Health Consultation

CORPUS CHRISTI LANDFILLS

CORPUS CHRISTI, NUECES COUNTY, TEXAS

EPA FACILITY ID: TX0000605320

JANUARY 25, 2001

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

CORPUS CHRISTI LANDFILLS

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EPA FACILITY ID: TX0000605320

Prepared by:

Texas Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

SUMMARY

The petitioners have expressed many concerns with regards to the Chula Vista and Greenwood Landfills. These concerns include the possible hazards to children and other people frequenting schools as well as other buildings rumored to have been built on the landfills, children currently playing on or practicing band on the landfills, and children who played on or swam in the landfills in the past. Additionally, the petitioners have expressed concerns about potential health hazards associated with possible contamination of the groundwater.

The Texas Department of Health (TDH), under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), studied all of the evidence (historical information, sampling data and community concerns) and concluded that currently people are not being exposed to harmful chemicals from the landfills via indoor air, surface soil, drinking water or groundwater. Therefore, the landfills **currently pose no public health hazard**.

The limited information concerning what chemicals people may have been exposed to in the past, if any, and how often exposures may have occurred, prevents a quantitative evaluation of possible health risks from past exposures. Although information to evaluate past exposure pathways will never be complete, by considering realistic exposure scenarios, we estimate that the potential for current health risks from past exposures is low.

The following is a list of questions raised by community members, with answers from TDH.

- **Were the schools built on the landfills?**
  Available evidence indicates that the schools were not built on the landfills. This is based on a review of historical aerial photographs and available soil boring data.

- **Are there possible hazards to children/people frequenting schools and other buildings rumored to have been built on the landfills?**
  There is no evidence that either of the landfills has affected the indoor air quality at the schools or other nearby buildings. There is no evidence of a methane hazard at the schools or other buildings. The drinking water at the schools is similar in quality to that used in other parts of Corpus Christi; there is no indication that the drinking water has been affected by the landfills.

- **Are there possible hazards to children currently playing on or practicing band on the landfills?**
  A review of surface soil and soil gas data indicates that there is no evidence that either of the landfills currently poses any hazards to children who play on or practice band on the landfills.

- **Could current or future health problems result from playing in the landfills in the past?**
  The lack of historical environmental and exposure information prevents a quantitative evaluation of possible health risks from past exposures; however, based on plausible exposure scenarios, the potential for current health risks from past exposures is low.

- **Are there potential health hazards associated with possible contamination of groundwater?**
  Although the groundwater beneath the landfills has not been sampled, it is not used for drinking, cooking or bathing. Even in the absence of sampling data, the lack of exposure precludes the groundwater from posing a public health hazard. In addition, based upon the methane monitoring and soil gas measurements conducted by the TNRCC in June, July, and September 2000, we would not expect contaminants in groundwater to migrate into indoor air of nearby buildings.

BACKGROUND AND STATEMENT OF ISSUES

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) received a petition in April 2000, to investigate two former landfills in the John Jones subdivision in Corpus Christi, Nueces County, Texas (Figures 1A and B). People who grew up in the subdivision were concerned that the landfills, the Chula Vista Landfill (also known as the Cunningham Dump) and the Greenwood Landfill (also referred to as the Villareal Pit), were causing health problems.

The petitioners grew up in the John Jones subdivision and attended both Cunningham Middle School on Prescott Road (next to the Chula Vista Landfill) and J.A. Garcia Elementary School on Greenwood Drive (next to the Greenwood Landfill) [1, 2]. They began investigating the landfills sometime in 1999, after a family member died of breast cancer and neighbors and friends commented that "several other people who grew up in the area were getting cancer and dying at a young age" [2]. The petitioners believe that these cancers are occurring in young (3 years of age through teenagers) to relatively young people (50 years of age or younger). They were concerned about breast cancer, kidney cancer, and other cancers. They also mentioned knowing families in the area with three or more members having cancer or benign tumors. In addition, they had read of cancers and benign tumors being attributable to living near landfills. Other health concerns included headaches, miscarriages, and nosebleeds [1, 2, 3].

In late February 2000, staff from the regional office of the Texas Natural Resource Conservation Commission (TNRCC) notified the Texas Department of Health (TDH) of the cancer concern. A TDH epidemiologist contacted the petitioners and worked with the TDH Cancer Registry Division (CRD) to obtain information on the number of cancer cases (incidence) and cancer deaths (mortality) for the area. Since the zip code area is the smallest geographic unit for which cancer data are available, TDH evaluated cancer incidence and mortality data for the zip code 78416 which encompasses the area of interest to the petitioners. On March 30, 2000, TDH sent the petitioners an evaluation of the cancer incidence and mortality experience for the area adjusted for race, gender, and age for the following types of cancer: breast, esophagus, kidney, leukemia, and liver. The cancers reviewed were not elevated when compared to race-adjusted cancer incidence and mortality rates for Texas as a whole [4]. TDH had planned to meet with the petitioners on April 17, 2000 to obtain more detailed information about the cancers of concern and discuss the survey information collected by the petitioners; however, the petitioners canceled the meeting after petitioning ATSDR [5].

In response to the petition, ATSDR and TDH met with the petitioners on May 16, 2000. At that time the petitioners asked TDH to update the cancer report to include colon and ovarian cancer. TDH updated the cancer report for the same zip code area and did not find either type of cancer to be elevated [6]. On May 31, 2000, ATSDR and TDH completed the petition scoping report.

ATSDR asked TDH to complete a health consultation using available environmental and historical information to address the petitioners' concerns.

Site Description and History

The area in the immediate vicinity of the two landfills consists of residential homes, schools, municipal parks, and a number of commercial businesses (Figure 2). One of the parks, the John Jones Park, is near the Chula Vista Landfill and consists mainly of a playground. The other park, the Hector P. Garcia Park, is located on the property containing the Greenwood Landfill. Approximately 7,000 people live within a ½ mile of the two landfills. Of these approximately 1,400 are women between the ages of 15 and 44, 730 are children below the age of six, and 760 are adults older than age 65 [7].

The Chula Vista Landfill is 4.6 acres in area; neither the type of waste deposited nor the specific years it was operated were documented in the records we reviewed. The landfill was closed by the time that solid waste regulations were established in the 1970s [8, 9]. When we visited the site in May and July 2000, we saw thick, healthy grass growing on the Chula Vista Landfill. We did not see any areas of exposed soil, and we noted that two trees were growing out of the landfilled area. There was an area of standing water approximately 3 feet by 10 feet in size between the Cunningham Middle School property and the Chula Vista Landfill area. Growing in this wet area were types of plants known to be adapted to wet conditions, suggesting that this area stays wet most of the time. The concrete opening to the City's storm drain system was on the south corner of the Chula Vista landfill near Prescott Road. During our investigation for the scoping report, the petitioners expressed concerns about water ponding on the former landfill and drainage problems in the area. The petitioners later met with city officials [10]. Although fences border part of the Chula Vista Landfill, access is not restricted or posted. Three school properties border the Chula Vista Landfill: Cunningham Middle School to the south, Mary Grett School for the multi-handicapped to the west-southwest, and Chula Vista Academy of Fine Arts to the west. The backyards of eleven occupied homes border the Chula Vista Landfill to the north.

The 45-acre Greenwood Landfill was operated by the City of Corpus Christi from 1940 until 1965. During its operation, household, commercial, and construction waste were put into the landfill [8, 9]. Most of Hector P. Garcia Park is situated over the former landfill [11]. The J.A. Garcia Elementary School, the State of Texas Department of Child Protective Services offices, and the municipal swimming pool are immediately east of the Greenwood Landfill. The Lulac Village Park Apartments are immediately north of the landfill area. The Molina Drainage Ditch runs parallel to the western boundary of the park property. We saw ball fields immediately south of the landfill area on the park property. No stained soil, trash, barrels or waste chemicals were observed on or near either landfill [3].

DISCUSSION

The petitioners have expressed many concerns with regards to these landfills. These concerns include the possible hazards to children and other people frequenting schools as well as other buildings purported to have been built on the landfills, children currently playing on or practicing band on the landfills, and children who played on the landfills in the past. Additionally, the petitioners have expressed concerns about potential health hazards associated with possible contamination of groundwater. Of primary importance, the petitioners have expressed their belief that their past exposure to landfill material is responsible for current health problems such as cancer (various types; Table 1), allergies, asthma, autism, cough, diabetes, headaches, high blood pressure, kidney complications with chemotherapy, miscarriages, nosebleeds, thyroid problems, vertigo, and hysterectomies.

