such as turpentine, gasoline, perchlorates, or trichloroethylene
- Art materials
- Other eye or nose irritants
- Asbestos
- Sandblasting, silica, rock crushing, drilling or talc
- Rock cutting

APPENDIX D: Initial Statistical Models

The following outcome and potential covariate combinations were utilized in the initial binary regression models for each of the three exposure variables; Before 1978 or After 1978, Reported Area of Residence and Reported Eating Rock Pit Lake Fish.

Self-Reported Diseases:

Asthma was the outcome variable

Potential Covariates: age group, race, gender, BMI group, smoked, asthma job hazard

Bronchitis was the outcome variable

Potential Covariates: age group, race, gender, smoked

Removed from analysis all individuals who were exposed to arsenic at work

Chloracne was the outcome variable

Potential Covariates: age group, race, gender

Removed from analysis all individuals who were exposed to dioxin at work

Hyperkeratosis was the outcome variable

Potential Covariates: age group, race, gender

Removed from analysis all individuals who were exposed to arsenic at work

Hyperpigmentation was the outcome variable

Potential Covariates: age group, race, gender

Removed from analysis all individuals who were exposed to dioxin at work

Anemia was the outcome variable

Potential Covariates: age group, race, gender, BMI group

Removed from analysis all individuals exposed to arsenic at work and the five people who reported diagnosis with sickle cell disease

Other blood disorders with a low RBC count was the outcome variable

Potential Covariates: age group, race

Hypercholesterolemia was the outcome variable

Potential Covariates: age group, race, gender, BMI group, smoked

Glucose Intolerance was the outcome variable

Potential Covariates: age group, race, gender, BMI group

Removed from analysis all individuals who were exposed to dioxin at work

Cardiac Arrhythmias was the outcome variable

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to arsenic at work

Cancers of Concern was the outcome variable

Potential Covariates: age group, race, gender, BMI group, smoked, work exposure to carcinogens

Self-Reported Symptoms:

Irritation or burning in the eyes or nose or throat

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to arsenic at work

Numbness, tingling, or weakness in arms or legs

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to arsenic at work

Removed from analysis all individuals who were exposed to dioxin at work

Inability to move arms or legs without known cause

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to dioxin at work

Irritation, redness and swelling of skin

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to arsenic at work

Heavy perspiration not related to heat or exercise

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to dioxin at work

Bruising easily

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to arsenic at work

Unexpected short seizures not related to epilepsy

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to dioxin at work

Extreme sleepiness

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to dioxin at work

Extreme sleeplessness

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to dioxin at work

Ringing in ears

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to dioxin at work

Neck pain

Potential Covariates: age group, race, gender, BMI group, smoked

Difficulty in urination (passing water)

Potential Covariates: age group, race, gender, BMI group, smoked

Nausea, vomiting or diarrhea

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to arsenic at work

Severe (strong) headaches

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to dioxin at work

Anxiety, nervousness or depression

Potential Covariates: age group, race, gender, BMI group, smoked

Removed from analysis all individuals who were exposed to dioxin at work

APPENDIX E:

Evaluation of Potential Emissions from Solid Waste Incinerators Formerly Operated At City of Fort Lauderdale Wingate Road Site

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July 2002

INTRODUCTION AND DISCLAIMER

At the request of the Florida Department of Health (DOH), the Florida Department of Environmental Protection (DEP) prepared this report based on information and documents obtained by the DOH and information available from the U.S. Environmental Protection Agency (EPA) as well as the technical literature. The DOH's stated objective was to approximate and evaluate the amount and nature of incinerator emissions and the pattern of associated pollutant depositions that may have occurred since 1955 at the City of Ft. Lauderdale's Wingate Road Site. Due to the lack of adequate records of the design and operation of incinerators at the site, varied assumptions had to be made based on limited data and therefore the DEP must assert a proper disclaimer regarding any conclusions that may be stated or implied in the discussion. Thus, neither the DEP, nor the authors, nor any person acting on behalf of either: (a) makes any warranty or representation, express or implied, with respect to the accuracy or completeness or usefulness of the information contained in this report or (b) assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information discussed in this report.

OBJECTIVE

The objective of this report is the approximate assessment of the nature and magnitude of atmospheric emissions as well as the dispersion patterns that possibly occurred during the period of operation of the former refuse incinerators.

BACKGROUND

Former and current residents in neighborhoods around the site have expressed concerns to the City of Fort Lauderdale and the Florida DOH regarding perceived high incidences of cancer and/or other serious illnesses in the subject population residing near the EPA Superfund site. It is the opinion of some in the affected population that toxic and other compounds in the incinerator stack emissions directly and adversely affected the health of those living in the vicinity of the plant.

The DOH asked the DEP to review the references and written materials provided by the DOH and make an assessment, albeit highly presumptive, of past emissions from incinerators at the site and their potential deposition in the vicinity of the plant. It was agreed that the DEP could not and would not make any conclusions or presumptions as to the degree of adverse environmental impacts associated with the estimated emissions. Information and documents provided by the DOH were obtained from archived records at the DEP's Southeast District Office, the City of Fort Lauderdale, and Broward County.

