Health Consultation

Hydrogen Sulfide in Ambient Air

COYOTE CONSTRUCTION AND DEMOLITION DEBRIS LANDFILL

HOLLEY NAVARRE, SANTA ROSA COUNTY, FLORIDA

SEPTEMBER 30, 2008

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

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HEALTH CONSULTATION

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HOLLEY NAVARRE, SANTA ROSA COUNTY, FLORIDA

Prepared By:

Florida Department of Health
Bureau of Community Environmental Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Summary

In this report, the Florida Department of Health (DOH) reviews hydrogen sulfide air levels near the Coyote Landfill. Between late January and early March 2007, the Santa Rosa County Health Department (CHD) tested the air outside one home just south of this landfill and requested Florida DOH review the results.

After the 2004 and 2005 hurricanes, the Coyote Landfill accepted large volumes of construction and demolition debris including drywall (also known as wallboard or sheet rock). When drywall and other landfill wastes decompose, they generate odors and gases. Decomposing drywall produces hydrogen sulfide gas, which has a characteristic "rotten egg" odor. Because landfill decomposition produces heat, hydrogen sulfide and other landfill gasses can ignite resulting in frequent surface and sub-surface fires.

In July and August 2006, Santa Rosa CHD staff surveyed over 200 residents living within 2 miles of the Coyote Landfill for signs of illness. People closer to the landfill complained more often of respiratory problems, eye/nose/throat irritation, headaches, nausea and other symptoms. Residents associated these symptoms with landfill odors and with smoke and odors from the October and November 2005 surface fires, which were reported to cause more and greater symptoms. Santa Rosa CHD staff advised residents with respiratory symptoms to seek medical care, remain indoors, or leave the area if their symptoms became intolerable. They also supplied hydrogen sulfide indoor air filters to 23 nearby residents. A group of concerned citizens, the Holley Action Group, applied for a grant to buy 24 air filters for residences. According to the group, these air filters were not available until two years after residents had begun complaining of hydrogen sulfide exposures. The Florida DOH bought 10 additional air filters in December 2007, which the Holley Action Group distributed to homes with small children or senior citizens with health problems.

The Florida DOH classifies past and current exposures to air near the Coyote Landfill as a "public health hazard". Concentrations of hydrogen sulfide measured in the air south of the Coyote Landfill between January 29 and March 2, 2007 could have adversely affected children with respiratory-diseases and could have caused eye irritation, nasal irritation, cough, breathlessness/wheezing, and headaches in children and adults. Although levels of air-borne particulates (smoke) from the landfill fires were not measured at that time, smoke could also have aggravated symptoms in people with preexisting respiratory conditions.

Studies comparing communities near paper mills, refineries and animal feedlots that emit hydrogen sulfide along with other chemicals, with communities that do not smell hydrogen sulfide and other odors have shown significantly higher rates of psychological symptoms such as tension, depression, and fatigue in the odor-exposed groups than in the control groups. The Protocol for Assessing Community Excellence in Environmental Health (PACE-EH) informal community health survey showed 20 to 30 % of the survey respondents had symptoms of fatigue, restlessness, and sleeplessness, and between 11 and 18% reported dizziness, inability to concentrate, nervousness, and feelings of confusion.

The Florida DOH recommends:

- Reducing residential exposures to hydrogen sulfide from the Coyote Landfill as soon as possible. Nearby residents should report any odors or smoke to Santa

Rosa CHD and Florida Department of Environmental Protection (DEP), Northwest District Office.

- Continuing real-time monitoring for hydrogen sulfide around Coyote Landfill to ensure levels are below those of public health concern. If site perimeter values exceed those of public health concern, a contingency plan should be developed for monitoring in residential areas and stopping the source of hydrogen sulfide emissions. Nearby residents should stay inside or leave the area based on the level of irritation or symptoms they are experiencing due to hydrogen sulfide exposure. Persons who feel ill, especially those with persistent symptoms, should see their doctors. They should tell their doctors about any concerns they might have about environmental exposures.
- Reducing the threat of landfill fires and other sources of odors or chemical releases.
- Continuing to restrict landfill access.

According to recent Florida Department of Environmental Protection (DEP) site inspection reports, the Coyote Landfill operators moved debris from surface water, covered smoldering areas with soil, and have begun covering the active dumping areas (working faces) with soil on a weekly basis.

Purpose

The Florida Department of Health (DOH) evaluates the public health significance of environmental contamination sources through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). Florida DOH evaluated hydrogen sulfide air monitoring data collected by the Santa Rosa County Health Department (CHD) at the Coyote Landfill in Holley-Navarre. This report evaluates the potential for hydrogen sulfide emissions from the landfill to affect the health of nearby residents based on the results of hydrogen sulfide monitoring from January 29, 2007 to March 2, 2007. U.S. Environmental Protection Agency conducted subsequent residential air sampling for hydrogen sulfide in November/December 2007 and January/February 2008. These data have been evaluated by Florida DOH. The results are similar to those found with the data collected by the CHD. Florida DOH will release a separate health consultation about the more recent data.

Background

Coyote Landfill occupies 37 acres at 3201 Five Forks Road, in a rural area off Avery Olsen Road north of Navarre, Santa Rosa County, Florida (Figure 1). Eighteen acres of the site were developed as a borrow pit prior to 1980 (Brown, Burdine & Associates 2006). The Florida Department of Environmental Protection (DEP) permitted those 18 acres as a construction and demolition debris landfill beginning in 1987. In 1998, site debris occupied about 6 acres, and K&K Construction Group permitted the site as Kevin Jernigan C&D Landfill, Inc. Coyote Land Company purchased the 18.8-acre landfill site in 2001 and applied for a transfer of the prior C&D permit. Coyote purchased 19 adjacent acres to complete the acreage of the present property and expanded the permit for the landfill to include the entire property in 2004.

In 2000, over 300 people lived within a 1-mile radius of the landfill. Approximately 95 % were white, and 5 % percent were American Indians, Hispanics, or Asians. Much of the area is rural

and housing density is higher near State Road 87, two-tenths of a mile south of the southern tip of the site.

Construction and demolition debris includes concrete, asphalt, wood, metal, drywall (also known as wallboard or sheet rock) and roofing material from construction, renovation or demolition of structures. Coyote Landfill received a large volume of debris following hurricanes in 2004 and 2005. The debris included water-damaged drywall from homes and businesses. After rains saturated the lower levels of this landfill, anaerobic bacteria converted the sulfate in the drywall into hydrogen sulfide gas.† Rain also displaced hydrogen sulfide gases produced in the landfill causing it to escape into the air around the landfill. Hydrogen sulfide gas has a characteristic "rotten egg" smell.

The processes that form hydrogen sulfide and methane are exothermic (produce heat). Hydrogen sulfide and methane are flammable gases and depending on concentrations in air, it can result in landfill fires. The lower explosive limits of hydrogen sulfide by percent volume of air are 4.0 to 4.3%, and the upper limit is 46%; for methane, the lower explosive limit is 5% and the upper is 15%. A fire burned in the Coyote Landfill in June 2000. Another fire burned in October 2005. It is unclear from the available records whether fires were completely extinguished after that time.

Decomposition in construction and demolition landfills can also generate sulfur gases other than hydrogen sulfide. Many of these other sulfur gases have a strong smell. In addition to hydrogen sulfide in soil gas (3-12,000,000 parts per billion) and in outdoor air (3-50,000 parts per billion), the University of Florida researchers found the following sulfur gases in the soil gas at 10 different Florida construction and demolition landfills (Lee et al. 2006).

Table 1. Sulfur Gases in Soil Gas at 10 Florida Construction and Demolition Landfills

Sulfur Gases	Range Detected (ppb)
carbonyl sulfide	BDL to 61,000
methyl mercaptan	BDL to 164,000
dimethyl sulfide	BDL to 2,100
ethyl mercaptan	BDL to 200
carbon disulfide	BDL to 91,000
isopropyl mercaptan	BDL to 2,800
butyl mercaptans	BDL to 200
thiophene	BDL to 100
2- and 3-methylthiophene	BDL to 400

ppb = parts per billion **BDL = below detection limit**

†Hydrogen sulfide gas is poisonous, colorless gas. People can begin to smell hydrogen sulfide at 1 to 300 parts per billion. Human and animal studies suggest the respiratory tract and nervous system are the most sensitive to hydrogen sulfide toxicity. In addition to landfill debris, anaerobic bacteria often produce hydrogen sulfide from other sources including sewage treatment plants and manure from animal feed lots. Hydrogen sulfide may be a component of the buried organic materials that produce oil reserves and natural gas, or may originate from pulp and paper mill effluent/exhaust, water from sulfur springs and swamps, or from volcanic and geothermal activity. Sulfate-reducing bacteria need sulfate, carbon, anaerobic conditions (no oxygen), moisture, a pH between 6 and 9 (slightly alkaline), and temperatures between 68 to 102 degrees Fahrenheit to produce hydrogen sulfide. Either one of the following processes reduces sulfate into hydrogen sulfide, depending on the kind of bacteria involved:

- $2(CH_2O\text{-}R) + SO_4^{2-} \rightarrow 2(HCO_3^-) + H_2S + 2R$,
- $S0_4^{2-} \rightarrow S032^- \rightarrow S3062^- \rightarrow S2032^- \rightarrow S^{2-}$,
- $S^{2-} + H^+ \leftrightarrow HS$
- $HS^- + H^+ \leftrightarrow H_2S$

Coyote Landfill management practices and conditions may have intensified the production of hydrogen sulfide and other reduced sulfide gases. Specific site practices and conditions include lack of covering the debris, lack of collection of surface water in the debris pile, pH of the waste, and fire history (Durno et al. 2006, Appendix 4).

In the fall of 2005, the Santa Rosa CHD received numerous health complaints from residents living near the landfill. They were concerned about smoke and rotten egg and other odors coming from the landfill. They complained of respiratory problems, eye, nose and throat irritation, headaches, and nausea.

In July 2006, Florida DEP fined Coyote Landfill for open burning, objectionable smoke and odors, debris in contact with water, failure to maintain a small working face, and failure to provide weekly cover. Coyote Landfill has corrected some of these violations; although, the landfill still emits objectionable odors, and community members state there is no evidence they have removed all the debris from contact with water.

According to recent Florida Department of Environmental Protection (DEP) site inspection reports, the Coyote Landfill operators moved debris from surface water, covered smoldering areas with soil, and have begun covering the active dumping areas (working faces) with soil on a weekly basis. Santa Rosa County Health Department staff reported fewer odor complaints in June and July 2007. Based on recent discussions with a local community group (Holley Action Group or HAG), numerous odor and health complaints continue in the area [personal communication, 8/20/07 (FDOH) and 8/27/07 (ATSDR)].

Florida DEP has alerted the landfill owner of possible violations of law for which he may be responsible in a January 14, 2008 letter. That letter is part of an agency investigation, preliminary to agency action, to resolve objectionable odors emissions from the site. This letter advised the owner that materials that are impermeable to water have helped allay hydrogen sulfide odors at another Santa Rosa County C&D landfill.

The Santa Rosa CHD has done extensive community outreach, with $15,000 from the County Commission, $10,000 from the Florida DOH Protocol for Assessing Community Excellence in Environmental Health (PACE-EH), and $25,000 from the Community Environmental Health Assistance Board (CEHAB).