To address these concerns, we compiled and reviewed all the available data pertaining to these landfills that we could find. The information that we reviewed includes, but is not limited to, data collected during a TDH investigation in 1990, a 1998-1999 City of Corpus Christi investigation, a June/July 2000 TNRCC investigation, and a September 2000 EPA/TNRCC investigation [11-20]. In reviewing these data we relied on the information provided in the referenced documents and assumed adequate Quality Assurance and Quality Control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The conclusions that we reached in this consultation are valid only if the referenced information is valid and complete. For ease of presentation, we have presented these data below as they pertain to each of the main concerns expressed by the petitioners as outlined above.

Concern

Were the schools built on the landfills?

Summary: Available evidence indicates that the schools were not built on the landfills. This is based on a review of historical aerial photographs and available soil boring data.

To determine the nature and extent of the landfill areas and address the concern that various structures were built on the landfills, we examined aerial photographs provided by the petitioners (1948, 1951, 1952, 1953, and 1965) and the city (1996) [21, 22]. These photographs show that the Chula Vista Landfill does not overlap with any of the schools or homes in the vicinity. The Greenwood Landfill does not overlap with the sites currently occupied by the J.A. Garcia Elementary School, the Lulac Village Park Apartments, the state offices, or the municipal swimming pool. Soil boring data that we were able to review indicated that the boundaries as identified from the aerial photographs were accurate.

Based on a 1952 aerial photograph which showed a cleared area east of the Greenwood Landfill, the petitioners were concerned that there was a previously unidentified landfill site underneath the Garcia Elementary School. On first inspection the cleared area seemed to be in the location

of the school and the petitioners were concerned that this cleared area had received waste (Figure 3). To investigate this concern, we overlaid the 1952 aerial photograph on the most recent aerial photograph showing the school (1996) and determined that part of the school does overlap the cleared area from the 1952 aerial photograph. In an attempt to determine if the cleared area had received waste material first we asked experts in aerial photograph interpretation to examine the photographs. They examined the photographs and concluded that the cleared area did not have the characteristics of a pit or depression. We then examined geotechnical information provided by the Corpus Christi Independent School District for the land under the school and found that seven borings to depths of 15 to 25 feet below ground surface were made in the area in 1969, 1987, and 1993 [23]. Three of the borings from 1969 were in the area where Garcia Elementary overlaps the cleared area. If the area had received waste, there would be evidence of landfill trash in the borings; however, landfill trash was not found in any of the borings. In September 2000, two additional soil borings were made in this area by the TNRCC and the city. These borings indicated that the soil in this area was native, previously undisturbed soil. Based on available information, we were not able to find any evidence indicating that Garcia Elementary School was built over any landfill waste.

Concern

Are there possible hazards to children/people frequenting schools and other buildings rumored to have been built on the landfills?

Summary: There is no evidence that either of the landfills has affected the indoor air quality at the schools or other nearby buildings. There is no evidence of a methane hazard at the schools or other buildings. The drinking water at the schools is similar in quality to that used in other parts of Corpus Christi; there is no indication that the drinking water has been affected by the landfills.

Although we did not find any evidence that any of the schools were built on landfills, we searched for evidence of contamination at the schools and tried to determine whether the contamination, if any, could be related to the landfills. Regardless of the source and in accordance with ATSDR's Child Health Initiative [24], we also tried to determine whether the contaminants could pose a possible health hazard to children attending the schools. Due to the nature of the indoor environment, most of the information that we were able to find dealt with possible exposures through inhalation; however, we also obtained information on the quality of the drinking water.

In September 1990, in response to a concern about the Chula Vista Landfill, TDH inspectors tested the air at seven (7) locations inside the Cunningham Middle School, and seven (7) locations inside the Chula Vista Academy of Fine Arts. The indoor air samples were tested for volatile organic compounds (VOCs), formaldehyde, pesticides, carbon monoxide, and carbon dioxide. Additionally, the inspectors also tested for methane (a common landfill gas) at four (4)

locations inside the Cunningham Middle School and three (3) locations inside the Chula Vista Academy of Fine Arts.

The only VOCs that they detected were trace amounts of isopropyl alcohol, pinene, limonene, and iso-octane in the cafeteria and room 15 at Chula Vista Academy of Fine Arts. While the exact sources for these VOCs were not determined, these compounds are commonly found in cleaning agents, the types of which may have been in use at the school. These compounds do not represent a threat to the students. Pesticides and methane were not detected in any of the samples.

At Cunningham Middle School, the inspectors detected formaldehyde in the cafeteria at concentrations ranging from 0.02 to 0.04 parts per million (ppm) and carbon monoxide (CO) next to the oven in the home economics room at a concentration of 2.0 ppm. They also found carbon dioxide (CO_2) at elevated levels at both schools.

Formaldehyde is a common indoor air pollutant that can come from a variety of sources including wood furniture, paneling, insulation, carpets, and permanent press clothing. Breathing air containing too much formaldehyde can cause eye, nose, mouth, and throat irritation; however, the concentrations of formaldehyde often associated with these types of effects is over 25 times higher than the maximum concentration detected at the school. While formaldehyde in indoor air is not desirable, the formaldehyde was found in only one location and does not pose a health hazard to the students. The oven in the home economics room was identified as the probable source for the CO. While exposure to too much CO can interfere with the oxygen carrying capacity of the blood, it was not detected in the air by the desks where the students sat.

CO_2 is a normal constituent of exhaled air and was measured in several locations at concentrations high enough to be of potential concern since exposure to CO_2 at the reported levels could result in headaches and fatigue. At that time, TDH inspectors recommended that ventilation in areas of the Cunningham Middle School and Chula Vista Academy of Fine Arts be increased to reduce CO_2 levels [13]. We have no information as to whether this recommendation was followed.

In June and July 2000, TNRCC personnel took approximately 40 methane samples from three permanent buildings and two portable buildings near the Greenwood Landfill and three permanent buildings and two portable buildings near the Chula Vista pit (Tables 2 and 3). Methane was not detected in any of the schools or other buildings tested [14, 15, 16, 17].

In 1990, drinking water samples were collected from the Cunningham Middle School cafeteria and tested for minerals, metals, and pesticides to ensure that the water was safe to drink [13]. In 2000, water samples were collected from Chula Vista Academy, Mary Grett, Cunningham Middle School and Garcia Elementary School. The water sampled from these schools was similar in quality to water from other parts of Corpus Christi which is not unusual since the water

is supplied by the City of Corpus Christi and comes from a surface water source outside of the subdivision. The water is subjected to a complete treatment process prior to being distributed throughout Corpus Christi [25].

We do not consider any of the contaminants detected at the schools to be related to the landfills. Based on available information, we did not find any evidence that the air quality at the buildings in the vicinity of the landfills is being affected by the landfills. The drinking water is similar in quality to that used in other parts of Corpus Christi.

Concern

Are there possible hazards to children currently playing on or practicing band on the landfills?

Summary: A review of surface soil and soil gas data indicates that there is no evidence that either of the landfills currently poses any hazards to children who play on or practice band on the landfills.

In order for children playing or practicing band on the landfills to be at risk from possible contaminants in the landfills there must be a way for the contaminants to get into their bodies. Additionally, the contaminants would have to get into their bodies often enough at high enough concentrations to pose a health threat. Incidental ingestion of contaminated soil or inhalation of airborne contaminants would be the most likely ways that chemicals could get into the bodies of children playing or practicing band on the landfills. Thus, we attempted to address this concern by examining available information for contaminants in surface soil and air. We compared contaminant concentrations to health-based screening values for both non-cancer and cancer endpoints.[1] Because of the conservative nature of the assumptions used to generate the screening values, failure to exceed a screening value generally indicates that the chemical does not pose a health hazard. While exceeding a screening value does not necessarily mean that a contaminant poses a health threat, it does suggest that the contaminant warrants further consideration by reviewing relevant toxicologic information and plausible site-specific exposures.

In 1990, surface soil samples were collected from the courtyard at Cunningham Middle School, the proposed site of the Mary Grett School, a location at John Jones Park, and from the Chula Vista Landfill. The four (4) samples were tested for priority pollutants including pesticides,

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[1] We used ATSDR's Health Assessment Comparison (HAC) values which are media and contaminant specific concentrations used to screen contaminants for further evaluation. Non-cancer HAC values are called environmental media evaluation guides (EMEGs) or reference dose media evaluation guides (RMEGs), and are respectively based on ATSDR's minimal risk levels (MRLs) or EPA's reference doses (RfDs). MRLs and RfDs are estimates of a daily exposure to a contaminants that is unlikely to cause adverse non-cancer health effects.. Cancer risk evaluation guides (CREGs) are based on EPA's chemical specific cancer slope factors and an estimated excess lifetime cancer risk of one-in-one-million persons exposed for a lifetime. We used standard assumptions to calculate appropriate HAC values [26].

metals, and semivolatile organic compounds (SVOCs). Pesticides were not detected in any of the samples and the trace levels of metals and SVOCs that were found were not at levels that would be expected to result in adverse health conditions (Table 4).