To fill some informational gaps and gain better insight on the history of the facility, the DEP's Bureau of Air Regulation contacted the City of Fort Lauderdale and their consultant, Task Environmental, Inc. From these contacts it was established that the Wingate incinerators were shut down permanently in 1977/1978 when city officials decided not to make the modifications that would have been required to meet the new air pollution regulations. It was also established that the 1975 stack test reviewed in this report was the only official stack test done at the facility since testing was not required prior thereto and since the decision was made to shut the facility down soon thereafter.

Although the facility burned all types of waste, it is reasonable to assume that the diversification of waste categories would have been somewhat limited compared to the waste

component mix typical of current refuse incineration facilities. Prior to 1975, the City of Fort Lauderdale's population and industrial base was such that the diversification of waste types burned at the Wingate facility would have been very limited compared to that associated with the population explosion occurring after 1975. According to census data and other records, per-person garbage disposal rates in Fort Lauderdale essentially doubled from about one-half ton in 1965 to almost one ton in 1975.

Finally, it was established by the City of Fort Lauderdale that the Wingate facility, during the period it operated, complied fully with all air pollution requirements in effect at the time and was under no consent order to change its method of operation or alter its emissions in any manner.

DISCUSSION

Process Operation/Description

Records indicate that the two refuse incinerators were capable of processing up to 700 tons per day (TPD) of waste, although the actual operating rates appear to have been around 560 TPD. The incinerators consisted of a 250 TPD dual-furnace Nichols batch-type mass burn unit and a 450 TPD Detroit Stoker unit (Plant # 1) fed through traveling grates. Evidence of the exact shutdown dates for these units is sketchy at best. One reference indicated that the 250 TPD unit (Plant # 2) operated from 1955 until about 1978, whereas another referred to a shutdown date of 1977. The 450 TPD unit was evidently placed in service in 1965 but a specific shutdown date could not be verified from the records provided. However, the record does establish that the 450 TPD unit was operating at rates averaging around 410 TPD in 1976. It may be presumed, then, that the 250 TPD and the 450 TPD incinerators were operated concurrently for at least ten years with intermittent outages for maintenance and/or necessary modifications.

The Nichols incinerator consisted of two side-by-side 125 TPD mass burn furnace chambers fed batch-wise by overhead buckets loaded from a common refuse bin. Combustion was initiated in the furnaces under starved air conditions forming combustible gases and ash. Flue gases from the furnaces were discharged through separate ducts into a secondary combustion chamber for burnout before being discharged into a common 100-ft. high, 9 ft. diameter stack. As each batch of waste was burned in the Nichols incinerator, workers using long iron hooks stoked the charge manually. After the charge was burned sufficiently, ashes were manually pulled from the furnace and discharged through dumping grates into the ash pit.

The Detroit Stoker (Plant # 1) consisted of two 225 TPD reciprocating stoker furnaces fed by a traveling crane system. The mass burn furnaces were fed through reciprocating grates with the charge being pushed into the primary combustion chamber by hydraulic rams. No. 2 fuel oil was used for auxiliary firing on startup. Ash was cooled by a quench tank spray system and removed by a drag conveyor mounted below the furnaces. Combustible gases formed under the starved air conditions in the ignition chamber were burnt out in the secondary combustion chamber after flowing through a central mixing chamber. Temperature of flue gases leaving the secondary combustion chambers was monitored and controlled to ensure efficient combustion.

Scrubber Operation/Description

Details about the respective scrubbers were difficult to pin down since no complete drawings or specifications were found in the documents provided. Also, much of the record refers to the "Fort Lauderdale incinerator" without identifying which plant is being referred to. It appears from one of the

schematic drawings that the Nichols incinerator did not include a scrubber initially. The undated elevation drawing No 1-3 for the Nichols unit depicts a multi-chamber in-line incinerator design with a natural draft stack. No induced draft fan ahead of the stack is shown on this drawing. Comments in Sanitation Department records indicate that the Nichols unit must have been converted to an induced draft fan and scrubber system at some time prior to 1975. Regarding the details of the Nichols scrubber system, only one comment was found in the record referring to the Nichols scrubber water supply connection.

Evidently, the Detroit Stoker plant had scrubbers included in the initial installation. It appears that these were impingement-type orifice plate scrubbers containing three plates each. Although the design efficiency of these low-energy scrubbers could not be verified from the limited data in the record, it is reasonable to conclude that these scrubbers were not capable of removing very much of the finer-sized particulate or gaseous pollutants. The records indicate that the plate scrubbers would plug frequently and required a lot of maintenance. Certainly, in hindsight, venturi scrubbers would have been a better choice for this application as they do not plug as frequently and do not require as much maintenance as plate scrubbers. A 1975 stack test report showed that the scrubbers exceeded the new standard of 0.1 grain per standard cubic foot emission limit for incinerators by amounts ranging from 84 to 182 percent. A discussion of the results is given in the following section.