Community Health Concerns

In July and August 2006, the Santa Rosa CHD PACE-EH Program and the Community Environmental Health Assessment Team (CEHAT) developed a health survey and an air pollution log. PACE-EH and CEHAT members distributed the surveys and logs door-to-door to homes near the site. Residents from 115 homes out of 200 surveyed returned usable surveys. Although adults (n=157) and children (n=83) reported smelling odors from the landfill, only the adults' symptoms were tallied. (http://www.doh.state.fl.us/ENVIRONMENT/programs/PACE-EH/PACE-EH_SantaRosa.htm).The average respondent was 47 years old and lived in the area 18 years. The frequency of symptoms was:

- 75% – coughing and/or congestion,
- 73% – burning eyes,
- 67% – difficulty breathing/respiratory issues,
- 67% – burning or scratchy throat,
- 64% – headaches,
- 63% – fatigue/restlessness,
- 57% – sleeplessness,

- 56% – sneezing problems,
- 52% – upset stomach,
- 49% – nose burning/bleeding,
- 46% – eyesight problems,
- 39% – dizziness,
- 36% – inability to concentrate,
- 33% – vocal problems,
- 31% – nervousness,
- 30% – feelings of confusion,
- 12% – ringing in ears, and
- 7% – other

Some residents reported difficulty breathing at night when the air was calm. Some had duct-taped their windows and doors and were unable to use their air-conditioners. Residents near the landfill reported more symptoms. The 43 residents less than a quarter mile from the site reported more than 10 symptoms on average. Most of the adults who reported symptoms gave the time of onset as after the October 2005 fires at the landfill. Although at the time of health survey, most reported their symptoms persisted and fewer complaints were reported in July and August after the landfill managers made changes recommended by Florida DEP (Santa Rosa CHD, personal communication, July 2007). Based on recent discussions with a local community group (Holley Action Group or HAG), numerous odor and health complaints continue in the area [personal communication, 8/20 (DFOH) and 8/27 (ATSDR)].

Florida DOH received various health concerns following an October 2007 mail-out to nearby residents. Many of these health concerns are similar to those recorded during the PACE Environmental Health Survey in 2006. Some additional concerns expressed during the 2007 comment period included skin problems, kidney failure, and heart problems. Also, a concern was raised about the health and development of children. Lastly, some of the residents had questions about drinking ground water and/or eating fish from a surface waterbody within the vicinity of Coyote Landfill that could possibly be contaminated with hydrogen sulfide.

Air Monitoring Methods

Between January 29 and March 2, 2007, the Santa Rosa CHD rented a Jerome 631-X continuous air-monitor (Appendix 3), and deployed it at a home south of the site (Figure 2). The stationary unit was mounted 4 feet off the ground outside the residence. This factory-calibrated meter has an accuracy of about 6% and a precision of about 5% (Arizona Instruments, 2007). This meter, however, does not detect other reduced sulfur gases known to occur with hydrogen sulfide at landfills. Jerome Communications Interface (JCI) software allowed unattended air monitoring and daily/weekly data transfer.

Results

Table 2 summarizes the number of hours that hydrogen sulfide was detected above various guidance values, listed in the column headings.

Table 2. Outdoor Hydrogen Sulfide Air Sampling Results (ppb = part of hydrogen sulfide per billion parts of air, by volume)

Sample Location(Figure 2)	Total Number of Hours Tested	Number of hours ≥1 ppb	Number of hours > 20 ppb	Number of hours >30 ppb (for 30 minutes)	Number of hours > 70 ppb	Number of hours >100 ppb
South of Landfill	**764 (32 days)**	**652 (27 days)**	**101**	**73**	**39**	**27**

- 1.4 ppb is the EPA Integrated Risk Integration System reference concentration for long-term exposure (RfC = 2 mg/m^3).
- 20 ppb is the ATSDR Intermediate (14-364 days) Minimum Risk Level (ATSDR 2006).
- 30 ppb (for 30 minutes) is a level associated with increased unplanned hospital visits for children with respiratory-related symptoms, (Campagna et al. 2007).
- 70 ppb is the ATSDR Acute (1-13 days) Minimum Risk Level (ATSDR 2006).
- 100 ppb is the American Industrial Hygiene Association's Emergency Response Preparedness Guideline-1 (ERPG-1), a level to which most persons could be exposed to for up to one hour without experiencing a clearly objectionable odor. ERPGs are meant for use as guidelines for evacuation due to chemical emergency incidents.

Table 3 summarizes the daily average hydrogen sulfide air concentrations. Daily average concentrations were calculated using all the daily results (including "zeros", meaning those intervals when no hydrogen sulfide was measured) for each location.

Table 3. Listings of the Hydrogen Sulfide Results for days when either the daily average was greater than 4 ppb or the daily maximum was greater than 70 ppb

Date	Daily Average Hydrogen Sulfide Air Concentration (ppb[+])	Daily Maximum Hydrogen Sulfide Air Concentration (ppb)	Time of maximum hydrogen sulfide concentration
1/29/2007	22.8	115	10:30 pm
1/30/2007	7.6	88	12:00 pm
2/3/2007	6.6	110	12:45 pm
2/4/2007	40.4[++]	> 233 (sensor saturated)	7:45-8:45 pm
2/5/2007	25.0	150	12:45 pm
2/6/2007	45.2[++]	> 233 (sensor saturated)	6:30-7:45 pm
2/7/2007	13.9	120	7:00 pm
2/8/2007	7.1	108	12:15 pm
2/9/2007	5.2	120	12:45 pm
2/10/2007	11.3	140	11:46 pm
2/11/2007	32.8	200	12:45 pm
2/12/2007	12.3[++]	> 233 (sensor saturated)	4:00-5:00 am
2/16/2007	23.4	200	10:45 pm
2/17/2007	30.7	190	1:45 am
2/18/2007	13.5	110	10:30 pm
2/19/2007	15.3	150	2:45 am
2/21/2007	7.5	130	9:45 pm
2/22/2007	5.7	34	8:15 pm
2/23/2007	11.9	120	1:00 am
2/25/2007	5.3	110	12:45 pm – 1:15 am
2/26/2007	12.9	110	3:00 am
2/27/2007	10.4	130	1:00 am
2/28/2007	8.4	140	3:00 am
3/1/2007	2.9	110	1:00 am

[+]ppb = parts hydrogen sulfide per billion parts of air, by volume

[++]the daily average value is likely underestimated due to instrument saturation. Since the daily maximum values could have exceeded the 233 ppb value, the daily average could have been higher as well.

Discussion

Florida DOH compared the measured hydrogen sulfide air concentrations with concentrations known to cause symptoms or illness. Medical reports and animal studies show that breathing hydrogen sulfide can cause symptoms and illness, depending on the concentrations and length of exposure. Acute or short-term exposures last less than 14 days. Intermediate exposures last between 14 and 364 days. Chronic exposures last for more than a year.

Pathways analysis

Florida DOH determines exposure to environmental contamination by identifying exposure pathways. An exposure pathway is generally classified by environmental medium (e.g., water, soil, air, food). A completed exposure pathway consists of five elements: a source of contamination; transport through an environmental medium, a point of exposure, a route of exposure, and a receptor population. A completed exposure pathway exists when people are actually exposed through ingestion or inhalation of, or by skin contact with a contaminated medium.

In completed exposure pathways, all five elements exist, and exposure to a contaminant has occurred in the past, is occurring, or will occur in the future. In potential exposure pathways, at least one of the five elements is not clearly defined, but could exist. Therefore, exposure seems possible. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring, or could occur in the future. However, key information regarding a potential pathway may not be available. It should be noted that the identification of a completed or potential exposure pathway does not necessarily result in human health effects. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present.

Florida DOH reviewed the site history, community concerns, and available environmental sampling data. We identified exposure to hydrogen sulfide in outdoor (ambient) air as a completed exposure pathway. Nearby residents likely breathed hydrogen sulfide and other sulfur gases from the Coyote Landfill. The highest hydrogen sulfide concentrations occurred at night, which is a typical pattern with emission of a contaminate that is heavier than air. From late evening to early morning there is usually very little wind. Hydrogen sulfide will not disperse into the atmosphere.

Santa Rosa CHD staff have addressed the groundwater exposure pathway. They confirmed that residents are using municipal water for drinking. Santa Rosa CHD staff have instructed residents not to use water from contaminated irrigation wells for livestock, pets, or swimming pools (Bill Sirmans, Santa Rosa County Health Department Environmental Health Administrator, personal communication, July 2007).

Comparison of results to guidelines

Florida DOH uses ATSDR Minimum risk levels (MRLs) to screen test data for further evaluation. MRLs are contaminant concentrations at which exposures are unlikely to cause non-cancer health effects over a specified duration of exposure. MRLs include ample safety factors to ensure protection of sensitive human populations. Therefore, levels below an MRL are unlikely to cause illness. Levels above an MRL warrant further evaluation. Because of built-in safety factors, exposure to a concentration above an MRL does not necessarily cause symptoms or illness.

Uncertainties with the derivation of MRLs are associated with their application over a less than lifetime duration or for health effects that are delayed in development or are acquired following repeated acute insults, such as hypersensitivity reactions, asthma, or chronic bronchitis. As these kinds of health effects data become available and methods to assess levels of significant human exposure improve, ATSDR revises their MRLs.

The ATSDR MRL for hydrogen sulfide is 70 parts per billion (ppb) for short-term (acute) exposures (less than 14 days). This short-term (acute) MRL is based on a study in which 2 of 10 asthmatics exposed to 2,000 ppb hydrogen sulfide for 30 minutes experienced apparent bronchial obstruction (Jappinen et al. 1990). This MRL includes a safety factor of 27 (3 for the use of a minimum Lowest Observed Adverse Effect Level, 3 for human variability, and 3 for database deficiencies). Hydrogen sulfide levels near the Coyote Landfill exceeded the short-term MRL.

The ATSDR MRL for hydrogen sulfide is 20 ppb for intermediate length (14-364 days) exposures. The intermediate hydrogen sulfide MRLs is based on a no observable adverse effect level (NOAEL) in an animal study that showed olfactory neuron (nose nerve) loss and basal cell hyperplasia (increase in the number of cells on the inside covering of the nose - Brenneman et al. 2000). Hydrogen sulfide levels exceeded the intermediate length MRL (Table 2).

Although Florida does not have an air standard or guideline for hydrogen sulfide, test levels exceeded the following standards and guidelines established in other states.

State	*Exposure Length*	*Description*	*Concentration*	*Source*
Arizona	1 hour	(Ambient Air Quality Guideline)	45 ppb	Arizona DEQ 2005
	24 hours	(Ambient Air Quality Guideline)	27 ppb	Arizona DEQ 2005
California	1-hour average	(Ambient Air Quality Standard)	30 ppb	CalEPA 2005
Delaware	3-min. average	(Ambient Air Quality Standard)	60 ppb	Delaware DNREC 2005
	1-hour average	(Ambient Air Quality Standard)	30 ppb	Delaware DNREC 2005
Minnesota	30-min. average	(Ambient Air Quality Standard) not to be exceeded over two times a year	50 ppb	Minnesota PCA 2004
	30-min. average	(Ambient Air Quality Standard) not to be exceeded over two times in any five consecutive days	30 ppb	Minnesota PCA 2004
Missouri	30-min. average	(Ambient Air Quality Monitoring Yearly Standard)	50 ppb	Missouri DNR 2004
Montana	1-hour average	(Ambient Air Quality Standard) not to be exceeded over once a year	50 ppb	Montana DEQ 2004
Nevada	1-hour average	(Ambient Air Quality Standard)	80 ppb	Nevada DEP 2005
New York	1-hour average	(Ambient Air Quality Standard)	10 ppb	New York DEC 2005

(Source: ATSDR 2006)

Health effects from breathing hydrogen sulfide

A person is primarily exposed to hydrogen sulfide through inhalation. Ingestion and absorption through the skin can also occur; however, these exposure routes contribute only small amounts to the overall body burden. Depending on the concentration in the air, hydrogen sulfide can affect

the eyes, lungs, and nervous system (ATSDR 2006). Hydrogen sulfide irritates the eyes, nose, and throat by forming sodium sulfide which raises the pH (caustic or basic). Once inhaled, hydrogen sulfide can enter the blood stream by diffusion through the lungs. Most of the hydrogen sulfide in the blood is oxidized to sulfates (primarily thiosulfate) by the liver and excreted in the urine. People with cardiac or nervous system disorders, people with pre-existing respiratory problems (asthma, restrictive lung disease, etc.), the very young, and the elderly are more sensitive to hydrogen sulfide (ATSDR 2006).