In 1998, Southern Ecology Management collected six surface soil samples from Hector Garcia Park at locations on the Greenwood Landfill, on the ball fields, and near the swimming pool (Figure 4) [11]. The samples were analyzed for VOCs, total organic halogens including PCBs, and metals. The VOC hexane was detected at a concentration of 0.316 mg/kg in one sample collected from the landfill. All other volatile organic compounds and total organic halogens were below their respective detection limits. Hexane is a hydrocarbon produced from crude oil and is a component of solvents, glues, and gasoline. Exposure to high levels of hexane in the air (500 to 2,500 ppm) for prolonged periods of time (six months to several years) for 8 to 14 hours per day has resulted in significant adverse health effects in humans. Exposure to 0.316 mg/kg hexane in soil would not result in adverse health outcomes and does not pose a health threat. The metals all were well within the concentrations normally found in soil in the Western United States (Table 5) [26].

On September 22, 2000, EPA collected surface soil samples both on and in the vicinity of the Chula Vista and Greenwood Landfills [18]. Background samples were collected for both landfills to determine the concentrations of constituents in the area's soil. All of the samples were analyzed for VOCs, SVOCs, metals, pesticides, and PCBs.

Six locations on the Chula Vista Landfill and two locations on the playground at the Chula Vista Academy were tested in the September 22, 2000 sampling event [18]. VOCs were not found and SVOCs, pesticides, and PCBs were measured at levels that would not pose a health hazard. Metals concentrations both on the Chula Vista Landfill and on the Chula Vista Academy playground were similar to concentrations measured in the background sample. The only exception was arsenic, measured at three times background in one sample collected from the Chula Vista playground on the ballfield (SO8). In this sample arsenic was measured at a concentration of 3.4 milligrams per kilogram (mg/kg), a concentration that is below the average arsenic concentration for soil in this part of the United States (5.5 mg/kg) and significantly below the 20 mg/kg cleanup standard that has been used by EPA and TNRCC at other sites in Texas. The concentration of arsenic in the soil does not pose a public health threat.

Nine locations on the Greenwood Landfill were tested in the September 22, 2000 sampling event; two of these locations were near the slides and another was near the ball fields [18]. Samples also were collected at two locations on the Lulac Apartments property, two locations between Garcia Elementary and the swimming pool, and one location near the swimming pool. The SVOC benzo(a)pyrene was detected at one location on the Greenwood Landfill (S17) at a concentration of 0.46 mg/kg, exceeding its HAC value of 0.1 mg/kg. This HAC value is based on the assumption that a person ingests 200 mg of soil each day for 70 years. The theoretical excess lifetime cancer risks associated with any plausible exposure to this soil would be

insignificant and would not pose a public health threat. The concentration of metals in surface soil at both the Chula Vista Landfill and the Greenwood Landfill are comparable to the background metal concentrations.

In 1990, TDH inspectors tested for methane outdoors at the Cunningham Middle School courtyard and playground, the Chula Vista Academy of Fine Arts courtyard and playground, the proposed building site of the Mary Grett School, a location on John Jones Park, and locations at the Chula Vista Landfill. Methane, a non-toxic simple asphyxiant that also could present an explosion hazard, is an indicator of landfill activity. Methane was not detected in any of these samples. We do not believe this to be unusual given the age of the landfills.

Other than methane, ambient air monitoring data were not available to assess whether air releases from the landfills posed a possible health hazard. However, to determine whether VOCs were being given off by the Chula Vista and Greenwood Landfills, the TNRCC collected samples of air (soil gas) from the soil in stainless steel canisters at depths between 18 and 24 inches deep (Table 6). On September 22, 2000, instantaneous grab samples were collected from Chula Vista Landfill (one sample), Greenwood Landfill (two samples) and at an open field (one sample) [19]. On September 29th two five-minute grab samples were collected at the Chula Vista Landfill [20].

Low concentrations of VOCs were detected in all of the samples. Although none of the VOCs exceeded the TNRCC's short term exposure effects screening levels, benzene, 1,3-butadiene, and chloroform exceeded ATSDR's health assessment comparison values. These HAC values were calculated by assuming that a person inhales 20 cubic meters (20,000 liters) of air containing the contaminant at the reported concentration every day for 70 years. Exposure to significant concentrations of any of these contaminants from the soil gas is not plausible. Thus, the frequency and duration of exposure to these contaminants, under any plausible exposure scenario, would not pose a public health hazard to children playing or practicing band on the landfill.

Concern

Could current or future health problems result from playing in the landfills in the past?

Summary: The lack of historical environmental and exposure information prevents a quantitative evaluation of possible health risks from past exposures; however, based on plausible exposure scenarios, the potential for current health risks from past exposures is low.

According to area residents, in the past, children swam in water at the dump sites and ate mud pies composed of dirt from the Chula Vista Landfill. These children, now adults, are concerned that these activities may have exposed them to chemicals that could be responsible for their current health problems. While there are health risks associated with swimming in potentially unsanitary water or eating dirt, our focus here is on potential health risks from possible chemical exposures.

Although the types of waste put into the landfills are not known, it is certainly possible that chemicals such as household cleaning fluids, pesticides, oil waste, fuel, lead, and paint were deposited there. The presence of volatile organic compounds in the soil gas samples certainly supports this as a possibility. Whether the water that the children swam in or the mud pies that they ate were contaminated is not known; therefore, we cannot determine if exposure to chemicals from these activities has occurred. At this point in time, it would be difficult if not impossible for any amount of environmental sampling to determine whether these activities exposed the children to chemicals.

Because of the lack of historical environmental and exposure information, we were not able to quantitatively estimate the risk for adverse effects; however, we have made a qualitative estimate of possible risks by reviewing plausible exposure scenarios. In any exposure situation, the potential for adverse health effects from exposure depends on the nature and extent of the exposure. In this instance, how often people ate mud pies, how much they ate on each occasion, and the number of years that this behavior occurred over all are important parameters. Similarly, how often they swam in the water, how long they swam on each occasion, and how many years they swam in the water are important. Of course, the types of contaminants in the mud and water as well as the concentrations of the contaminants also would be important.

Most of the reported adverse non-cancer health problems which could be caused by chemicals, have relatively short latency periods. Thus, these types of effects would have occurred shortly after exposure, not years later. On the other hand, cancers associated with chemical exposures often have long latency periods and can show up many years after exposure.

There are many causes for cancer; different types of cancer have been associated with different causes. Some chemicals are classified as "known" or "probable" human carcinogens and the actual risk of developing cancer as a result of exposure to these chemicals depends on the potency of the chemical to cause cancer and the daily amount of the chemical that the person was exposed to averaged over a lifetime. Generally, the risks associated with developing cancer from exposure to an environmental pollutant are small when compared to the background rate of cancer. For instance, benzene is a known human carcinogen. Ingesting 200 milligrams of soil containing 10,000 micrograms of benzene per kilogram soil every day for 70 years would result in a theoretical excess lifetime cancer risk of one-in-one-million. This means that if one million people were exposed to this amount of benzene every day, over the course of 70 years, one of the one million people might get cancer. Qualitatively, this type of risk is considered to be insignificant. Given that the lifetime risk for cancer from all sources is about four-in-ten, it would be difficult to attribute any one individual's cancer to such an exposure. Incidental ingestion of landfill soil on a limited number of occasions in the past would not have resulted in a significant excess lifetime risk for cancer. We cannot envision any plausible past exposure situations that would have resulted in a significant excess lifetime risk for cancer.

Concern

Are there potential health hazards associated with possible contamination of groundwater.

Summary: Although the groundwater beneath the landfills has not been sampled, it is not used for drinking, cooking or bathing. Even in the absence of sampling data, the lack of exposure precludes the groundwater from posing a public health hazard. In addition, based upon the methane monitoring and soil gas measurements conducted by the TNRCC in June, July, and September 2000, we would not expect contaminants in groundwater to migrate into indoor air of nearby buildings.