Pollutants Emitted

In connection with an investigation of the causes of the relatively high 1975 stack emissions, the Sanitation Department ordered a spectrographic analysis of one of the test filter samples to determine its contents. It was suspected that the high scrubber emissions were associated with solids contained in the scrubber water that was being carried over into the stack as entrained water droplets. The consulting engineer reasoned that if it could be shown that a substantial portion of the collected particulate was the result of impurities in the water supplied to the scrubbers, the scrubbers might be found to comply with the emission limits after all.

The filter was analyzed for calcium, sodium, chloride, iron, magnesium, sulfate, carbon, carbonate, and potassium. It was then compared with a corresponding analysis of a filter from another incinerator plant that used a dry precipitator for pollution control. The objective of the dry system comparison was to see if there was any significant difference in the formation of solids in the wet vs. dry control systems. Results showed that the wet system filter had an order of magnitude higher chloride content presumably combined with hydrogen as hydrochloric acid and as metallic salts of iron, zinc, or aluminum. Further indicating the presence of hydrochloric acid was the fact that the wet system filter showed relatively low carbonates which would be expected since HCl reacts with carbonates to liberate CO_2. Since hazardous air pollutant regulations did not exist at that time, no analyses for dioxins/furans or other toxic compounds were made.

After reviewing results of the analyses performed on the filter and scrubber water, the investigation concluded that the scrubber was experiencing heavy carryover of liquid, probably due to poor liquid distribution and plugged holes in the plates. One of the 1975 stack test runs showed a stack moisture content of 40 percent while most of the runs were at about 30 percent stack moisture. For the scrubbers to have consistently achieved the 1975 new emission limit of 0.1 grain would have required eliminating the water-soluble portion of the filter catch from the reported results. Of course, this would not have been permissible, and thus the scrubber could not achieve compliance under the new standards. The 1975 test report showed a scrubber removal efficiency for particulate matter of about 80 to 85 percent, a performance that is not atypical for low-energy plate scrubbers, but was nevertheless insufficient.

If it is assumed that the scrubbers emitted particulate matter at the 1975 test rate of about 0.2 grains per standard cubic foot at 50 percent excess air or about 1 lb per minute per scrubber (based on a stack flow rate of 36,000 scfm for each of the three scrubbers), and each scrubber was operated for at least 3500 hours per year (a lot of downtime for maintenance is indicated in the record), annual particulate emissions would have approached at least 300 tons and could easily have exceeded 400 tons. An upper limit based on the highest stack test data might be in the 600 to 700 tons per year range. As no actual hourly refuse tonnage estimates for the tests could be found in the record, it was not possible to determine an emission factor based on the amount of charge processed. The record does state that the charge was milled, i.e. ground to a smaller size, rather than standard refuse and that increased particulate loading from the milled charge was a suspected cause of the high particulate readings.

EPA's AP-42 document (Section 2.1 – Refuse Combustion) states that mass burn/refractory units typically operate at high excess air rates to prevent excessive temperatures that could damage or foul the refractory and as a result they carry over more particulate matter from the combustion chamber than other designs. The DEP's analysis of the 1975 stack test data for the 450 TPD unit showed that the stack had approximately 160 percent excess air. Thus stack emissions tend to be higher for the non-heat recovery mass burn refractory design than for other types of incinerators such as the waterwall or rotary types that recover heat for generation of steam and/or power. Heat recovery designs require only 80 to 100 percent excess air.

According to EPA's AP-42 document, high particulate carryover from the combustion chamber can contribute to higher dioxin/furan formation due to the greater opportunity for catalytic action on the refractory surface. Another drawback of the non-heat recovery type is that higher excess air can over-quench the combustion reactions making it more difficult to destroy organics.

The type of waste incinerated also affects the amount and type of emissions generated. Documents in the record refer to the types of waste processed by the Fort Lauderdale units as "Type 2 – 90 percent by weight – 864,000 lb/day; Type 3 – 5 percent by weight – 48,000 lb/day; Type 1 – 2 percent by weight – 19,200 lb/day; Type 0 – 3 percent by weight – 28,800 lb/day." This classification breakdown was based on a typical daily load of 480 tons averaged over a seven-day period.

Definitions of waste classifications as they existed at that time are listed below:

> Type 1 – Rubbish, consisting of combustible waste such as paper, cartons, rags, wood scraps, sawdust, foliage, and floor sweepings from domestic, commercial and industrial services.
>
> Type 2 – Refuse, consisting of an approximately even mixture of rubbish and garbage by weight.
>
> Type 3 – Garbage, consisting of animal and vegetable wastes from restaurants, cafeterias, hotels, hospitals, markets and like installations.
>
> Type 4 – Human and animal remains, consisting of carcasses, organs, solid organic wastes from hospitals, laboratories, abattoirs (slaughterhouses), animal pounds and similar sources.

Type 5 – By-product waste, gaseous, liquid or semi-liquid, such as tar, paints, solvents, sludge, fumes, etc., from industrial operations.