30-minute periods when hydrogen sulfide air concentrations exceeded 30 ppb

A study of children in Nebraska found an association with respiratory-related hospital visits after episodes when hydrogen sulfide concentrations were above 30 parts per billion (ppb) for longer than 30 minutes the previous day (Campagna et al. 2004). The hydrogen sulfide concentration at the monitoring site south of the Coyote landfill reached 30 ppb (or higher) for 30 minutes (or longer) on two-thirds (22/32) of the days tested.

Health effects from breathing smoke

Landfill fires can emit gases and fine particles (smoke) into the air. When landfill fire are at their worst, smoke inhalation affects most people. However, even minor fires can affect people with respiratory disease, lung disease, asthma, and certain cardiovascular problems. The amount of smoke (fine particles) near the Coyote Landfill during fire events has not been measured.

Other hazards

In addition to hydrogen sulfide, other reduced sulfur gases typically found at construction and demolition landfills may be present at this landfill. These other sulfur gases have odor thresholds and toxicities similar to hydrogen sulfide. The meter used to monitor the air near the Coyote Landfill was unable to detect or measure these other sulfur gases.

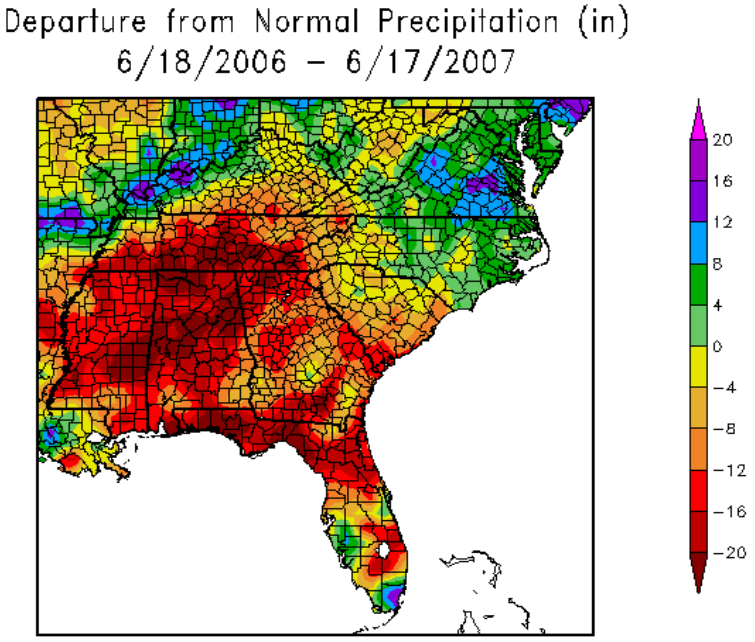
Because hydrogen sulfide and other landfill gases are flammable; heavy equipment, smoking, and other ignition sources could reignite fires.

The Coyote Landfill is gated and fenced to control vehicular access and to deter access by foot. Injury from falling, tripping, or being cut by debris could be hazards for trespassers.

Limitations

Air quality data evaluated for this report reflect only a short, 32 day duration (January 29, 2007 to March 2, 2007), at one location south of Coyote Landfill. Air sampling conducted at only one monitoring location south of the site may not represent all areas around the site. The results cannot be used to determine “worst case” exposures, the frequency of worst-case exposures, or to represent “typical” ambient air hydrogen sulfide concentrations.

While air monitoring was conducted for 1 month, the concentrations of hydrogen sulfide in the air near the landfill before and after the testing could have been higher or lower. During a 12-month period in which the early '07 air monitoring occurred, the rainfall in this part of Florida was 20" below normal (NOAA 2007). A return to more normal rainfall levels could enhance conditions favorable to hydrogen sulfide production.



Child Health Considerations

ATSDR and FDOH recognize that the unique vulnerabilities of infants and children demand special attention (ATSDR 2005a). Children can be at a greater risk for exposure to hydrogen sulfide than adults might be, because their breathing zone is closer to the ground and they may spend more time playing out-of-doors. Because children are smaller than adults are, their exposures can result in higher doses of the chemical per body weight. If toxic exposures occur during critical growth stages, the developing body systems of children can sustain permanent damage. Probably most important, however, is that children depend on adults for risk identification and risk management, hygiene awareness, and access to medical care. Thus, adults should be aware of public health risks in their community, so they can guide their children accordingly. In recognition of these concerns, ATSDR developed the chemical screening values for children's exposures that FDOH used in preparing this report.

Children are likely exposed to hydrogen sulfide in a similar manner as adults, excluding adults that work around the chemical. However, children may be exposed to more hydrogen sulfide because it is heavier than air and children are shorter than adults. There is little information on possible health problems in children who are exposed to hydrogen sulfide. Exposed children will probably experience effects similar to those of exposed adults. Whether children are more sensitive to hydrogen sulfide than adults is not known. Animal studies have shown that exposure to low concentrations of hydrogen sulfide during pregnancy does not cause birth defects (ATSDR 2006).

Other susceptible populations may have different or enhanced responses to toxic chemicals than will most persons exposed to the same levels of that chemical in the environment. Reasons may include genetic makeup, age, pre-existing medical conditions, nutritional status, and exposure to other toxic substances (like cigarette smoke or alcohol). These factors may limit a susceptible

person's ability to detoxify or excrete harmful chemicals or may increase the effects of damage to their organs or systems.

Conclusions

The Florida Department of Health (DOH) classifies the air south of the Coyote Landfill as a past and current "Public Health Hazard". Florida DOH bases this public health assessment category on hydrogen sulfide concentrations measured between late January and early March 2007 by the Santa Rosa County Health Department (CHD).

1. Concentrations of hydrogen sulfide measured in the air south of the Coyote Landfill from January 29, 2007 to March 2, 2007 were above concentrations known to adversely affect community members with pre-existing respiratory problems. Exposures to these levels can also result in eye irritation, nasal irritation, cough, breathlessness/wheezing, and headaches. We do not have measured particulate levels for past exposures when the landfill was on fire. Nevertheless, the Santa Rosa County Protocol for Excellence in Environmental Health (PACE) survey found burning or scratchy throats in persons without pre-existing respiratory problems. More than 20% of the community adults surveyed also reported fatigue, restlessness, sleeplessness, sneezing problems, upset stomachs, bleeding or burning noses, and eyesight problems. These symptoms are consistent with hydrogen sulfide exposure.

2. The Coyote Landfill likely continues to emit hydrogen sulfide gas. Past measurements collected south of the landfill showed levels associated with adverse health effects with short-term exposures. Community members continue to report odors and adverse health affects.

3. Although levels of air-borne particulates (smoke) from the landfill fires have not been measured, smoke can aggravate symptoms in nearby residents with preexisting respiratory conditions. Other hazards from the landfill include the potential for re-ignition and additional exposures.

4. Injury from falling, tripping, or being cut by debris are hazards for trespassers on the Coyote Landfill.

Recommendations

1. Reduce residential exposures to hydrogen sulfide from the Coyote Landfill as soon as possible. Community members should report odors or smoke coming from the landfill to the Santa Rosa County Health Department and Florida DEP, Northwest District Office.

2. Continue real-time monitoring for hydrogen sulfide gas around the Coyote Landfill until verification that on-site remedies have reduced emissions below those of public health concern. If site perimeter values exceed those of public health concern, develop a contingency plan to monitor in residential areas and stop the source of hydrogen sulfide emissions. Nearby residents should stay inside or leave the area based on the level of irritation or symptoms they are experiencing due to hydrogen sulfide exposure. Residents who feel ill, especially those with persistent symptoms, should see their health care providers. They should tell their doctors about any concerns they might have about environmental exposures.

3. Reduce the threat of landfill fires and other sources of odors or chemical releases.

4. Continue to restrict access to the landfill.

Public Health Action Plan

1. To reduce exposures to hydrogen sulfide from the Coyote Landfill, the Santa Rosa County Health Department used PACE-EH grant funds to purchase 23 air scrubbers for residents to use in their homes. Florida DOH purchased an additional 10 air filters with ATSDR grant funds in December 2007. These scrubbers are able to remove hydrogen sulfide from indoor air in 30 to 60 minutes.

2. Based on the air quality results from 9 pairs of monitors installed by the U.S. EPA from November 21 to December 21, 2007 and January 14 to February 13, 2008, Florida DEP is requiring the Coyote Landfill owner eliminate odors and hydrogen sulfide emissions.

3. Florida DOH has reviewed the EPA sampling results above and will provide a public health evaluation in the near future.

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References

Agency for Toxic Substances and Disease Registry. ATSDR Hydrogen Sulfide (H2S) CAS 7783-0604; UN 1053. Available at: http://www.atsdr.cdc.gov/MHMI/mmg114.pdf. Accessed on December 17, 2006.

Agency for Toxic Substances and Disease Registry. ATSDR landfill gas primer an overview for environmental health professionals chapter 3 landfill gas basics. Available at: http://www.atsdr.cdc.gov/HAC/landfill/PDFs/Landfill_2001_ch3.pdf Accessed on December 17, 2006.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2006. Toxicological Profile for hydrogen sulfide: U.S. Department of Health and Human Services, U.S. Public Health Service. July 2006.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2002. Agency for Toxic Substances and Disease Registry Health Consultation: Hydrogen Sulfide Exposure, Warren Township, Trumball County, OH. September 12, 2002.

[AIHA] American Industrial Hygiene Association.1991. Emergency response planning guidelines: Hydrogen sulfide. Fairfax, VA.

Brenneman KA, James RA, Gross EA, et al. 2000. Olfactory neuron loss in adult male CD rats following acute inhalation exposure to hydrogen sulfide: Reversibility and the possible role of regional metabolism. Toxicol Pathol 30(2):200-208

Brown, Burdine, and Associates, LLC. 2006. Site Assessment Report, Coyote Navvarre C&D Debris Disposal Facility. Navarre, Santa Rosa Co. Florida.// FDEP File # 0005651-004-50

Bureau of the Census. 2000. LandView 5 Software on DVD, A Viewer for EPA, Census and USGS Data and Maps. U.S. Department of Commerce.

Campagna D, Kathman SJ, Pierson R., et al. 2004. Ambient hydrogen sulfide, total reduced sulfur and hospital visits for respiratory diseases in northeast Nebraska, 1988-2000. J Expo Anal Environ Epidemiol 14(2): 180-187.

Durno M. Mendoza, RC, Tolaymat T. 2006. Management practices to prevent and control hydrogen sulfide gas emissions at C&D debris landfills which dispose of pulverized gypsum debris in Ohio. Letter from USEPA Region 5 Superfund Division to Ohio State Environmental Protection Agency.

[EPA] United States Environmental Protection Agency. 1994b. Methods for derivation of inhalation reference concentrations and application of inhalation dosimetry. U.S. Environmental Protection Agency. EPA600890066F.

Inserra S, Phifer B, Pierson R, Campagna D. 2002. Community-based exposure estimate for hydrogen sulfide. Journal of Exposure Analysis and Environmental Epidemiology. 12 (124-129).

Jaakkola P, Vilkka V, Marttila O, Haahtela T. 1990. The South Karelia air pollution study. The effects of malodorous sulfur compounds from pulp mills on respiratory and other symptoms Am Rev Respir Dis 142:1344-1350.