According to the soil boring logs from the Greenwood Landfill, groundwater was encountered at approximately 10-12 feet below ground surface [11]. Similar depth to groundwater was noted during construction at the schools in the vicinity of the Chula Vista Landfill. In order for the groundwater to present a possible health hazard, people would have to be using the groundwater for potable (drinking, cooking, bathing, and washing) purposes. Texas Water Development Board records indicate that there are no private or public water supply wells within one mile of the Chula Vista and Greenwood Landfills [27, 28]. Due to the hydrogeology of the area, this part of Nueces County has little groundwater to yield and, what little groundwater there is, is too salty and is too high in total dissolved solids to be palatable. We have concluded that because groundwater in the vicinity of the Chula Vista and Greenwood Landfills is not being used for drinking, the groundwater exposure pathway poses no public health hazard. In addition, based upon the methane monitoring and soil gas measurements conducted by the TNRCC in June, July, and September 2000, we would not expect contaminants in groundwater to migrate into any of the nearby buildings.

Child Health Initiative

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of their water, soil, air, or food [24]. Children are at greater risk than adults from certain kinds of exposures to hazardous substances emitted from waste sites and emergency events. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are shorter than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decision, and access to medical care.

TDH and ATSDR evaluated the likelihood for children living and going to school in the vicinity of the Chula Vista and Greenwood Landfills to be exposed to site contaminants at levels of health concern. Children who played in the landfills when they were open in the past may have been exposed to site-related contaminants in the soil. However, there are no data to

quantitatively evaluate this exposure pathway. Thus, due to a paucity of historical data, we were not able to adequately assess the potential public health significance of these potential past exposures; however, qualitatively, based on plausible exposure scenarios, we would estimate these risks to be low. Currently, children are not likely to be exposed to contaminants in surface soils from either the Chula Vista or Greenwood Landfills since the surface soil sampling at either site did not have contaminants at concentrations that would be expected to result in health problems. Although groundwater data are not available, children are not being exposed to contaminants in groundwater since groundwater in the vicinity of the landfills is not a source of drinking water for the John Jones Subdivision. TDH/ATSDR could find no evidence that the landfills pose any health hazard to children attending or visiting the schools and buildings near the landfills.

CONCLUSIONS

1. Available evidence indicates that the schools were not built on the landfills. This is based on a review of historical aerial photographs and available soil boring data.

2. There is no evidence that either of the landfills has affected the indoor air quality at the schools or other nearby buildings. There is no evidence of a methane hazard at the schools or other buildings. The drinking water at the schools is similar in quality to that used in other parts of Corpus Christi; there is no indication that the drinking water has been affected by the landfills.

3. A review of surface soil and soil gas data indicates that there is no evidence that either of the landfills currently poses any hazards to children who play on or practice band on the landfills.

4. While an actual inventory of the types of waste put into the landfills is not available, it is certainly possible that chemicals such as household cleaning fluids, pesticides, oil waste, fuel, lead, and paint were deposited there. The lack of historical environmental and exposure information prevents a quantitative evaluation of possible health risks from past exposures. Based on plausible exposure scenarios, we estimate that the potential for current health risks from possible past exposures is low.

5. Although the groundwater beneath the landfills has not been sampled, it is not used for drinking or other potable purposes (cooking, bathing, or washing). Since people are not using the groundwater, it poses no public health hazard.

PUBLIC HEALTH ACTION PLAN

Actions Completed

1. In late February 2000, staff from the regional office of the Texas Natural Resource Conservation Commission (TNRCC) notified the Texas Department of Health (TDH) of the cancer concern. A TDH epidemiologist contacted the petitioners and worked with the TDH Cancer Registry Division (CRD) to obtain information on the number of cancer cases (incidence) and cancer deaths (mortality) for the area.

2. On March 30, 2000, TDH sent the petitioners an evaluation of the cancer incidence and mortality experience for the area adjusted for race, gender, and age for the following types of cancer: breast, esophagus, kidney, leukemia, and liver.

3. TDH had planned to meet with the petitioners on April 17, 2000 to obtain more detailed information about the cancers of concern and discuss the survey information collected by the petitioners; however, the petitioners canceled the meeting after petitioning ATSDR [5].

4. In response to the petition, ATSDR and TDH met with the petitioners on May 16, 2000. At that time the petitioners asked TDH to update the cancer report to include colon and ovarian cancer.

5. On May 31, 2000, ATSDR and TDH completed the petition scoping report.

6. TDH visited the site in May and July 2000.

7. To determine the nature and extent of the landfill areas and address the concern that various structures were built on the landfills, TDH examined aerial photographs provided by the petitioners and the city.

8. In September 1990, in response to a concern about the Chula Vista Landfill, TDH inspectors tested the air at seven (7) locations inside the Cunningham Middle School, and seven (7) locations inside the Chula Vista Academy of Fine Arts. The indoor air samples were tested for volatile organic compounds (VOCs), formaldehyde, pesticides, carbon monoxide, and carbon dioxide. Additionally, the inspectors also tested for methane (a common landfill gas) at four (4) locations inside the Cunningham Middle School and three (3) locations inside the Chula Vista Academy of Fine Arts.

9. In June and July 2000, TNRCC personnel took approximately 40 methane samples from three permanent buildings and two portable buildings near the Greenwood Landfill and three permanent buildings and two portable buildings near the Chula Vista pit (Tables 2 and 3). Methane was not detected in any of the schools or other buildings tested [14, 15, 16, 17].

10. In 1990, drinking water samples were collected from the Cunningham Middle School cafeteria and tested for minerals, metals, and pesticides to ensure that the water was safe to drink [13]. In 2000, water samples were collected from Chula Vista Academy, Mary Grett, Cunningham Middle School and Garcia Elementary School. The water sampled from these schools was similar in quality to water from other parts of Corpus Christi which is not unusual since the water is supplied by the City of Corpus Christi and comes from a surface water source outside of the subdivision.

11. In 1990, surface soil samples were collected from the courtyard at Cunningham Middle School, the proposed site of the Mary Grett School, a location at John Jones Park, and from the Chula Vista Landfill. The four (4) samples were tested for priority pollutants

including pesticides, metals, and semivolatile organic compounds (SVOCs). Pesticides were not detected in any of the samples and the trace levels of metals and SVOCs that were found were not at levels that would be expected to result in adverse health conditions (Table 4).

12. In 1998, Southern Ecology Management collected six surface soil samples from Hector Garcia Park at locations on the Greenwood Landfill, on the ball fields, and near the swimming pool (Figure 4) [11]. The samples were analyzed for VOCs, total organic halogens including PCBs, and metals.

13. On September 22, 2000, EPA collected surface soil samples both on and in the vicinity of the Chula Vista and Greenwood Landfills [18]. Background samples were collected for both landfills to determine the concentrations of constituents in the area's soil. All of the samples were analyzed for VOCs, SVOCs, metals, pesticides, and PCBs.

14. In 1990, TDH inspectors tested for methane outdoors at the Cunningham Middle School courtyard and playground, the Chula Vista Academy of Fine Arts courtyard and playground, the proposed building site of the Mary Grett School, a location on John Jones Park, and locations at the Chula Vista Landfill. Methane, a non-toxic simple asphyxiant that also could present an explosion hazard, is an indicator of landfill activity. Methane was not detected in any of these samples.

15. On September 22, 2000, instantaneous grab samples were collected from Chula Vista Landfill (one sample), Greenwood Landfill (two samples) and at an open field (one sample) [19]. On September 29th two five-minute grab samples were collected at the Chula Vista Landfill [20]. Low concentrations of VOCs were detected in all of the samples. The frequency and duration of exposure to these contaminants, under any plausible exposure scenario, would not pose a public health hazard to children playing or practicing band on the landfill.

Actions Planned

1. None at this time.

REFERENCES

1. Email to ATSDRIC@cdc.gov from Petitioners regarding landfill problems in Corpus Christi, TX. February 24, 2000.

2. Letter to Captain John A Steward, ATSDR Petition Coordinator, Agency for Toxic Substances and Disease Registry from Petitioners. Petition for a public health assessment. April 18, 2000.

3. Field notes of site visit May 16th and 17th, 2000. TDH, Susan Prosperie.

4. Texas Department of Health, Cancer Registry Division. Analysis of cancer mortality and incidence data for zip code 78416. March 30, 2000.

5. Letter from Suzie Canales to Texas Department of Health, Judy Henry. April 2, 2000.

6. Texas Department of Health, Cancer Registry Division. Analysis of cancer mortality and incidence data for zip code 78416. June 5, 2000.

7. 1990 U.S. Census Bureau. Database C90STF3B. Summary Level: Zip Code 78416.

8. Email to Petitioner from Joey Crumley, TNRCC regarding database information on the Villareal Pit and Chula Vista Academy. February 24, 2000.