Type 6 – Solid by-product waste, such as rubber, plastics, wood waste, etc. from industrial operations.

No definition of Type 0 waste could be found in the Rules of the Florida Department of Health and Rehabilitative Services (HRS), Chapter 10D-21, in effect at the time the above estimate was made. Even though Types 5 and 6 wastes were not listed by the City in the waste analysis cited, it is known that both industrial and biological waste would have been burned when received at the Wingate facility.

The HRS Chapter 10D-21 rule for incinerators required that the Department of Air and water Pollution Control (a DEP predecessor agency) approve the design of incinerators according to criteria specified in the rule. Chapter 10D-21 identified four types of incinerators – Municipal, Commercial, Domestic, and Other. Municipal incinerators were defined as those having a rated capacity of 1,000 pounds per hour or greater. Those with a rated capacity of 100 to 1,000 pounds per hour were classified as Commercial. Domestic incinerators were those rated at less than 100 pounds per hour. Other Incinerators were those designed to burn Types 4, 5, or 6 wastes.

The intent of the drafters of Chapter10D-21 was apparently to allow for considerable variation in the design of municipal incinerators while holding commercial and other units to stricter requirements resulting in less variation. Requirements for the design of Commercial Incinerators spelled out in the rule were very specific, whereas the rule required only that Municipal Incinerators meet "good sanitary engineering practices." For the design of Commercial Incinerators, the rule specified certain criteria such as heat release rate (the amount of heat liberated during combustion divided by the volume of the furnace where combustion takes place); a minimum average temperature of 1,700 degrees Fahrenheit in the primary chamber; minimum hearth and grate areas; air ports sized to admit 100 percent excess air to the primary chamber with up to 40 percent being used as underfire air; velocities of the incoming air and exit flue gases; as well as a multitude of other criteria covering everything from charging equipment to stack design. Incinerators designed for Type 4 waste were required to have two burners - one in the primary chamber and one in the secondary chamber – with specified fuel rates for each.

According to EPA's AP-42 document, emissions from municipal incinerators burning wastes of the type handled at Wingate consisted of particulate matter, metals including mercury, acid gases including hydrogen chloride and sulfur dioxide, carbon monoxide, nitric oxide and nitrogen dioxide, and toxic organics including dioxins/furans. Based on the 1975 Wingate test results (approximately 85 percent removal of particulate), the 480-ton per day waste load cited in the record, and the uncontrolled emission factors given in AP-42, the Wingate site *may* have emitted these pollutants in the following amounts:

Pollutant	**AP-42 Emission Factor**	**Rate Factor**	**AP-42 Tons Per day**
Particulate Matter	2.51 E+01 lb/ton refuse	480 x 0.15/2000	0.9 E+00
Arsenic	4.37 E-03 " "	" "	2.0 E-04
Cadmium	1.09 E-03 " "	" "	4.0 E-04
Chromium	8.97 E-03 " "	" "	3.0 E-04
Mercury	5.60 E-03 " "	" "	2.0 E-04
Nickel	7.85 E-03 " "	" "	3.0 E-04
Lead	2.13 E-01 " "	" "	7.7 E-03
SO_2	3.46 E+00 " "	" "	1.2 E-01
HCl	6.40 E+00 " "	" "	2.3 E-01

Pollutant Deposition

Given the information provided by the DOH, and making the assumptions and estimations provided above, the DEP made estimates of the dry deposition of particulate matter in the surrounding area. No estimate of wet (rainfall) deposition was made. To make this estimation of dry deposition, the DEP used an EPA-approved air quality model called the Industrial Source Complex Short-term, version 3 (ISCST3) model. The ISCST3 model is a steady-state Gaussian plume model which can be used to assess pollutant concentrations from a variety of sources associated with an industrial source complex. This model can account for the following: settling and dry deposition of particles; downwash; area, line, and volume sources; plume rise as a function of downwind distance; separation of point sources; and limited terrain adjustment.

To accommodate the use of this model, information about the source and surroundings must be input. These data include location, emission rate, physical stack height, stack gas exit velocity, stack inside diameter, and stack gas temperature. Optional inputs include source elevation, building dimensions, and particle size distribution. Meteorological data required includes hourly surface weather data from the preprocessor program RAMMET, which provides hourly stability class, wind direction, wind speed, temperature, and mixing height. Receptor data (i.e., where deposition is to be calculated) includes coordinates and optional ground elevation for each receptor.

The subject Wingate incinerators ceased operation in the 1970's. As a result, limited information is available about the characteristics of these incinerators. Nevertheless, the DEP has proceeded to make estimates of deposition in the surrounding area using the available data, supplemented by reasonable estimates and assumptions. Interpretation of the results of this analysis should fully weigh the uncertainties implicit in these estimates.

Source Characteristics:

The following source characteristics were used for the Wingate incinerators.