Lee S, Xu Q, Booth M, Townsend T, Chadik P, Bitton G. 2006. Reduced sulfur compounds in gas from construction and demolition debris landfills. Waste Management. 26(526-533).

NOAA 2006. National Oceanographic and Atmospheric Administration maps at http://hprcc.unl.edu/products/current.php.

National Institute for Occupational Safety and Health. 2005. Hydrogen sulfide. National Institute for Occupational Safety and Health pocket guide to chemical hazards. Washington, DC: National Institute for Occupational Safety and Health. http://www.cdc.gov/niosh/npg/npgd0337.html accessed April 9, 2007.

Reinhart D, Townsend T. 2003. State University System of Florida, Florida Center for Solid and Hazardous Waste Management. Gypsum drywall impacts on odor production at landfills: Science and control strategies. December 2000 (updated August 2003). Report #00-09.

Santa Rosa County Health Department PACE Project July – August 2006 Progress Report accessed 6/13/06 http://www.doh.state.fl.us/environment/programs/pace-eh/PACE-EH_SantaRosa.htm

Santa Rosa County Health Department data for Jerome 631-X sent by email 3/15/2007.

Figures

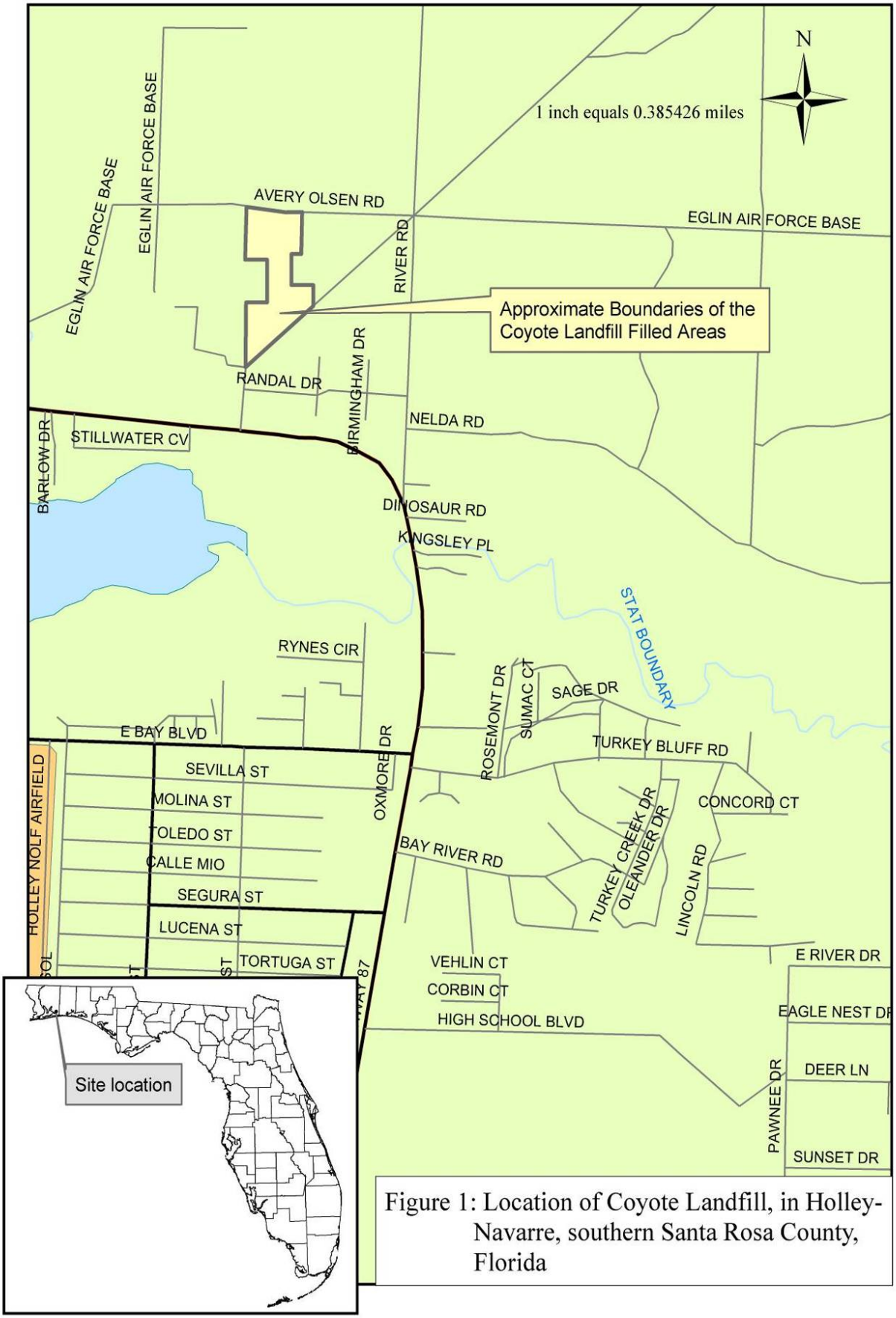


Figure 1: Location of Coyote Landfill, in Holley-Navarre, southern Santa Rosa County, Florida

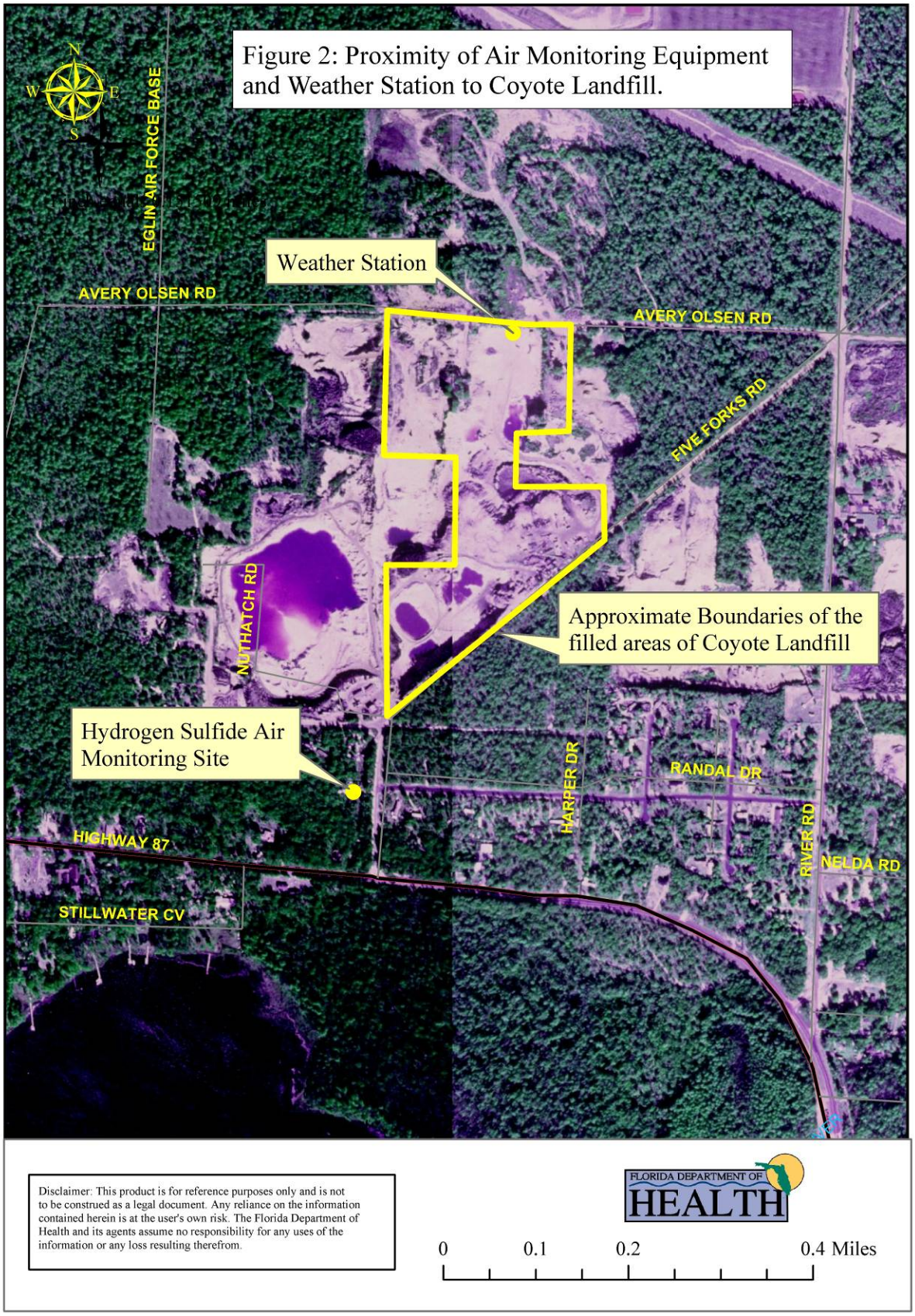
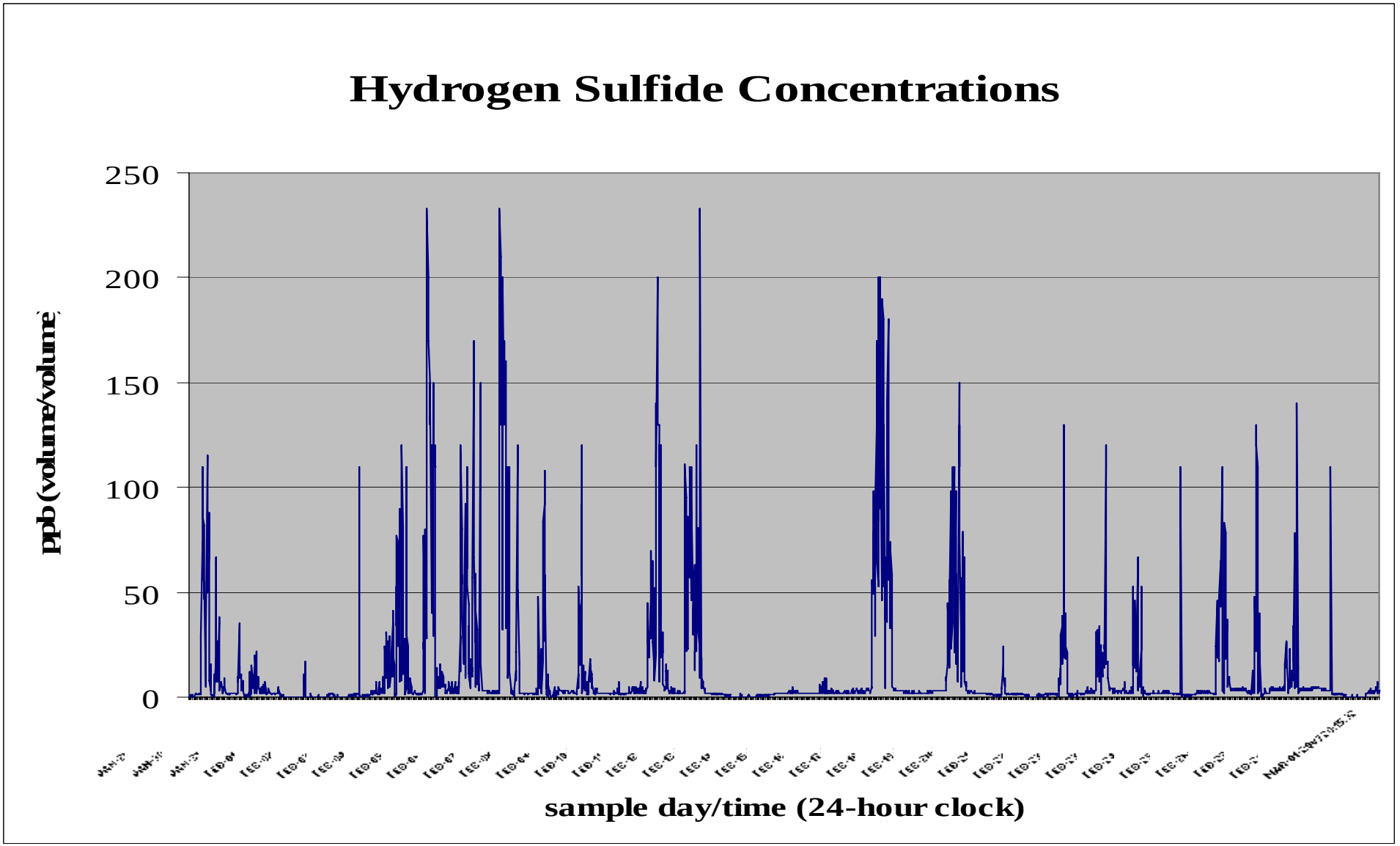