9. Fax from Dr. Robert Larsen, South West Texas State University Department of Geography and Planning. Maps and documentation of Nueces County Unauthorized Landfills. March 8, 2000

10. Email message from Ron Massey, City of Corpus Christi to Angel Escobar et al regarding drainage at Cunningham Dump (a.k.a. Chula Vista dump) meeting with Ms. Canales. August 29, 2000.

11. ARCADIS Geraghty & Miller, Inc. Closed Landfill Investigation. Hector P. Garcia Park, 4400 Greenwood Drive, Corpus Christi, Nueces County, Texas. City of Corpus Christi. November 23, 1999.

12. Letter, map and sampling data to Dr. Charles Benson, Corpus Christi Independent School District from W.H. Clay, Jr, Texas Department of Health, regarding the types and locations of the tests made at the Cunningham/Chula Vista Schools. October 2, 1990.

13. Letter and Report to Abelardo Saavedra, PhD of the Corpus Christi Independent School District from Quade Stahl, PhD, Texas Department of Health regarding investigation of

indoor air quality and other sampling for the Cunningham Middle School, Chula Vista Academy of Fine Arts, proposed location of the Mary Grett School and the Chula Vista Landfill. April 2, 1991.

14. Texas Natural Resource Conservation Commission. MSW Inspection Report. Inspection of Closed Landfill Villarreal Pit. Corpus Christi, Texas. Inspection Date: 6/15/00. Methane monitoring Lulac Village Park Apartments and Texas Department of Protective and Regulatory Services. Report date July 28, 2000.

15. Texas Natural Resource Conservation Commission. MSW Inspection Report. Inspection of Closed Landfill Villarreal Pit. Corpus Christi, Texas. Inspection Date: 6/21/00. Methane monitoring J.A. Garcia Elementary School. Report date July 28, 2000.

16. Texas Natural Resource Conservation Commission. MSW Inspection Report. Inspection of Closed Landfill Chula Vista Pit. Corpus Christi, Texas. Inspection Date: 6/21/00. Methane monitoring Chula Vista Elementary School. Report date July 28, 2000.

17. Texas Natural Resource Conservation Commission. MSW Inspection Report. Inspection of Closed Landfill Chula Vista Pit. Corpus Christi, Texas. Inspection Date: 7/27/00. Methane monitoring Cunningham Middle School and Mary Grett School. Report date July 28, 2000.

18. Environmental Protection Agency. Region VI. Email from Bill Rhotenberry to Cstanley (TNRCC), Sprosperie (TDH), and Kimm (City of Corpus Christi). Surface soil sampling data for Chula Vista and Greenwood Landfills collected September 22, 2000. November 15, 2000.

19. Texas Natural Resource Conservation Commission. Fax from Russell Lewis TNRCC Region 14 to S. Prosperie TDH. Toxicological Evaluation of Results of Soil Gas Sampling for Volatile Organic Compounds (VOCs) Historic Landfills, Corpus Christi, Nueces County. Samples collected September 22, 2000. October 3, 2000.

20. Texas Natural Resource Conservation Commission. Interoffice Memo from Steven Pike Toxicology and Risk Assessment to Buddy Stanley, TNRCC Corpus Christi. Toxicological Evaluation of Results of Soil Gas Sampling for Volatile Organic Compounds (VOCs) Historic Landfill, Corpus Christi, Nueces County. Samples collected September 29, 2000. October 12, 2000.

21. Email message from MFEJ to S. Prosperie TDH with attached aerial photographs of Chula Vista and Greenwood Landfills. 1948, 1951, 1952, 1953, and 1995. June 26. 2000.

22. City of Corpus Christi Planning Department. 1996 aerial photograph.

23. Corpus Christi Independent School District. Letter from Mr. Leroy SanMiguel, Director Facilities & Operations, to Mr. Kim McGuire, Director Environmental Programs, City of Corpus Christi. Regarding Garcia Elementary School Geotechnical Information. September 29, 2000.

24. Agency for Toxic Substances and Disease Registry, Office of Children's Health. Child Health Initiative. 1995.

25. Drinking Water Quality Report for 1999. City of Corpus Christi Water Department. June 2000.

26. Agency for Toxic Substances and Disease Registry. Public Health Assessment Guidance Manual. 1992.

27. Texas Water Development Board. Ground Water Data System. Records of Wells, Springs, and Test Holes. Nueces County. December 29, 1998.

28. USGS, TerraServer. Digital OrthoPhoto Quadrangle Image Corpus Christi, Texas, United States, 1995. Coordinates of area within one mile of the Villareal Pit and the Chula Vista Academy landfill.

PREPARERS OF THE REPORT

Susan L. Prosperie, M.S., R.S.
Environmental Health Specialist
Environmental Epidemiology and Toxicology Division

John F. Villanacci, Ph.D.
Co-Director
Environmental Epidemiology and Toxicology Division

ATSDR REGIONAL REPRESENTATIVE

Jennifer Lyke
Regional Representative
ATSDR - Region 6

ATSDR TECHNICAL PROJECT OFFICER

Alan W. Yarbrough
Division of Health Assessment and Consultation
Superfund Site Assessment Branch
State Programs Section

CERTIFICATION

This Corpus Christi Landfills Health Consultation was prepared by the Texas Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.

Technical Project Officer, SPS, SSAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

Chief, State Programs Section, SSAB, DHAC, ATSDR

FIGURES

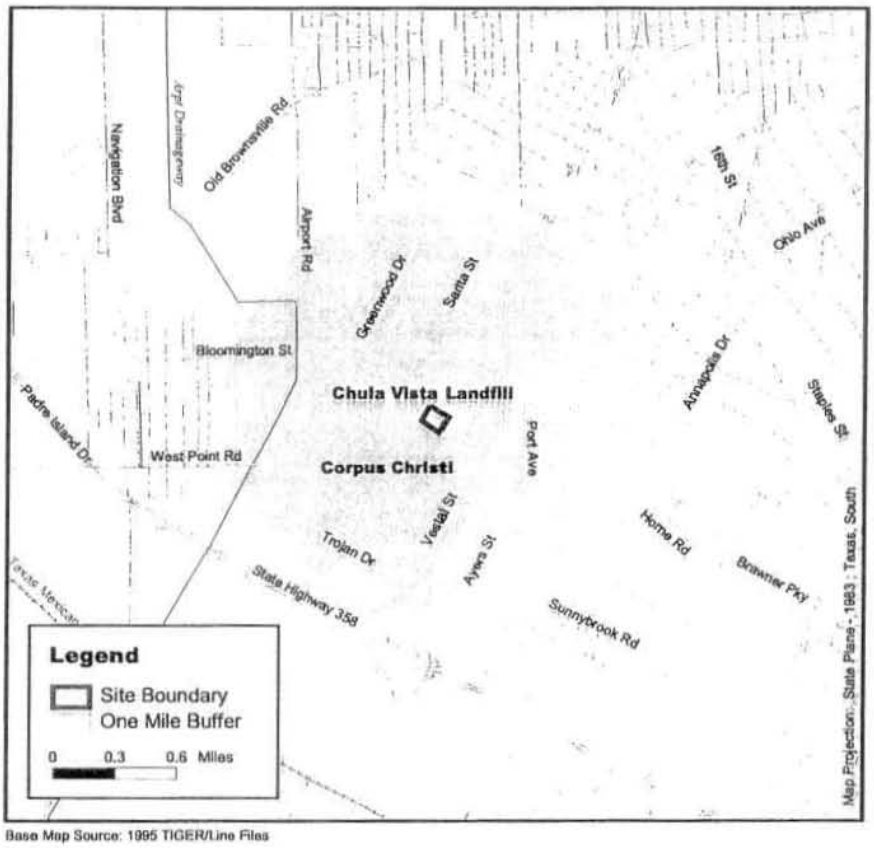
Figure 1A General location and Demographics Information