	Incinerator 1	Incinerator 2
Stack Height (ft)	106.5	100
Stack Diameter (ft)	5	9
Exit gas velocity (ft/s)	50	50
Exit gas temperature (F)	150	150

Both of the two stacks associated with incinerator 1, and the single stack associated with incinerator 2, were located at the same location – lat 26^{o} 08' 00", long 80^{o} 11' 06".

The following emission characteristics were used.

	Incinerator 1	Incinerator 2
Particulate Emission Rate (lb/hr) (controlled)	48.4	26.9
Particulate Emission Rate (lb/hr) (uncontrolled)	322.7	179.3

Particulate Size Distribution:

UNCONTROLLED

Range	Mean Diameter (μm)	Mass Fraction	Density(g/cm^3)
0 – 2.5μm	2	0.54	0.87
2.5μm – 6μm	4.25	0.06	0.87
6μm – 10μm	8	0.07	0.87
> 10μm	50	0.33	0.87

Controlled

Range	Mean Diameter (μm)	Mass Fraction	Density(g/cm^3)
0 – 2.5μm	2	0.76	0.87
2.5μm – 6μm	4.25	0.09	0.87
6μm – 10μm	8	0.10	0.87
> 10μm	50	0.05	0.87

The mass fraction by size category for uncontrolled emissions was taken from Appendix B-1 of EPA's AP-42 Emissions Factors compilation. The density was calculated from data taken at the facility during a stack test.

A building associated with the incinerator complex was included in the model to account for downwash effects on the plume. The building characteristics are: height – 75 feet, width – 131 feet, and length – 131 feet. The building is located 33 feet to the east of the stacks.

Meteorology:

Eight years (1984 – 1991) of National Weather Service meteorological data were used for this analysis. The surface data is from Miami and the upper air data is from West Palm Beach. In creating a suitable meteorological data set for calculating dry deposition of particles, several boundary layer parameters had to be provided. The values used were:

Minimum Monin-Obukov Length	25 m
Roughness Length	1 m
Noon Time Albedo	0.160
Bowen Ratio	2.0
Anthropogenic Heat Flux	15 W/m^2
Fraction Net Radiation Absorbed by Ground	0.20

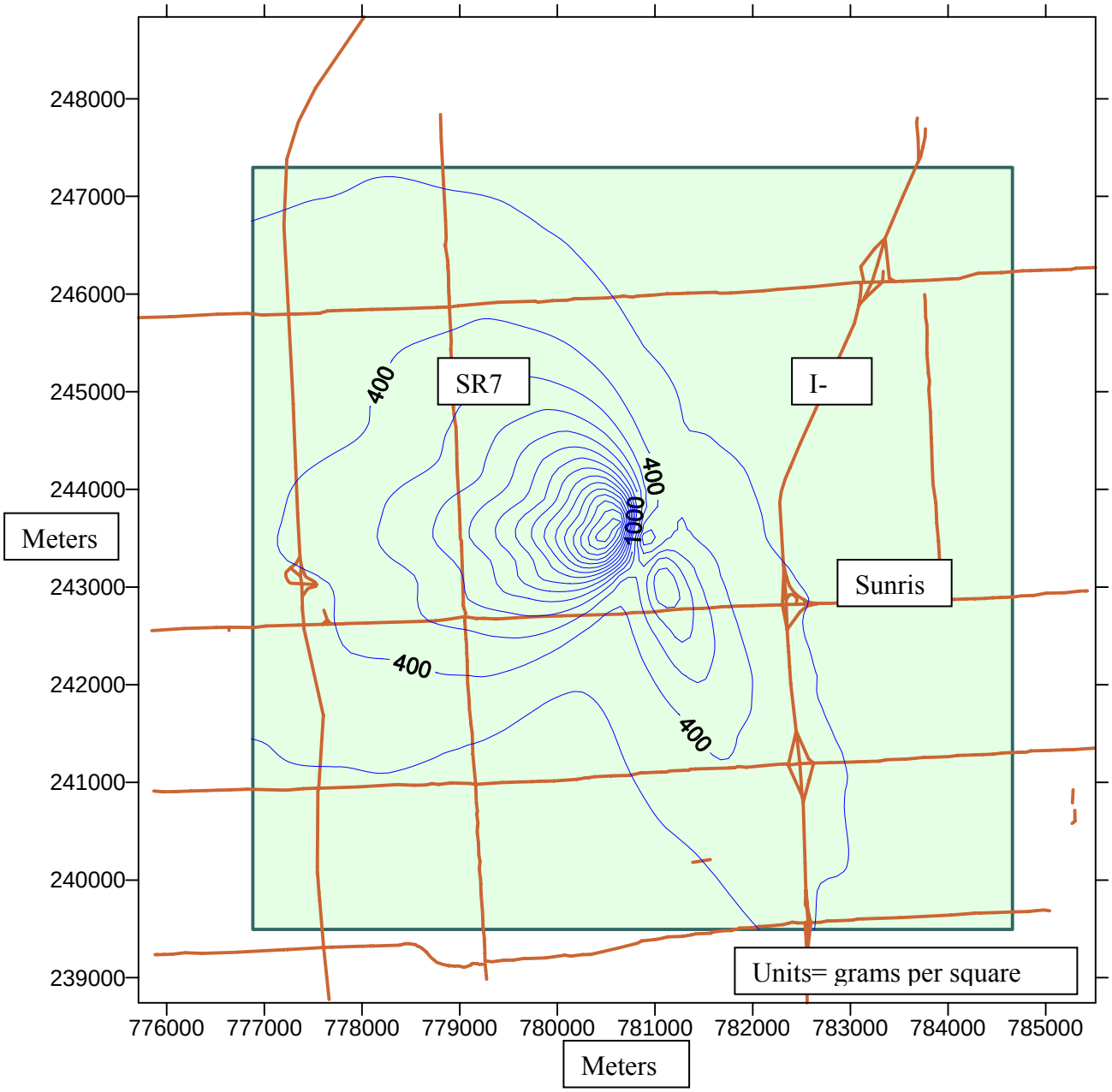
Receptor Data:

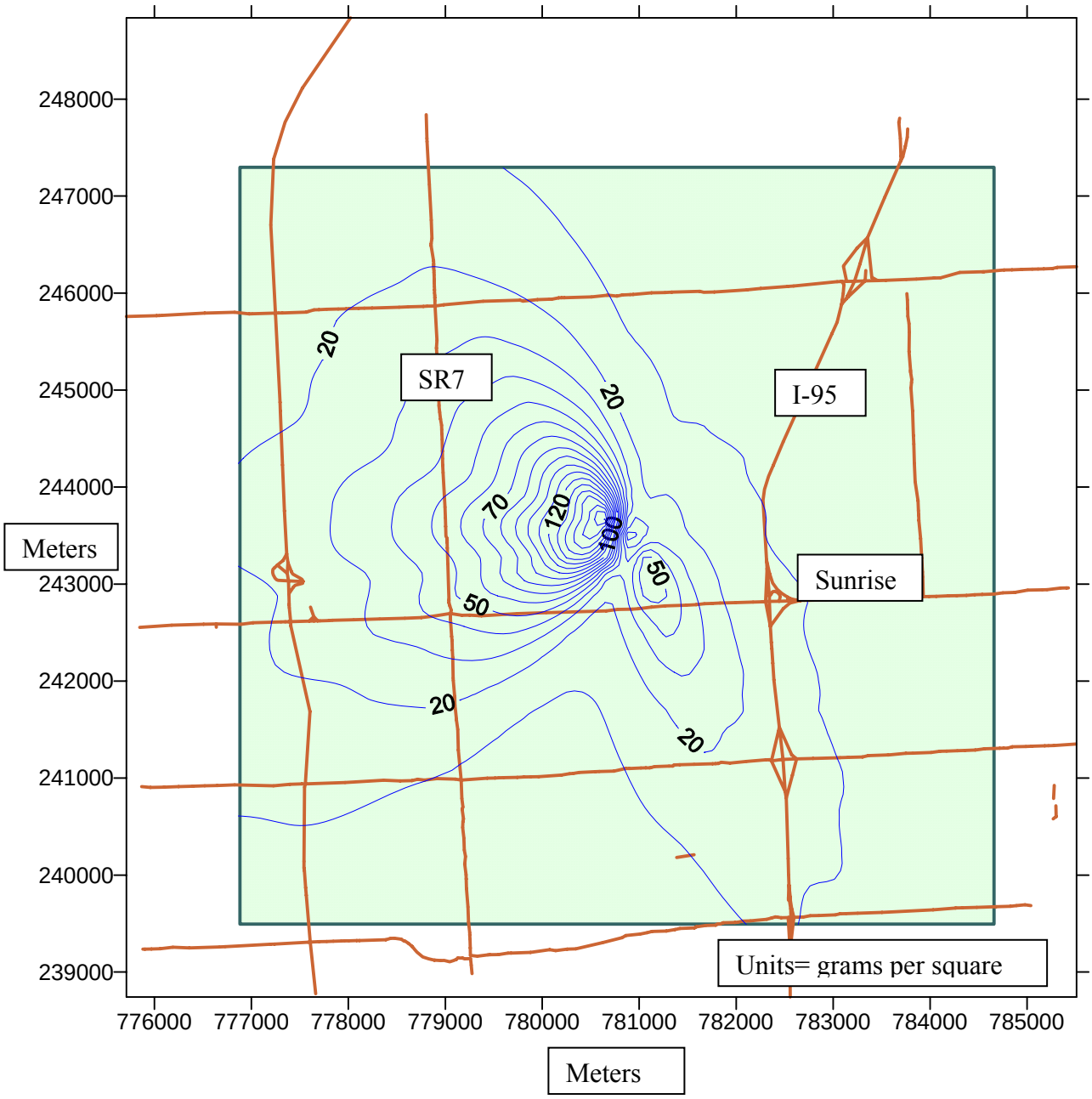
Estimates of dry deposition were made in the area surrounding the Wingate complex. Receptors (i.e., locations where estimates are made) were placed at 100 meter intervals in a 40 by 40 grid centered on the stacks.