Figure 2: Proximity of Air Monitoring Equipment and Weather Station to Coyote Landfill.
N
W
E
S
EGLIN AIR FORCE BASE
Weather Station
AVERY OLSEN RD
AVERY OLSEN RD
FIVE FORKS RD
NUTHATCH RD
Approximate Boundaries of the filled areas of Coyote Landfill
Hydrogen Sulfide Air Monitoring Site
HARPER DR
RANDAL DR
RIVER RD
NELDA RD
HIGHWAY 87
STILLWATER CV
Disclaimer: This product is for reference purposes only and is not to be construed as a legal document. Any reliance on the information contained herein is at the user's own risk. The Florida Department of Health and its agents assume no responsibility for any uses of the information or any loss resulting therefrom.
FLORIDA DEPARTMENT OF HEALTH
0
0.1
0.2
0.4 Miles

Figure 3


Hydrogen Sulfide Concentrations
250
200
150
100
50
0
ppb (volume/volume
sample day/time (24-hour clock)

Appendices

Appendix 1

Existing Levels of Health Concern

The following exposure guidelines have been derived for hydrogen sulfide exposures by ATSDR and other government agencies and organizations. Note that occupational exposure values are not used for community exposure/health outcome assessments. Occupational values are provided for informational purposes and for short-term (10 to 15-minute ceiling values) comparisons that do not exist for environmental exposure scenarios.

Agency/Organization*	Exposure Value**	Exposure Period/Intent
EPA	1.4 ppb	RfC—an estimate of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime
WHO	14 ppb	Medium-term tolerable concentration—level at which exposure could occur for up to 90 days without appreciable risk of adverse health effects
ATSDR	0.07 ppm (70 ppb)	Acute Minimal Risk Level—value for up to 14 days of continuous exposure. Exposures below this value are not expected to result in non-cancerous adverse health effects
	0.02 ppm (20 ppb)	Intermediate Minimal Risk Level— value for longer than 14 to 364 days of exposure. Exposures below this value are not expected to result in non-cancerous adverse health effects.
NIOSH	100 ppm	IDLH –Based on the ability of a worker to escape an area w/out loss of life or irreversible health effects.
	10 ppm	Worker exposure- 40 hour work week; is also the 10 minute ceiling value
AIHA	0.1 ppm	ERPG-1—The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without perceiving a clearly defined objectionable odor.
	30 ppm	ERPG-2-The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without developing irreversible or other serious health effects that could impair ability to take protective action
ACGIH	10 ppm/ to 1 ppm	Worker exposure-40 hour work week, this guideline is currently on the ACGIH "notice of intended changes list" the new value will be **1 ppm**
	15 ppm/ to 5 ppm	Worker exposure-15 minute ceiling, this guideline is currently on the ACGIH "notice of intended changes list" the new value will be **5 ppm**

* EPA is the U.S. Environmental Protection Agency, ATSDR is the Agency for Toxic Substances and Disease Registry; NIOSH is the National Institute for Occupational Safety and Health; AIHA is the American Industrial Hygiene Association; ACGIH is the American Conference of Industrial Hygienists

**ppm is parts per million (part hydrogen sulfide per million parts air, by volume); ppb is parts per billion (part hydrogen sulfide per million parts air, by volume).

Appendix 2

Jerome® 631-X
Hydrogen Sulfide Analyzer

With the push of a single button, the portable Jerome 631-X hydrogen sulfide analyzer displays low-level concentrations in just seconds. It offers an analysis range of 0.003 - 50 ppm for odor and corrosion control, safety, and leak detection in such industries as wastewater treatment, oil and gas, pulp and paper, and farming. This simple-to-use instrument weighs only 7 pounds, utilizes an internal rechargeable battery pack or AC power, and is easily carried to suspected sources of hydrogen sulfide for detection and measurement. Locked in survey mode, the 631-X automatically displays hydrogen sulfide concentrations as quickly as every 3 seconds.

The Jerome 631-X utilizes a patented gold film sensor. The sensor's selectivity to hydrogen sulfide eliminates interferences from sulfur dioxide, carbon dioxide, carbon monoxide, and water vapors. When the sample button is pressed, an internal pump draws air into the instrument. Any hydrogen sulfide in the sample is adsorbed by the sensor, which registers a proportional change in electrical resistance. The hydrogen sulfide concentration is displayed on the LCD, where it remains until the next sample is taken.

Additional accessories are available to customize the Jerome 631-X to meet individual application needs. For unattended sampling, the instrument can be programmed by a computer using the Jerome Communications Interface (JCI) software. A data logger plugs into the back of the instrument for data acquisition during portable surveys or unattended sampling without a computer. Recorded data can be downloaded later to the computer using the JCI software for analysis printout, permanent record keeping. An internal option board allows auto zeroing, DC power operation, timed regeneration, and timed sampling during prolonged unattended sampling periods. The option board also allows external fresh air solenoid support and 4-20 mA or 0-2 V analog output. Instrument calibration can be verified in the field using the Functional Test Module (FTM). A molded hard carrying case or soft field case give added versatility and organized storage for the instrument and its accessories.

Appendix 3

Hydrogen Sulfide Air Concentrations Above 70 ppb

Date/Time	H2S ppb
FEB-04-2007 19:45:33	233.3
FEB-06-2007 18:30:33	233.3
FEB-06-2007 19:31:00	233.3
FEB-12-2007 04:00:33	233.3
FEB-06-2007 19:45:55	210
FEB-04-2007 20:45:54	200
FEB-04-2007 21:00:27	200
FEB-06-2007 21:45:27	200
FEB-11-2007 00:45:27	200
FEB-16-2007 22:45:27	200
FEB-16-2007 23:30:27	200
FEB-17-2007 01:45:27	190
FEB-04-2007 21:15:27	180
FEB-06-2007 21:30:27	180
FEB-17-2007 01:30:27	180
FEB-17-2007 02:00:27	180
FEB-17-2007 05:15:27	180
FEB-04-2007 21:30:27	170
FEB-06-2007 02:30:27	170
FEB-06-2007 20:45:27	170
FEB-06-2007 22:30:27	170
FEB-16-2007 21:30:27	170
FEB-06-2007 02:15:55	160
FEB-06-2007 22:45:27	160
FEB-06-2007 23:00:27	160
FEB-16-2007 22:30:27	160
FEB-17-2007 02:15:27	160
FEB-04-2007 21:45:27	150
FEB-04-2007 22:30:27	150
FEB-05-2007 00:45:27	150
FEB-06-2007 06:31:00	150
FEB-06-2007 22:15:27	150
FEB-11-2007 01:00:27	150
FEB-11-2007 01:15:27	150
FEB-16-2007 23:00:27	150
FEB-19-2007 02:45:55	150
FEB-04-2007 22:15:27	140
FEB-04-2007 22:45:27	140
FEB-06-2007 20:15:27	140
FEB-06-2007 20:30:27	140
FEB-10-2007 23:46:00	140

Date/Time	H2S ppb
FEB-17-2007 00:45:27	140
FEB-17-2007 05:00:27	140
FEB-28-2007 03:00:27	140
FEB-04-2007 22:00:27	130
FEB-06-2007 20:00:27	130
FEB-06-2007 22:00:27	130
FEB-11-2007 01:30:27	130
FEB-11-2007 01:45:27	130
FEB-16-2007 21:15:27	130
FEB-17-2007 00:00:27	130
FEB-17-2007 03:00:27	130
FEB-19-2007 03:15:27	130
FEB-21-2007 21:45:55	130
FEB-27-2007 01:00:27	130
FEB-04-2007 04:00:27	120
FEB-04-2007 23:30:27	120
FEB-05-2007 01:00:27	120
FEB-05-2007 01:15:27	120
FEB-05-2007 02:00:27	120
FEB-05-2007 18:30:27	120
FEB-06-2007 02:45:27	120
FEB-06-2007 06:45:27	120
FEB-06-2007 07:00:27	120
FEB-06-2007 23:15:27	120
FEB-07-2007 07:00:55	120
FEB-09-2007 00:45:27	120
FEB-11-2007 02:30:27	120
FEB-11-2007 02:45:27	120
FEB-12-2007 02:00:27	120
FEB-17-2007 02:30:27	120
FEB-23-2007 01:00:27	120
FEB-27-2007 01:15:27	120
JAN-29-2007 22:30:32	115
FEB-11-2007 18:46:00	111
JAN-29-2007 20:00:27	110
FEB-03-2007 00:45:54	110
FEB-04-2007 06:45:55	110
FEB-04-2007 23:15:27	110
FEB-04-2007 23:45:27	110
FEB-05-2007 01:30:27	110
FEB-05-2007 01:45:27	110

Date/Time	H2S ppb
FEB-05-2007 22:15:27	110
FEB-06-2007 21:15:27	110
FEB-06-2007 23:45:27	110
FEB-07-2007 00:45:27	110
FEB-07-2007 01:45:27	110
FEB-07-2007 02:00:27	110
FEB-11-2007 00:00:27	110
FEB-11-2007 02:00:27	110
FEB-11-2007 22:00:27	110
FEB-11-2007 22:45:27	110
FEB-17-2007 01:15:27	110
FEB-18-2007 22:30:27	110
FEB-18-2007 23:00:27	110
FEB-19-2007 03:00:27	110
FEB-21-2007 22:00:27	110
FEB-23-2007 00:45:55	110
FEB-23-2007 01:15:27	110
FEB-25-2007 00:45:55	110
FEB-25-2007 01:00:27	110
FEB-25-2007 01:15:27	110
FEB-26-2007 03:00:27	110
FEB-27-2007 00:45:55	110
FEB-27-2007 01:30:27	110
MAR-01-2007 00:45:55	110
MAR-01-2007 01:00:27	110
FEB-08-2007 00:15:32	108
FEB-28-2007 02:46:00	100
FEB-16-2007 19:30:32	98
FEB-18-2007 20:45:32	98
FEB-19-2007 00:00:32	98
FEB-05-2007 21:45:32	97
FEB-11-2007 22:30:32	96
FEB-11-2007 19:00:32	95
FEB-18-2007 22:15:32	95
FEB-05-2007 20:45:32	92
FEB-08-2007 00:00:32	92
FEB-08-2007 23:45:32	92
FEB-11-2007 23:00:32	92
FEB-16-2007 21:00:32	92
FEB-04-2007 02:15:32	90
FEB-16-2007 23:45:32	90