Chula Vista Landfill

INTRO MAP

Corpus Christi, Texas

CERCLIS No. TX0000605320



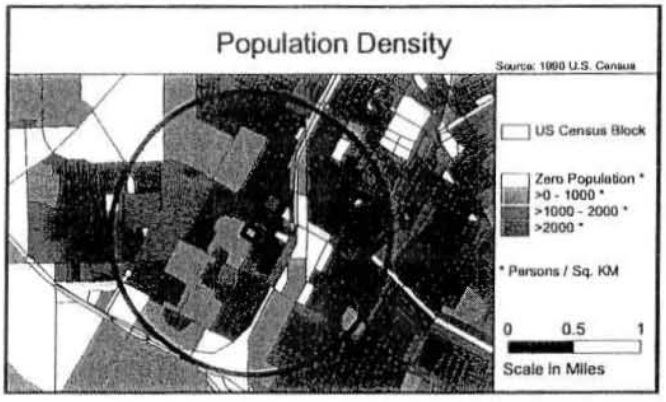
Base Map Source: 1995 TIGER/Line Files

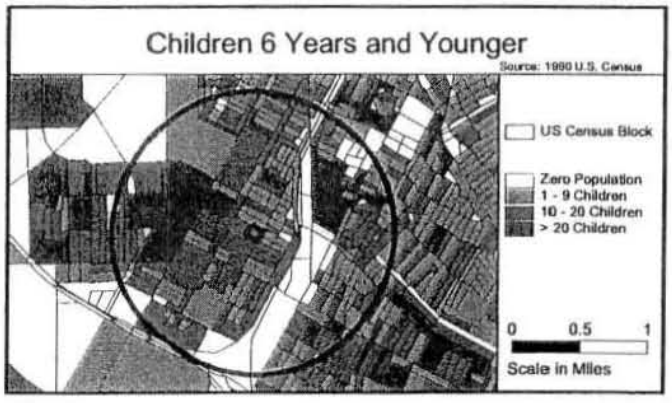
Nueces County, Texas

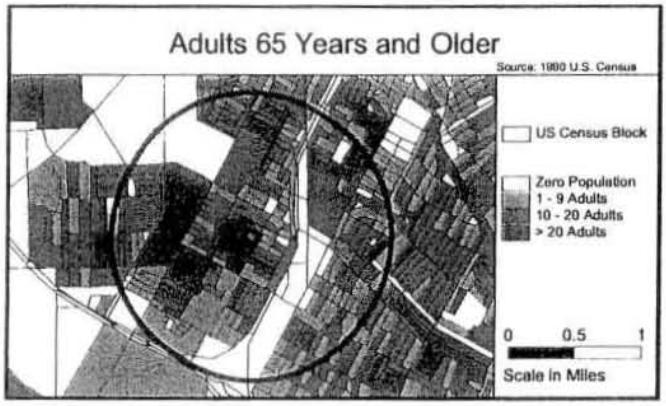
Demographic Statistics
Within One Mile of Site*

	1mi	.5mi
Total Population	21958	6140
White	13822	4146
Black	1970	140
Am. Indian, Eskimo, Aleut	32	10
Asian or Pacific Islander	72	14
Other Race	6059	1830
Hispanic Origin	18486	5781
Children Aged 6 & Younger	2729	659
Adults Aged 65 & Older	2592	726
Females Aged 15 - 44	4817	1301
Total Housing Units	6990	1832

Demographics Statistics Source: 1990 US Census
*Calculated using an area-proportion spatial analysis technique







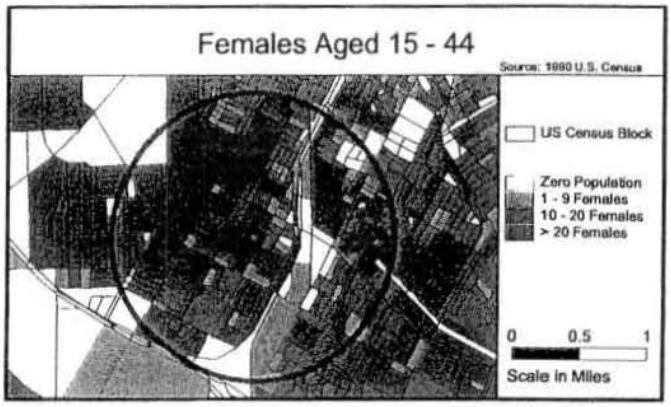


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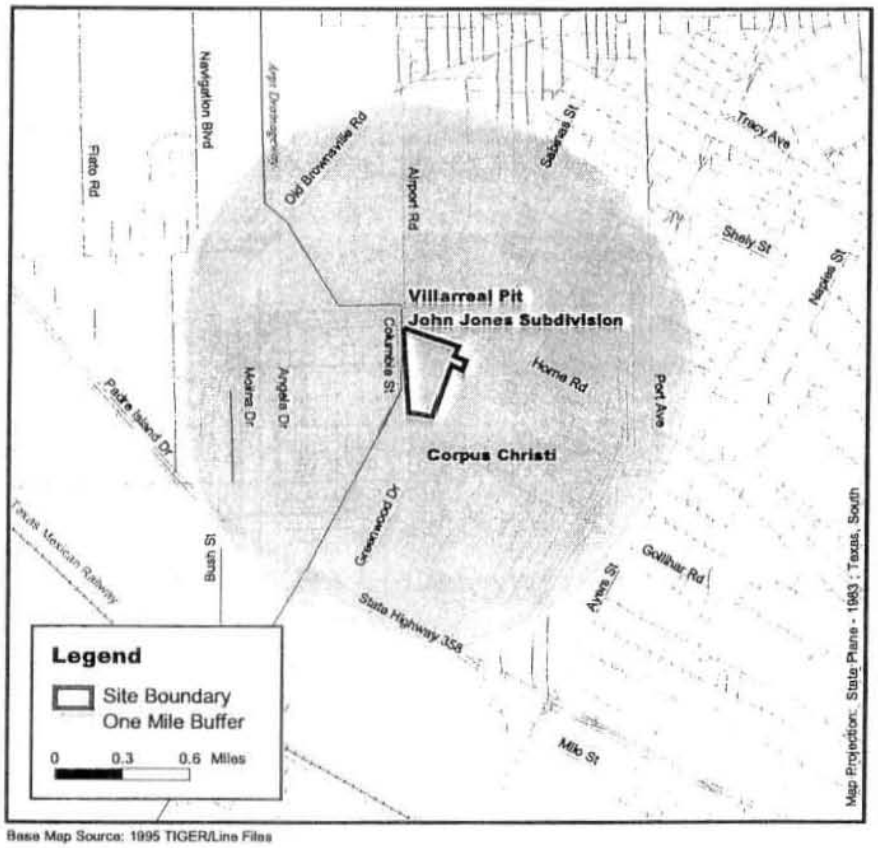
Figure 1B General location and Demographics Information

Villarreal Pit John Jones Subdivision

INTRO MAP

Corpus Christi, Texas

CERCLIS No. TX0000605320

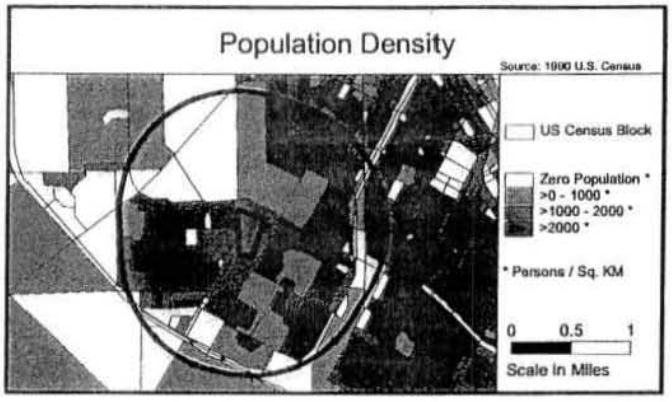


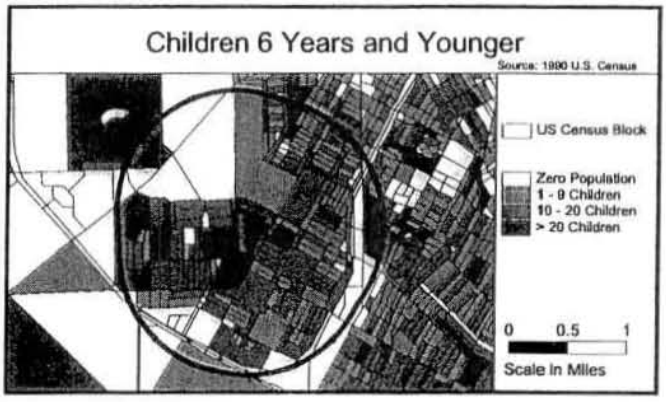
Base Map Source: 1995 TIGER/Line Files

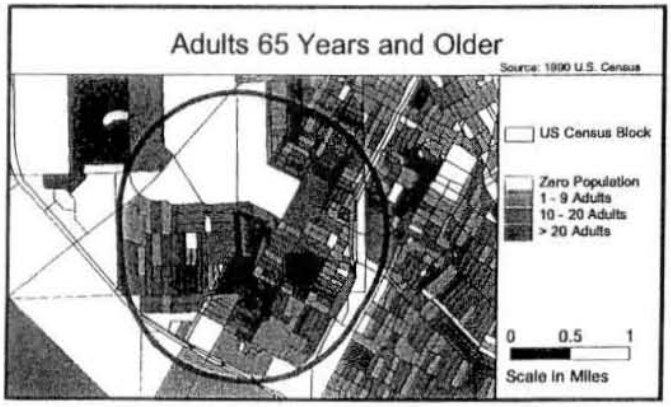
Nueces County, Texas

Demographic Statistics Within Special Distance*	1Mi	.5mi
Total Population	21095	7188
White	12473	4413
Black	2858	1005
Am. Indian, Eskimo, Aleut	37	6
Asian or Pacific Islander	65	12
Other Race	5666	1758
Hispanic Origin	17535	5934
Children Aged 6 & Younger	2516	803
Adults Aged 65 & Older	2371	802
Females Aged 15 - 44	4688	1593
Total Housing Units	6423	2154