Results:

Dry deposition in units of grams per square meter were estimated at each of the receptor locations for the eight-year period, 1984 to 1991. Two scenarios were modeled. The first considers the incinerators with no pollution control. The second considers pollution control using the scrubber system used at this facility. The following diagrams show the general dry deposition pattern in the area surrounding the incinerators. In reviewing these results, emphasis should be on the general pattern of deposition. Little reliance on the absolute values of deposition should be made. This is due to the fact that only dry depositon has been accounted for and the general uncertainty of the particulate data available.

Wingate – Uncontrolled Emissions Case





PRELIMINARY CONCLUSIONS

Estimates of the dry deposition of particulate matter surrounding the Wingate facility have been made. Due to the uncertainties in both the source characteristics and the particulate matter data, care should be taken in interpreting the results of this analysis. For example, the distance to the maximum values shown on the chart will change with different source and particulate characteristics. In general, maximum dry deposition occurs to the west and west, northwest of the Wingate facility. A secondary maximum occurs to the southeast of the

facility. This general pattern is reflective of the climatic wind patterns of the region which are predominated by the southeasterly flow of the trade winds. The secondary maximum is associated with transient low-pressure systems, primarily

APPENDIX F: Wingate Survey Questionnaire

Phone Number: _____
Date: _____
Time: _____

WINGATE SURVEY QUESTIONNAIRE

Interviewer, please read before starting.

"***Hello! My name is _____, and I am with the Broward County Health Department Wingate Survey Project. I would like to speak to someone in your household who is 25 years of age or older. Are you 25 years old?***

The Wingate community leaders support the Department of Health in conducting a survey to ask public health questions of residents in the area. If you choose to participate in the survey, we will compensate you by sending a gift card in the value of $10.00 from _____ on completion of the survey. This is in respect for your time and effort. Will you participate?

All information provided by you will be kept confidential and your name will not be used in survey results.

With your permission I would like to ask you some questions and this could take about 20 minutes. This will include questions about your health and where you have lived. Your participation is voluntary and you can refuse to answer any question at any time.

Also, we may need to contact you later to verify diseases that you report and this may include contacting physicians and hospitals.
May I have your name and address for purposes of mailing you the gift card?"
Fill in the blanks:

_____ _____ _____

First **Middle** **Last Name**

_____

Current Mailing Address

_____, _____ _____

City **State** **Zip code**

"What is your birth date?" : _____

If you have questions, please contact Dr. Prakash S. Patel at toll free (877) 798-2772 or at p.s.patel@doh.state.fl.us

SECTION A: RESIDENCE

"This section asks questions about where you live. Please list every address you have lived at for at least one year. Start with your current address and go back to 1954."

(After a code for general geographic area is put in the database, this page with specific addresses will be destroyed.)

Address	Moved In & Out Enter Years		# Street	City	State
Current			If different from mailing address		
Prior			Street # only if in Ft. Lauderdale area		

SECTION B: MEDICAL DIAGNOSES

"Now, I want to ask you about the health problems that your doctor may have diagnosed."

Interviewer, Please complete each question in each column with the diagnosis name.

"Do you recall if a doctor has ever told you that you have_____"			***. If yes, "How old were you? _____"***	***If yes "Have you been treated for _____"***		**comments**
	NO	YES	AGE	NO	YES	
1. ***Asthma*** (wheezing or breathing difficulty not related to exercise)						
2. ***Bronchitis*** (Productive cough with fever & sore throat).						
3. ***Chloracne*** (Predominance of dry open blackheads and straw colored cysts distributed on cheek bones area of face; behind ears; armpits; scrotum, but absent around nose.)						
4. ***Hyperkeratosis*** (Thickening of the skin on palms of hands, soles of feet or trunk of body)						
5. ***Hyperpigmentation*** Darkening of skin or patches of darker skin than your normal skin color)						
6. ***Anemia***, (Low Red blood cell count)						
If yes: ***Was it a Sickle cell anemia?***						
7. ***Other blood disorders with lower blood cell count.***						
8. ***Hypercholesterolemia*** (High cholesterol levels in blood)						
9. ***Glucose Intolerance*** (High blood sugar levels)						
10. ***Cardiac Arrhythmias*** (Abnormal heart beats not related to exercise)						

CANCER QUESTIONS

Interviewer, Please repeat the question when asking about each item in the list.

"Do you recall a doctor ever telling you that you had cancer?" If **NO:** SKIP TO SECTION C If **YES:** CONTINUE BELOW HERE **If yes, *"Please specify the name of the primary site, where it started first. Has a doctor ever told you that you have cancer of the _____"***	**NO**	**YES**	***"How old were you when the doctor first told you?"*** **AGE**	**comments**
1. ***Digestive system*** *If yes,* specify site: _____ stomach, liver, esophagus, mouth, colon, or rectum				
2. ***Skin*** *If* yes, specify _____ Melanoma or other				
3. ***Respiratory system*** *If* yes, specify _____ lung, bronchi, trachea, throat, or nose				
4. ***Renal system*** *If yes,* specify: _____ Kidney, bladder.				
5. ***OTHER Cancer type*** Specify: _____				

SECTION C: MEDICAL SYMPTOMS

"Now I want to ask you about particular symptoms you may have experienced."