Date/Time	H2S ppb
JAN-30-2007 00:00:32	88
JAN-29-2007 20:15:32	86
FEB-11-2007 20:45:32	86
FEB-07-2007 23:45:32	84
FEB-16-2007 21:45:32	84
FEB-16-2007 23:15:32	84
FEB-17-2007 05:30:32	83
FEB-26-2007 05:01:05	83
JAN-29-2007 20:30:32	82
FEB-04-2007 04:15:32	81
FEB-05-2007 18:01:05	81
FEB-12-2007 02:45:32	81
FEB-04-2007 18:45:32	80

Date/Time	H2S ppb
FEB-05-2007 18:45:32	80
FEB-11-2007 20:30:32	80
FEB-16-2007 20:00:32	79
FEB-18-2007 21:15:32	79
FEB-19-2007 05:15:32	79
FEB-04-2007 19:00:32	78
FEB-26-2007 05:15:32	78
FEB-28-2007 01:01:05	78
FEB-04-2007 00:45:32	77
FEB-04-2007 17:46:05	77
FEB-11-2007 19:15:32	77
FEB-17-2007 05:45:32	77
FEB-12-2007 02:15:32	76

Date/Time	H2S ppb
FEB-19-2007 03:30:32	76
JAN-29-2007 19:31:05	74
JAN-29-2007 23:15:32	74
FEB-04-2007 01:00:32	74
FEB-17-2007 07:00:32	74
FEB-05-2007 22:30:32	71
FEB-07-2007 07:15:32	71
FEB-17-2007 07:15:32	71
JAN-29-2007 23:45:32	70
FEB-10-2007 20:15:32	70

Appendix 4

EPA Region 5 Recommended Management Practices based on the Removal Action at the Warren Recycling/Warren Hills Construction and Demolition Debris Landfill site

Excerpted best management practices from a letter to Solid and Infectious Waste Chiefs at the Ohio Environmental Protection Agency from the EPA Region 5 on-scene coordinators:

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4.0 H_2S Prevention and Control Management Practices

Many states and C&D landfills have developed good management practices or requirements to control H_2S gas formations in C&D landfills. However, where a particular C&D debris landfill meets all of the conditions, described above, certain management practices (MPs) can be utilized to prevent and control such emissions. This section describes those management practices (MPs) that a C&D debris landfill may utilize to prevent and control H_2S gas emissions. Depending on the site conditions and the magnitude of the problem, one or more of the suggested MPs may be more effective than others. These MPs focus on controlling H_2S gas emissions by either removing an environmental requirement of SRBs or by changing environmental characteristics of the site. Any one or combination of more than one of the MPs may be implemented at a site depending on site-specific conditions and location. Therefore, we recommend that the MPs presented in this text be evaluated separately by the site owner/operator for technical feasibility and cost effectiveness.

4.1 Gypsum Drywall Diversion/Recycling

Gypsum drywall diversion, recycling and reuse of the material is recommended as the first MP examined, if possible. This practice removes or minimizes the gypsum before disposal. Gypsum drywall is commonly used in various recycling and reuse techniques. Source separation has been shown to be an effective method to collect gypsum drywall in a relatively clean fashion, while keeping cost at a minimum. A dedicated covered waste receptacle for drywall tends to facilitate recycling efforts at most construction jobs. For more information about drywall recycling and reuse, visit (https://www.drywallrecycling.org).

pH Control

SRBs require a pH range of approximately 6 to 9 to effectively reduce sulfur to produce H_2S gas. The idea of pH control is to alter the pH of the gypsum drywall to a range that is not hospitable for SRB growth. This can be accomplished by the application of a buffering agent which changes the pH of the system and maintains it at either an alkaline pH >9 or an acidic pH <6. However, since acidic pH in disposal environments may cause concern regarding the mobility of various other contaminants (e.g., metals), the use of acidic buffering agents (pH <6) is discouraged. Controlling the pH at an alkaline environment (pH >9) may provide a relatively safe and cheap method of H_2S gas emission control (Ref. 13). However, for consideration, certain metals, such as arsenic and selenium are more mobile at alkaline pH. Various methods of controlling alkaline pH are discussed below.

An example of pH control is the addition of lime (CaO), (Ref. 13). The use of lime as a treatment for H_2S gas control may also assist in the problems associated with leachate. An increase in the pH reduces the solubility of metallic salts and thus reduces the amount that may migrate to the leachate. Laboratory and field studies conducted at the University of Florida suggest that lime may also act as a sorbent material for H_2S gas, where it attenuates H_2S gas and prevents it from migrating from the landfill surface (Ref. 16).

4.3 Moisture Control (Ref. 16, 17, 18)

One of the required factors for SRBs to produce H_2S gas is moisture. Thus, moisture diversion can play a major role in controlling gaseous emissions, including H_2S, from debris disposal facilities that accept large amounts of pulverized gypsum drywall. Moisture control at such C&D debris landfills may include the management and diversion of storm water, as well as surface water management, and in some cases leachate management.

Specifically, we recommend that moisture infiltration into these types of wastes be controlled by using a surface water run-off management system similar to that found at various municipal solid waste management facilities. Storm water diversion from a debris disposal facility that accepts large amounts of pulverized gypsum drywall is also an important component in moisture control. Designing a proper storm water management system is important for adequate facility drainage and water control. Storm water can be managed with design and construction methods such as silt fences, rock dams, erosion control mats, diversion channels and berms. Such systems reduce the amount of moisture that gets in contact with the C&D debris and will help reduce ponding and leachate volume.

Daily and long-term cover to prevent storm water from infiltrating into the debris containing pulverized gypsum drywall may also be appropriate. Daily covers and long-term covers, as will be discussed later, may also play a major role in attenuating H_2S gas emissions. Long-term maintenance and cover erosion controls may be necessary to prevent washout. By maintaining an effective cover, facilities will reduce management costs by preventing the formation of H_2S gas.

In general, C&D debris landfills must comply with state and federal (40 Code of Federal Regulations Parts 257.3-1, 257.3-3, 257.8, 257.9 as appropriate) requirements to control surface water and prevent these types of facilities from being located in areas such as wetlands and floodplains. Compliance with these requirements should contribute to controlling H_2S gas emissions.

At the WRI cleanup, USEPA eliminated the leachate ponds and constructed an effective surface/storm water control system that prevented ponding and reduced the amount of leachate generated, leading to the reduction of H_2S gas emissions.

4.4 Leachate Management (13, 18)

Because of H_2S's high solubility in water, leachate from C&D debris landfills that contain H_2S gas may cause odor problems as it migrates off the site. Thus, C&D debris landfill leachate can become a significant source of H_2S gas, especially when sulfate concentrations are elevated. Depending on state and local regulations, C&D debris landfills that accept large amounts of pulverized gypsum drywall, particularly if it is pulverized into a powder form, may be required to collect and manage leachate generated at the site. In such a scenario, the collected leachate may have to be treated for H_2S gas and managed in accordance with specified requirements.

The removal of H_2S from leachate is mainly accomplished by chemical oxidation processes. These processes commonly utilize an oxidizing agent to oxidize H_2S to form elemental sulfur or sulfate depending on the pH. The oxidizing agent may be stored on site and is usually introduced to the leachate at the site before the leachate is transported to the local wastewater treatment plant for further treatment. Leachate recirculation is not recommended as a leachate management option at C&D debris landfills with significant amounts of pulverized gypsum. The recirculated leachate provides both the moisture and microbial seed, thus promoting further H_2S gas generation.

At the WRI cleanup, USEPA dewatered and filled in the leachate ponds and installed an effective leachate treatment and disposal system to effectively control H_2S gas emissions (Ref. 18).

4.5 Capping/Cover/Alternative Cover Materials (Ref. 16, 17, 18,19)

Temporary and permanent covers are effective in reducing H_2S gas emissions from C&D debris landfills by controlling and reducing the moisture and attenuation of H_2S gas emissions. Section 4.3 discussed the use of cover material to control moisture. This section will address issues regarding the use of various cover materials

as passive treatment systems for H_2S gas emissions from C&D debris landfills.

Research conducted at the University of Florida concluded that cover materials can effectively reduce H_2S gas emissions from C&D debris landfills. Apart from its thickness, cover effectiveness largely depends on the physical and chemical characteristics of the cover material. These studies concluded that lime and fine concrete are the most effective (99% reduction of H_2S gas) cover materials for reducing H_2S gas emissions, while sandy and clayey materials showed average reduction efficiencies (77% to 98% effective) and coarse concrete was the least effective (23%). Cover materials that contain a mixture of soil, ash, and compost have also been shown to be effective in controlling H_2S gas emissions.

To achieve the most effective H_2S gas control, it is generally recommended that permanent covers be installed as soon as the final grade of C&D debris is reached. In areas that are inactive, but have not yet met final grade, temporary covers can be used. We encourage that cover materials be inspected frequently to check that no damage has occurred. It may also be effective to apply cover materials prior to large rain events, in order to prevent the gypsum waste from getting wet.

Capping/cover materials are effective when combined with other management practices, such as gas collection. Several states have reported success with this remedy for C&D debris landfills (Ref. 19).

At the WRI cleanup, USEPA used a clay cover combined with surface/stormwater control and leachate control & treatment to effectively control H_2S gas emissions (Ref. 18). As previously noted, maximum detectable concentration of hydrogen sulfide gas was reduced from 165 ppm to 0.043 ppm at the surface of the landfill.

4.6 Education and Training

Recyclers, transfer station operators, and landfill operators should understand how H_2S gas is produced in C&D debris landfills, particularly at those C&D debris landfills that meet the criteria identified in Section 3. Awareness of the mechanisms behind the formation of H_2S gas and methods that effectively prevent or restrict the formation of H_2S gas will support knowledgeable decision-making when working with C&D debris (Ref. 11).

Specifically, it is recommended that landfill operator training at a C&D debris landfill managing large amounts of pulverized gypsum include: 1) how to identify and/or segregate C&D debris containing pulverized gypsum drywall; 2) cover application and maintenance; 3) moisture control methods such as surface water and stormwater control procedures (e.g. ponding prevention) and proper leachate management, 4) H_2S gas identification; 5) onsite/perimeter inspections and H_2S gas monitoring methods (Note: This includes recognition of H_2S gas odors and to report the time, location, weather conditions, and any unusual site conditions); and 6) health and safety/emergency procedures involving H_2S gas (Ref. 18).

4.7 Active Gas Collection

Active gas collection and recovery systems, if properly designed, can collect and treat the effluent gas and effectively reduce H_2S gas emissions at C&D debris landfills. According to a USEPA Region 5 preliminary survey in May 2005, several states, which have had serious H_2S gas odor problems, reported success in controlling H_2S gas odors by requiring C&D debris landfills to install these systems in combination with covers (Ref. 19).

However, due to the high capital, operations, and maintenance costs, we believe that active gas collection systems be considered as one of the last control options to be implemented at a given site. (Note: If such a

system is put into place, the owner and operator may want to consult a qualified professional engineer to design and construct the system.)

4.8 An Integrated Approach for the Identification and Remediation of H_2S Emissions

In some cases, owners and operators may find it appropriate to establish site-specific H_2S gas monitoring and response plans. Various state and/or local regulations may already require some type of monitoring at these facilities, however, H_2S gas specific monitoring systems discussed in this document can also be incorporated to provide additional assurance when needed.

Like all environmental monitoring plans, the main goal of an H_2S gas monitoring plan is to protect human health and the environment. Specifically, the goal of an H_2S gas monitoring and response plan is to prevent the inhalation of objectionable or unsafe concentrations of H_2S gas by onsite personnel and anyone who works or resides near a C&D debris landfill that disposed of C&D debris containing large amounts of pulverized gypsum drywall. A site owner's and/or operator's implementation of an early detection and response system for monitoring H_2S gas emissions may greatly reduce or eliminate potential need for future mitigation.