Demographics Statistics Source: 1990 US Census
*Calculated using an area-proportion spatial analysis technique







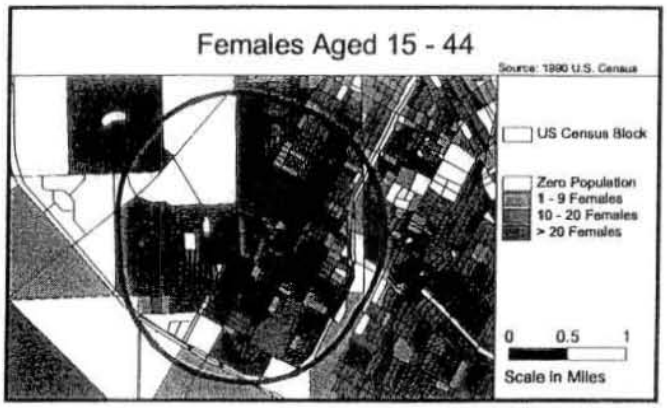


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Figure 2. Location of Former Landfills and Other Features

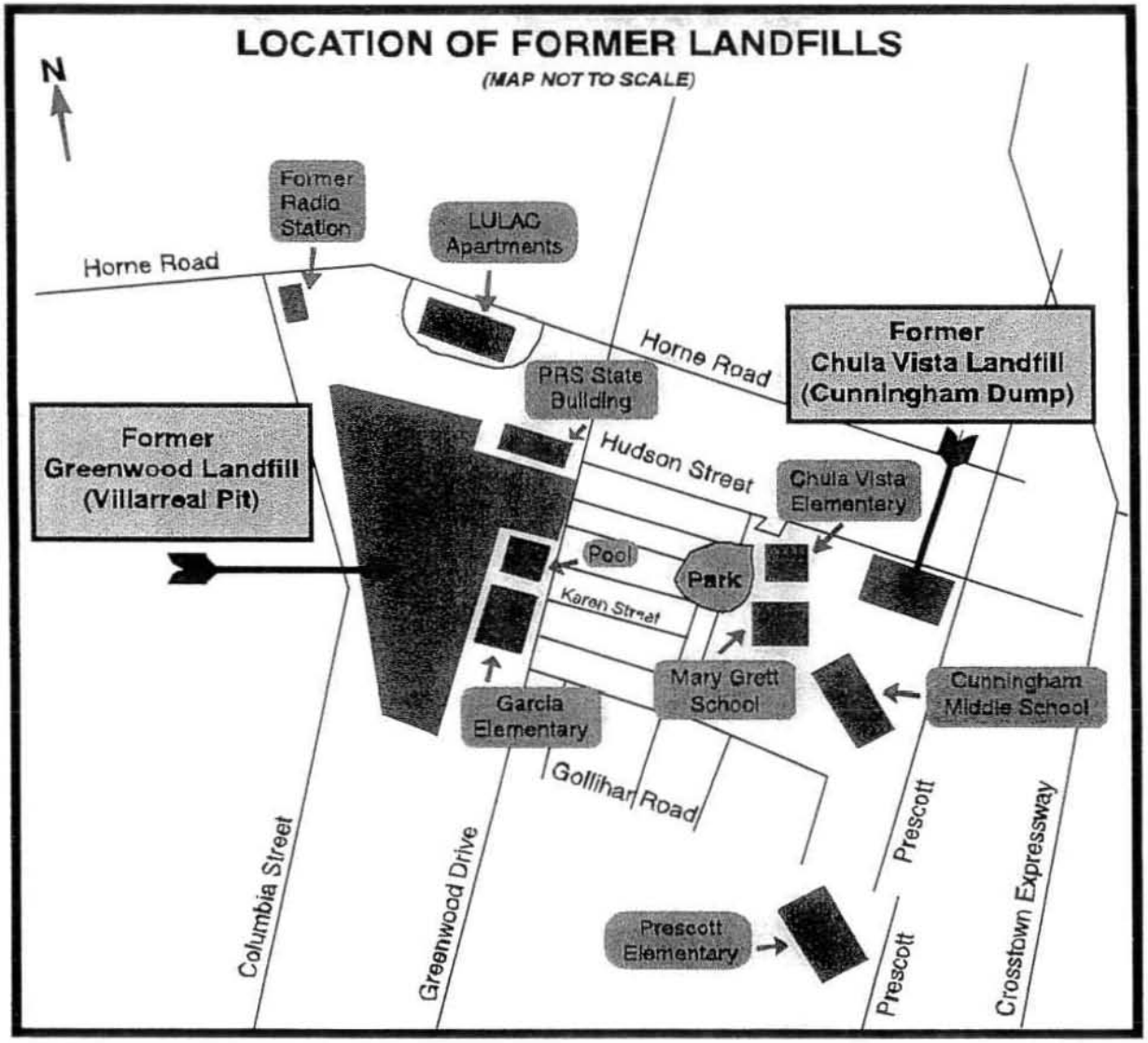

Figure 3. Historical Soil Boring Locations at Garcia Elementary

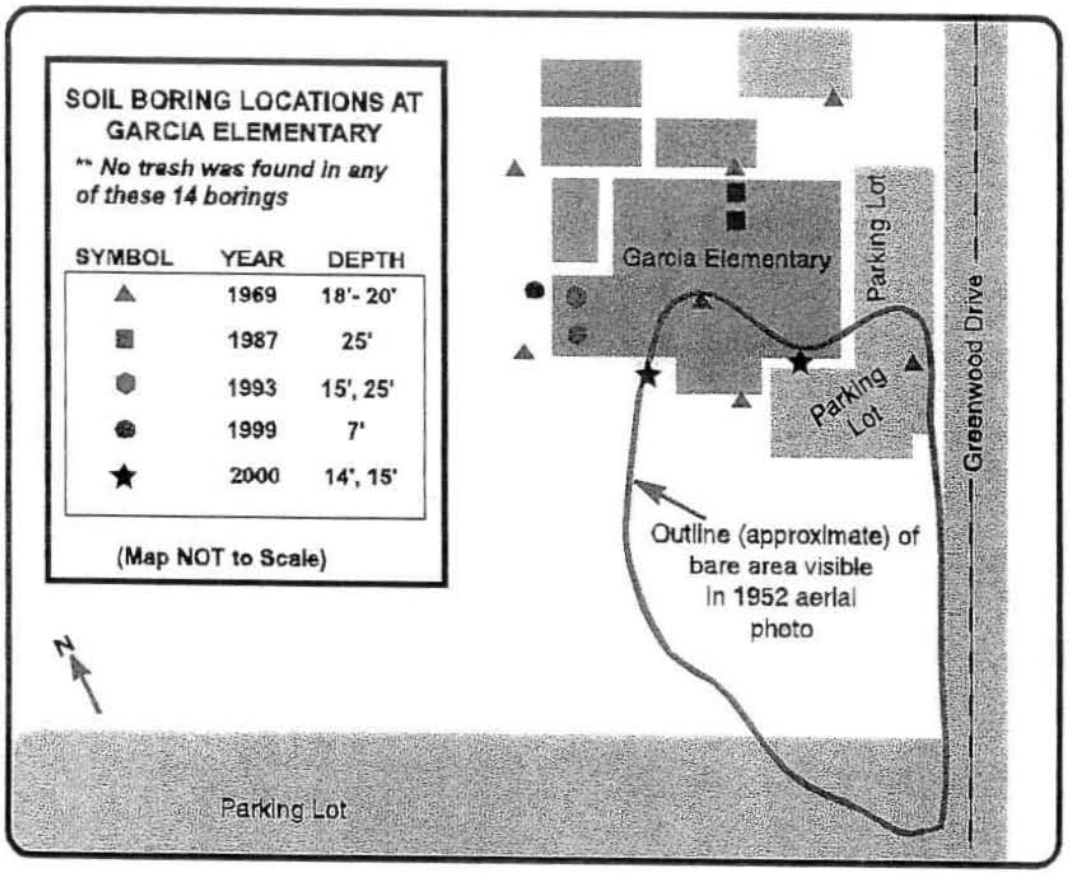

Table 3. Methane Testing in buildings near the Chula Vista landfill			
Building	**Date Sampled**	**Areas Sampled for Methane**	**Results of Methane Sampling**
Chula Vista Academy of Fine Arts (Elementary) 1761 Hudson	June 21, 2000	Portable buildings #22 and #25 were sampled. Rooms #2, 7, 9, 13, the music room, the custodial room, the bathroom, and the media room/library were sampled.	All samples non-detect (0% methane)
Cunningham Middle School 4321 Prescott	July 27, 2000	The kitchen, the crawl space in the janitor's closet in the kitchen below the slab, the crawl space under Rooms 512, 513, 519, 522, outside the book room, outside the cafeteria and outside the band hall), the band hall, the computer room, restrooms #601 and #602, rooms # 109, 204, 311, 513, 521, the choir room and a custodial closet, including crawl space below the slab.	All samples non-detect (0% methane)
Mary Grett School 4402 Castenon		Rooms 102, 104, 114, 116, and 120, the home management room, the mechanical room, the multi-purpose room, two storage areas, and a bathroom. Four- four foot deep holes dug for the setting of pillars for portable buildings also were sampled (no landfill waste was seen in the holes).	All samples non-detect (0% methane)

Table 4. 1990 Investigation Surface Soil Samples Collected by Texas Department of Health Bureau of Solid Waste Inspector September 20, 1990

Sample Location	Chula Vista Landfill	Cunningham Middle School Courtyard	Mary Grett School site	John Jones Park (at Chula Vista)	Screening Value (mg/kg)	
Lab Sample #	ESI 14	ESI 15	ESI 16	ESI 17		
Priority Pollutants Detected (mg/kg)					Background soil concentration for western United States†	
Metals					Average	Range
Arsenic	2.8	1.6	0.6	1.8	5.5	<0.10 - 97
Barium	80	151	42	245	580	70 - 5,000
Cadmium	<0.5	<0.5	<0.5	<0.6	not applicable	not applicable
Chromium	9.3	14	12	18	41	3 - 2,000
Copper	5.2	9.2	4.9	12	21	2 - 300
Iron	10,600 (1.06%)	13,700 (1.37%)	11,300 (1.13%)	16,800 (1.68%)	2.1% (or 21,000 ppm)	0.1 - >10
Lead	15	29	16	46	17	<10 - 700
Mercury	0.022	0.030	<0.02	0.028	0.046	<0.01 - 4.6
Nickel	5.7	7.7	6.1	8.8	15	<5 - 700
Selenium	<0.9	<1.1	<1.0	<0.9	0.23	<0.1 - 4.3
Silver	<1.0	<0.9	<0.9	<0.9	not applicable	not applicable
Zinc	42	53	30	74	55	10 - 2,100
Semivolatile Organic Compounds all constituents below the detection limit except					Health Assessment Comparison Values	
Phenanthrene	0.5	1.8	0.6	<3	none available	
Fluoranthene	1.6	3.5	0.8	<3	80/2,000/30,000 RMEG	
Pyrene	1.2	2.6	0.6	<3	60/2,000/20,000 RMEG	
Benzo(a)anthracene	0.6	1.2	BQL	<3	none available B2	
Chrysene	0.7	1.4	BQL	<3	none available B2	
Bis(2-ethylhexyl)phthalate	BQL	BQL	<0.05	<3	50 CREG B2; 40/1,000/10,000 RMEG	
Benzo(b)fluoranthene	0.6	1.1	BQL	<3	none available B2	
Benzo(k)fluoranthene	0.6	1.2	BQL	<3	none available B2	
Indeno(1,2,3-cd)pyrene	BQL	0.5	<0.5	<3	none available B2	
Benzo(ghi)perylene	BQL	0.5	<0.5	<3	none available	
Acenaphthene	<0.5	BQL	<0.5	<3	100/3,000/40,000 RMEG	