"***Do you remember having _____"*** (Name the symptom and the period of time)	**no**	**yes**	***"How old were you?"*** **age**	If yes ***"What age first treated for this symptom?"***	**comments**
1. ***Irritation or burning in your eyes or nose or throat***					
2. ***Numbness, tingling, or weakness in arms or legs***					
3. ***Inability to move arms or legs without known cause***					
4. ***Irritation, redness & swelling of skin***					
5. ***Heavy perspiration not related to heat or exercise***					
6. ***Bruising easily***					
7. ***Unexpected short seizures not related to epilepsy***					
8. ***Extreme sleepiness***					
9. ***Extreme sleeplessness***					
10. ***Ringing in ears***					
11. ***Neck pain***					
12. ***Difficulty in urination*** (passing water)					

SECTION C: MEDICAL SYMPTOMS (continued)

"Do you remember having _____" (Name the symptom and the period of time)	no	yes	***"When were you first treated for this symptom?"*** **age**	**comments**
13. ***Nausea, vomiting or diarrhea*** If yes, identify a frequency 1-4 times/year 1-3 times/month 2-5 times/week Daily				
14. ***Severe (strong) headaches*** If yes, identify a frequency 1-4 times/year 1-3 times/month 2-5 times/wk Daily				
15. ***Anxiety, nervousness or depression*** If yes, identify a frequency 1-4 times/year 1-3 times/month 2-5 times/wk Daily				

SECTION D: FISH CONSUMPTION	**no**	**yes**
"Do you recall if, since 1954, you ever ate fish caught from Lake Rockpit?" Lake Rockpit is located next to the Wingate incinerator on the east side of Martin Luther King Jr. Rd (NW 31st Avenue), just south of 19th street		

If yes, identify a frequency

Less than 2 meals/week	no	**More than 2 meals/week**	no	**How many years?_____**
	yes		yes	

"Please tell us about your tobacco use." Please repeat the question for a, b and c.

SECTION E: TOBACCO *"In your lifetime, have you ever _____"...*	**NO**	**YES, and I still use**	**YES, but I quit**	**Smoked ## years**
1. ***Smoked more than 100 cigarettes (5 packs)?***				
2. ***Smoked more than 50 cigars or pipes?***				
3. ***Smoked any other tobacco products (>50units)?***				

SECTION F: PERSONAL DESCRIPTION

Fill in the blanks with numbers or check the boxes

1. ***"How often do you receive regular complete physical health exams?"***
   - ❑ **Once a year**
   - ❑ **Every 1-5 years**
   - ❑ **More than 5 years or never**
2. **"*Are you male or female?"***
   - ❑ **Male**
   - ❑ **Female**
3. **"*What is your height?"*: _____Inches *"Your Weight"?*: _____Lbs.**

NOTE: ***"This section contains information needed to characterize the area population"***

4. ***"Are you Hispanic?"***
   - ❑ **no**
   - ❑ **yes**
5. **"*What is your race?"*** (Check only one. List any additional heritages under other**)**
   - ❑ **Black**
   - ❑ **Native American**
   - ❑ **White**
   - ❑ **Asian or Pacific Islander**
   - ❑ **Other (SPECIFY): _____**
   - ❑ **Don't know / refused**
6. ***"What is the highest grade of school or year of college that you completed?* "(**Check one)
   - ❑ **No schooling**
   - ❑ **Elementary school (grades 1-8)**
   - ❑ **High School (grades 9-12)**
   - ❑ **College**
   - ❑ **Graduate/professorial**

7 ***"Did you ever work at the Wingate Landfill and/or Incinerator?"***

- ❑ **No**
- ❑ **Yes** If yes, for how many years? _____**## years.**
- ❑ **Don't remember.**

8 ***"At any place you ever worked (job), do you recall being exposed to any of these substances?"***	**No**	**Yes**	If yes **# years**
a) Pesticides or Herbicides			
b) Smoke, fumes or vapors			
c) Paint strippers			
d) Art materials			
e) Glue			
f) Other eye or nose irritants			
g) Solvents or degreasers such as turpentine, gasoline, perc, or trichlor.			
h) Other metals such as mercury or cadmium			
i) Asbestos			
j) Radiation			
k) Sandblasting, silica, rock crushing, drilling or talc			
l) Rock cutting			
m) Arsenic			
n) Dioxin			

9 ***"Compared to other communities like this one, how much pollution do you think there is in this community?"***

- ❑ **Lower**
- ❑ **About the same**
- ❑ **Higher**
- ❑ **Don't know**

10 ***"Do you think your health has been affected by toxic chemicals in the environment?"***

- ❑ **Yes**
- ❑ **No**
- ❑ **Don't know**