In order to create an effective monitoring plan, the owner operator may consider the following factors:

4.8.1 Site Location (Ref. 18)

It is recommended that the location of debris disposal facilities that contain large amounts of pulverized gypsum drywall avoid areas where the debris may become wet or saturated. These locations include wetlands, flood plains or areas prone to flooding, or areas that have a high ground water table. By keeping the gypsum dry, H_2S gas generation would likely not occur and the potential problems associated with it.

States and local governments limit the siting of new C&D debris landfills near residential areas. This would reduce potential concerns in the case of H_2S gas problems. The greater distance (that separates these facilities from near-by communities) provides more time for natural dispersion and dilution of H_2S gas emissions, which ultimately leads to a lower exposure rate. Specifically, the owner or operator should consider the site-specific potential for debris saturation and the distance to human receptors for any new or pre-existing site.

The aforementioned location factors were present at the WRI Site. USEPA noted that the site was located in an area where residents were within 100 feet of the facility. In addition, the WRI site is situated in a low, poorly drained, former wetlands area with soils rich in clay, which facilitated stormwater ponding and exposed the C&D debris to wet/saturated conditions.

4.8.2 Site Conditions

For C&D debris disposal facilities that handle large amounts of pulverized gypsum drywall, it is a good practice for a facility operator to acquire documentation for the following:

Site topography. Since H_2S gas is heavier than air, it tends to settle and concentrate in low-lying areas. Understanding the topography will help in identifying areas where H_2S gas may linger and would lead to more effective management of such emissions.

On-site and off-site structures. Structures where leachate may migrate and subsequently emit H_2S gas causing some exposures to workers and nearby residents are important to identify.

Understanding of the water table and its seasonal fluctuation. One of the main factors in H_2S gas generation from pulverized drywall is wetting of it. Understanding where the groundwater table is and

keeping the pulverized debris containing gypsum drywall away from it helps in preventing H_2S gas generation. Knowing this also would help evaluate the maximum depth of any excavation to separation from groundwater.

- ***Location of other potential sources of H_2S gas in the area***. Debris disposal facilities that handle large amounts of pulverized gypsum drywall are not the only facilities that can be a potential source of H_2S gas. A poorly managed wastewater treatment plant may emit H_2S gas.

Identifying the source of H_2S gas is very important in addressing any potential problems that may arise.

Property boundaries and ownership adjacent to the facility. The owner or operator may wish to gather information beyond the immediately adjacent properties based on site-specific knowledge in order to identify potential receptors. Different gas monitoring techniques or instruments may be appropriate on-site and off-site. Such information is helpful in the rare event where offsite H_2S gas emissions become a concern.

The owner or operator may also find it useful to assemble the following site-specific information:

Records or information regarding the type of waste/debris disposed at the site.

Facility construction details, including any liners or final cover.

Details of any existing and/or operating gas extraction or venting system.

Details of any existing gas monitoring system.

Facility gas generation potential.

Historical records regarding gas investigations and monitoring, visual or olfactory observations, inspections or complaints, odor problems.

4.8.3 Self Inspection Strategy

Because of the high sensitivity humans have to H_2S gas odor (Humans can smell 0.0005 to 0.3 parts per million of H_2S gas), the initial warning of potential problems may be by smell. This would most likely be in the form of complaints from neighbors or onsite workers about a rotten egg smell.

Therefore, we encourage that periodic site inspections be conducted, by the facility operator, mainly to identify signs of potential H_2S gas emissions and to ensure implementation of management practices, if any. The inspections can also serve to identify areas of high temperatures that may indicate a higher rate of degradation. The inspections might include a general screening for H_2S gas odors along the facility perimeter and are best conducted during the early morning or late evening hours since odors are most likely to occur at these times. Emissions may vary depending on temperature changes, as well as wind speed and direction.

(Note: As mentioned earlier, inspectors should be aware that at higher concentrations, at or above 100 ppm, individuals may not detect H_2S gas due to olfactory fatigue. For this reason, odor is not a reliable indicator of H_2S's presence at higher concentrations and may not provide adequate warning of hazardous concentrations)

If an H_2S gas meter is available, the owner or operator may wish to include sampling along the perimeter and over a grid pattern across the areas of waste or debris placement during daily inspections.

Such sampling, conducted on a regular basis, could alert the owner or operator to the generation of H_2S gas. Gases could be released from the facility through fissures, cracks, uncovered areas, leachate ponds, or erosion gullies. Such areas may easily be repaired to reduce or eliminate off site migration. Early detection of potential

off site migration may also allow the operator to improve operational practices and employ additional MPs, thereby reducing the need for more costly solutions in the future.

If H_2S gas odors are detected, the owner or operator can use a portable H_2S gas analyzer to quantify the extent and concentration of the H_2S gas emissions and compare them to applicable health standards.

If the problem persists, we suggest that the owner and/or operator should consider a monitoring plan to quantify on-site and off-site H_2S gas levels. The plan would be site specific and could be modified as site-specific data becomes available. Initially, for example, monitoring can be conducted in downwind and low lying areas, especially if those areas are near potential receptors. Once sufficient data have been collected to determine the origin and extent of emissions, the monitoring plan can be updated to examine specific areas of concern.

The location of monitoring points is mainly a function of site-specific factors such as topography and atmospheric conditions. Understanding the site topography, as mentioned above, is helpful in identifying likely gas migration and accumulation locations and establishing monitoring points beyond the facility boundary. In addition, if on-site monitoring is considered appropriate, we believe that it be conducted in a manner that would facilitate delineation of areas with higher concentrations.

When H_2S gas monitoring is conducted, different gas monitoring instruments may be used for on-site workers and nearby residents, depending on the objective. For example, an instrument that is capable of detecting H_2S levels as low as 0.001 ppm (1.0 ppb) may be appropriate for perimeter monitoring to detect off-site migration. On the other hand, on-site monitoring to ensure personnel protection may only require an instrument that is capable of detecting H_2S gas levels at or above 1.0 ppm (1000 ppb). Instruments should be designed and calibrated specifically for H_2S. For maximum protection of the facility personnel, as well as the general public, proper sampling techniques and calibration should be followed. In addition, we encourage that trained personnel operate the monitors who understand the operating procedures and limitations of the instrument being used. For instance, monitors calibrated to detect H_2S gas may show interference from other sulfur gases.

If H_2S gas odor problems persist, meteorological data (i.e., temperature, wind speed and direction, precipitation and barometric pressure) may be collected and analyzed. For additional information on this topic, refer to EPA-454/R-99-005 and/or EPA-450/4-87-007.

Once the owner or operator has established the source, concentration and extent of the H_2S gas emissions, decisions concerning appropriate remedial action can be made. A few examples of the management practices outlined in this text include applying cover material, removing leachate, and diverting surface/stormwater from areas of debris placement.

4.9 Other Practices to be Considered

4.9.1 Community Outreach (Ref. 18)

Good community relations are part of every successful odor control program. Humans can detect the odor of H_2S gas at very low concentrations (as low as 0.0005 ppm). Even at low concentrations, H_2S gas can be offensive and complaints may occur, especially during unfavorable weather conditions. Therefore, we recommend that the owner or operator maintain effective communication with the surrounding community and encourage involvement.

At the WRI site, USEPA conducted regular meetings with the community and local government to ensure that they were aware of the removal activities and had a forum to express their concerns.

4.9.2 Local Fire Department Involvement

We recommend that the owner or operator establish action levels or be aware of required action levels that trigger notification to health officials, regulators, and local emergency response personnel.

5.0 H_2S Gas Off-Site Migration (WRI Site Case Study)

This section provides an example of monitoring and response (through a case study) in the event that H_2S gas migrates off-site into surrounding communities. These guidelines were used by USEPA, as part of its contingency plan, at the WRI site in Ohio, where a time critical removal action was initiated at a former C&D debris landfill to address H_2S gas releases to the surrounding community (visit www.epaosc.org/warrenrecycling). The contingency plan specifically focused on releases occurring as a result of on-site activities during USEPA's time-critical removal action. The following table summarizes actions required at the WRI site if certain H_2S gas conditions at the fenceline are achieved:

H_2S gas Concentration	**Length of Time of Sustained Readings**	**Actions Required**
.200 ppm	30 minutes at the fence line	1. Federal on-scene coordinator may advise residents to close windows and stay inside. 2. If resident gives permission, conduct air monitoring inside home. 3. If concentrations inside home are up to 200 ppb, FOSC should notify Warren City Fire Department and defer to their authority for community action.
1.0 ppm	10 minutes at the fence line	1. Take immediate action on-site to mitigate the cause of the gas release. 2. Alert the Warren City Fire Department and defer to their authority for community action.
3.0 ppm	5 minutes at the fence line	1. Take immediate action on-site to mitigate the cause of the gas release. 2.Alert the Warren City Fire Department and defer to their authority for community action.
25 ppm	sustained for any length of time, at the fence line	1. Take immediate action on-site to mitigate the cause of the gas release. 2. Inform residents to close windows, shut off air conditioners, and stay inside. 3. Alert the Warren City Fire Department and defer to their authority for community action.

This table pertains to releases that occur as a result of on-site work actions.

REFERENCES:

1. Agency for Toxic Substances and Disease Registry. Toxicological profile for hydrogen sulfide. Atlanta: US Department of Health and Human Services; 1999
1a. Agency for Toxics Substances & Disease Registry. Sept. 2004. Draft Toxicological Profile for Hydrogen Sulfide, http://www.atsdr.cdc.gov/toxprofiles/tp114.html .
2. Agency for Toxics Substances & Disease Registry, Medical Management Guidelines for Hydrogen Sulfide. http://www.atsdr.cdc.gov/MHMI/mmg114.html, accessed April 27, 2006.
3. EPA Region 9 Preliminary Remediation Goals. http://www.epa.gov/region9/waste/sfund/prg/ . Accessed February 16, 2006.
4. EPA Region 3 Risk Based Concentration Table. http://www.epa.gov/reg3hwmd/risk/human/index.htm . Accessed February 16, 2006.
5. EPA Acute Exposure Guidelines, http://www.epa.gov/oppt/aegl/chemlist.htm. Accessed April 27, 2006.
6. California Environmental Protection Agency, http://www.oehha.ca.gov/air/pdf/acuterel.pdf. Accessed April 27, 2006.
7. Occupational Safety and Health Administration, http://www.osha.gov/dts/chemicalsampling/data/CH_246800.html Accessed April 27, 2006.
8. USEPA , Characterization of Building Related Construction and Demolition Debris in the United States, Construction and Demolition Debris, June 1998.
9. USEPA , Construction and Demolition Debris; http://www.epa.gov/epaoswer/non-hw/debris-new/basic.htm ; Accessed April 27, 2006.
10. Timothy G. Townsend et al. Dec. 2000(Updated Jan. 2002), Gypsum Drywall Impact on Odor Production at Landfills: Science and Control Strategies, Florida Center for Solid and Hazardous Waste Management, State University System of Florida.
11. New Hampshire Department of Environmental Services, November 22, 2004 Interim Best Management Practices for the Use of C&D Process Fines.
12. Bogner and Heguy, March/April 2004, Hydrogen Sulfide from Landfilled Construction and Demolition Debris: When and How, MSW Management.
13. Hardy Associates (1978) Ltd., December 19, 1984, Gypsum Subcommittee of the Lower Mainland Refuse Project. Investigation of Means to Control Sulphide Production in Drywall Landfill Disposal Operations.
14. Gypsum Association, January 1991, Treatment and Disposal of Gypsum Board Waste Industry Technical Paper.
15. Timothy G. Townsend, et al, January 31, 2001, Recycling of Discarded Gypsum Drywall in Florida, Final report to the Florida Department of Environmental Protection, by University of Florida Department of Environmental Engineering Sciences.
16. Plaza, Townsend, Cover Materials for the Mitigation of Hydrogen Sulfide from C&D Landfill Gas, Department of Environmental Engineering Sciences, University of Florida. SWANA E-Training, July 13, 2005.
17. Shaw Environmental, EMCON/OWT, Inc. June 24, 2004, Final Report on Best Management Practices, Construction & Demolition Fines as Landfill Cover Material.
18. USEPA , Pollution Reports 1-16, Warren Recycling, Warren Ohio EPA Region V, http://www.epaosc.org/polrep_profile.asp?site_id=1622 , Accessed April 28, 2006.
19. USEPA Region 5, Letter to Ohio EPA, June 13, 2005, Hydrogen Sulfide Problems at Construction and Demolition Landfills at States Outside of Ohio in the United States.
20. Reinhart, et al, November 2004, Control of Odors from Construction and Demolition (C&D) Debris Landfills, Florida Center for Solid & Hazardous Waste Management, University of Florida.