Anthracene	<0.5	BQL	BQL	<3	600/20,000/200,000 RMEG	
Carbazole	not detected	0.3	not detected	not detected	none available	
Benzo(j)fluoranthene	not detected	0.4	not detected	not detected	none available	
Benzo(e)pyrene	not detected	0.6	not detected	not detected	none available	
Octodecanal	not detected	0.4	not detected	not detected	none available	
Hexyleicosone	not detected	0.9	not detected	not detected	none available	
Benzo(a)pyrene	not detected	<0.5	BQL	<3	0.1 CREG B2	
Pesticides	none detected	none detected	none detected	none detected	not applicable	

milligram per kilogram (mg/kg) = parts per million (ppm) BQL - Reported at Below Quantitation Limits RMEG - Reference dose based Media Evaluation Guide
† U.S. Geological Survey 1984 CREG - Cancer Risk Evaluation Guide

Table 5. Metals Concentrations (mg/kg) in Surface Soil Samples Hector A. Garcia Park 1998 (Figure 4)

Sample location	HB-1 Field north of school and west of swimming pool	HB-2 West of swimming pool entrance	HB-3 Play area across from pool entrance	HB-4 Field, top of hill, north of school	HB-5 Greenwood Ball Park, next to yellow dugout	HB-6 Greenwood Ball Park, next to blue dugout	Background soil concentration for western United States†	
							Average	Range
Arsenic	4.55	3.22	0.607	2.69	0.798	0.873	5.5	<0.10 - 97
Barium	261	227	79.9	125	46.9	23	580	70 - 5,000
Beryllium	0.914	1	0.667	0.718	0.344	0.179	0.68	<1 - 15
Cadmium	<1	<1	<1	<1	<1	<1	Not applicable	Not applicable
Chromium	14.9	20.2	7.89	12.7	9.18	9.66	41	3 - 2,000
Cobalt	7.84	7.45	3.94	4.86	<2.5	<2.5	7.1	<3 - 50
Copper	9.36	8.29	4.21	7.09	3.82	2.56	21	2 - 300
Iron	12,200	13,200	7,480	9,140	6,830	5,540	2.1% (or 21,000 mg/kg)	0.1 - >10%
Lead	31	16.6	15.2	28.6	9.1	19.4	17* (400 mg/kg EPA Action Level)	<10 - 700
Magnesium	5,400	5,740	2,340	4,940	2,230	1,240	0.74% (7,400 mg/kg)	0.03 - >10%
Nickel	12.1	10.8	6.85	8.15	4.38	<2.5	15	<5 - 700
Silver	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	Not applicable	Not applicable
Vanadium	17.3	17.8	4.98	10.2	12.4	8.73	70	7 - 500
Zinc	43.6	51.3	27.2	47	73.6	173	55	10 - 2,100

† U.S. Geological Survey 1984

++ chronic exposure to lead concentrations below 400 mg/kg are not likely to result in adverse health effects

Table 6. TNRCC Soil Gas Sampling Results (ppb$_v$)Exceeding ATSDR Health Assessment Comparison Values Chula Vista and Greenwood Landfills September 22, 2000							
Compound	Chula Vista/Cunningham Landfill			Greenwood Landfill/Villarreal Pit		Open Field	Health Assessment Comparison Values
	CV922001	CV929001	CV929002	GW922001	GW922002	OF922001	
Benzene	0.7	0.3	0.62	0.56	0.42	1.1	0.03 CREG*; 4 intEMEG**
1,3-Butadiene	ND	ND	0.43	0.67	0.76	1.6	0.001808 CREG†
Chloroform	0.48	0.48	0.14J	ND	ND	0.31	0.00819 CREG† 20 chrEMEG**

* CREG - Cancer Risk Evaluation Guide are based on EPA's chemical specific cancer slope factors and an estimated excess lifetime cancer risk of one-in-one million persons exposed for a lifetime.
** intEMEG and chrEMEGs - are intermediate and chronic Environmental Media Evaluation Guide based on ATSDR's minimal risk levels. Minimal Risk Levels are estimates of a daily exposure to a contaminant that is unlikely to cause adverse non-cancer health effects.
† The CREG value was converted from micrograms per cubic meter to parts per billion (ppb_v) so that it could be readily compared to the site measurements.