Appendix 5
Response to Public Comment

This document was available for public comment from September 28, 2007 to November 28, 2007. Public comments are followed by responses from Florida Department of Health (DOH) or Agency for Toxic Substances and Disease Registry (ATSDR). Underlined words in the responses are what we added or modified in the text of this document.

Comment #1: The Coyote Landfill accepted not only large volumes of construction and demolition (C&D) waste, but sworn testimony from former Coyote employees indicates that Coyote also accepted large volumes of prohibited and hazardous waste.

Response #1: This health consultation focuses on hydrogen sulfide (H_2S) in air around the landfill and is not an exhaustive history of landfill activities.

Comment #2: Large volumes of waste deposited in the Coyote Navarre Landfill were piled with steep slopes and without the application of cover as required by FDEP regulations. The heat generated from waste decomposition along with the wind blowing into the landfill because of the lack of cover resulted in spontaneous combustion resulting in frequent surficial and subterranean fires. The spontaneous combustion created voids in the landfill as well as chimneys.

Response #2: We do not have information on the slope steepness nor do we have information confirming how the fires were started. However, we have stated that surface and subsurface fires are a known phenomena at C&D landfills and are caused by the production of H_2S, methane, and other gases.

Comment #3: The chimneys then allowed for water to enter the body of the landfill, therefore, increasing hydrogen sulfide production, and provided a pathway for the hydrogen sulfide to escape the landfill in greater concentrations than would have occurred with proper cover soil and no fire**.**

Response #3: The focus of this health consultation is on the possible human exposure to H_2S in the ambient air around the landfill. The details of how H_2S is produced is not the emphasis of this report.

Comment #4: The residents living around the landfill did not limit their complaints to only the October and November fires, but to smoke and odors in general from the landfill which was reported to be worse around the October and November surficial fires.

Response #4: Florida DOH will modify the Summary as follows: **"**People closer to the landfill complained more often of respiratory problems, eye/nose/throat irritation, headaches, nausea and other symptoms. Residents associated these symptoms with landfill odors, and with smoke and odors from the October and November 2005 surface fires, which were reported to cause more and greater symptoms."

Comment #5: The air filters were supplied to 23 residents two years after they began complaining of hydrogen sulfide exposure as the result of a grant applied for by the residents.

Response #5: Florida DOH will modify the Summary as follows: **"**A group of concerned citizens, the Holley Action Group, applied for a grant to buy 24 air filters for residences. According to the group, these air filters were not available until two years after residents had begun complaining of hydrogen sulfide exposures. The Florida DOH bought 10 additional air filters in December 2007, which the Holley Action Group distributed to homes with small children or senior citizens with health problems."

Comment #6: In addition to the health effects, the hydrogen sulfide levels measured are known to have psychological impacts such as irritability and learned physical reactions to the odors such as nausea and vomiting.

Response #6: Florida DOH will add the following text to the Summary: "Studies comparing communities near paper mills, refineries and animal feedlots that emit hydrogen sulfide along with other chemicals, with communities that do not smell hydrogen sulfide and other odors have shown significantly higher rates of psychological symptoms such as tension, depression, and fatigue in the odor-exposed groups than in the control groups. The Protocol for Assessing Community Excellence in Environmental Health (PACE-EH) informal community health survey in the community surrounding this landfill showed 20% to 30% of the survey respondents had symptoms of fatigue, restlessness, and sleeplessness**,** and between 11% and 18% reported dizziness, inability to concentrate, nervousness, and feelings of confusion."

Comment #7: The recommendations do not identify the specific governmental agencies or individual parties who are to implement the recommendations. Furthermore, the recommendations fail to identify specific mandates for the Coyote Landfill to resolve the problems.

Response #7: The recommendations in this report are advisory, not regulatory. To the extent possible, Florida DOH will suggest which parties take action on each recommendation.

Comment #8: Coyote Landfill has not corrected the objectionable odors. Citizens still complain. Constant exposure to H_2S can lower ones smell threshold. There is no evidence all the debris was removed from water. Other violations, if corrected, have only recently been corrected.

Response #8: Florida DOH will modify the Background section of the report as follows: **"**In July 2006, Florida DEP fined Coyote Landfill for open burning, objectionable smoke and odors, debris in contact with water, failure to maintain a small working face, and failure to provide weekly cover. Coyote Landfill has corrected some of these violations; although, the landfill still emits objectionable odors, and community members state there is no evidence they have removed all the debris from contact with water."

Comment #9: The document states that the "Florida DEP continues to work with the landowner to improve conditions on the site". What have they done specifically? Nothing has been done to correct the existing problems of air pollution (and groundwater pollution) that continues to exist. Evidence, other than verbal comments should be required before adding such a statement.

Response #9: Florida DOH will modify the report as follows: "Florida DEP has alerted the landfill owner of possible violations of law for which he may be responsible in a January 14, 2008 letter. That letter is part of an agency investigation, preliminary to agency action, to resolve objectionable odors emissions from the site. This letter advised the owner that materials that are impermeable to water have helped allay hydrogen sulfide odors at another Santa Rosa County C&D landfill."

Comment #10: Concentrations of hydrogen sulfide measured in the air around the Coyote Landfill from January, 29, 2007 to March 2, 2007 were above concentrations, known to the scientific community to adversely affect the health of community members with pre-existing respiratory problems. Exposure to the concentrations measured around the Coyote Landfill are also known to cause self reported symptoms such as eye irritation, nasal irritation, congestions, coughing, breathlessness, wheezing, headaches, nausea and sore throats in community members without pre-existing respiratory problems.

Hydrogen sulfide has an associated odor commonly described as rotten eggs which is detectible by humans at concentrations as low as 0.5 ppb. Concentrations of hydrogen sulfide measured in the air around the Coyote

Landfill from January, 29, 2007 to March 2, 2007, were above concentrations known to the scientific community to have a detectible rotten egg odor. Exposure to hydrogen sulfide, at the concentrations measured around the landfill, and its associated odor are also known to cause psychological symptoms such as mood swings, nervousness, fatigue, irritability, confusion and inability to concentrate. Exposure to hydrogen sulfide also creates a learned association effect which means the community members continue to be able to detect hydrogen sulfide at lower and lower concentrations and each detection of an odor associated with hydrogen sulfide can therefore trigger a self reported symptom and/or psychological effect.

Response #10: Florida DOH will revise the first conclusion as follows: "Concentrations of hydrogen sulfide measured in the air around the Coyote Landfill from January, 29, 2007 to March 2, 2007 were above concentrations known to adversely affect community members with pre-existing respiratory problems. Exposures to these levels can also result in eye irritation, nasal irritation, cough, breathlessness/wheezing, and headaches. We do not have measured particulate levels for past exposures when the landfill was on fire. Nevertheless, the Santa Rosa County Protocol for Excellence in Environmental Health (PACE) survey found burning or scratchy throats in persons without pre-existing respiratory problems. More than 20% of the community adults surveyed also reported fatigue, restlessness, sleeplessness, sneezing problems, upset stomachs, bleeding or burning noses, and eyesight problems. These symptoms are consistent with hydrogen sulfide exposure."

Comment #11: The Coyote Landfill continues to emit hydrogen sulfide gas nine months after the air monitoring was conducted and after the landfill placed cover material. The levels of hydrogen sulfide community members were exposed to prior to the air testing is unknown, but it should be noted the measurements were taken after cover was placed on the landfill and cover has a diminishing effect.

Response #11: Florida DOH will modify the second conclusion in the report as follows: "The Coyote Landfill likely continues to emit hydrogen sulfide gas. Past measurements showed levels associated with adverse health effects with short term exposures. Community members continue to report odors and adverse health effects."

Comment #12: The first recommendation is a true statement but the Department of Health and ATSDR should be specific about what should be done. This should mandate specific emergency actions by governmental agencies to immediately relieve the population of the adverse affects. There should also be immediate requirements made of the operator of Coyote Landfill to **immediately** remediate the air and other pollution problems and, further, to require in the near future that the operator begin approved cleanup operations for long term solutions.

Response #12: Florida DOH acts only in an advisory role and cannot enforce actions by other agencies. Florida DOH will revise the first recommendation as follows: "Reduce residential exposures to hydrogen sulfide from the Coyote Landfill as soon as possible. Community members should report odors or smoke coming from the landfill to the Santa Rosa County Health Department and Florida DEP, Northwest District Office."

Comment #13: We agree with the recommendation that hydrogen sulfide monitoring should continue. It should not depend upon logged complaints from residents. The people in the immediate area have long since become disillusioned with making complaints to local and state government and simply no longer do so. Air monitoring should continue on a long term basis and should be required at all C&D landfills as should groundwater monitoring. Also, as stated in this report, other gases may be present that have not been monitored for. Grab samples should be regularly taken of the air in the vicinity and if other harmful gases are found they should also be monitored for and a corrective plan of action be activated. The polluter should ultimately pay for these expenses.

Response #13: Florida DOH will modify the second recommendation as follows: "Continue real-time monitoring for hydrogen sulfide gas around the Coyote Landfill until verification that on-site remedies have reduced emissions below those of public health concern. If site perimeter values exceed those of public health concern, develop a contingency plan to monitor in residential areas and stop the source of hydrogen sulfide emissions. Nearby residents should stay inside or leave the area based on the level of irritation or symptoms they are experiencing due to hydrogen sulfide exposure. Residents who feel ill, especially those with persistent symptoms, should see their health care providers. They should tell their doctors about any concerns they might have about environmental exposures."

Comment #14: We agree with your third recommendation. It should be noted, however, that many of the residents in this area do not have health insurance and many simply do not seek medical attention. Funding needs to be provided for health care for all related health issues and the availability clearly communicated to the affected members of the local community. Again, this should ultimately be funded by the polluter.

Response #14: Florida DOH acts only in an advisory role and cannot require others to perform specific actions. Currently state or federal funds are not available for health care for communities around hazardous waste sites. The county and state did, however, purchase H_2S air purifiers for use by some residents. The third recommendation has been combined with the second recommendation. See Response #13 above regarding the revisions and expansion to the second recommendation.

Comment #15: We agree with the fourth recommendation. Again it should be more specific and not be limited to landfill fire. It should also address other sources of hydrogen sulfide gas including, but not limited to, preventing drywall from being in contact with water, requiring a small working face, regular and sufficient cover, and otherwise complying with Florida Administrative Code for the operation of C&D landfills. Mandate aggressive enforcement of existing law by appropriate agencies such as FDEP including more inspectors and requiring strict compliance. DOH should further use its position to recommend, lobby for, and otherwise promote the need for C&D land fill reform in Florida Administrative Code. We are being briefed on this matter but it warrants significant additional discussion.

Response #15: Florida DOH makes recommendations to reduce or prevent exposures to toxic chemicals. Specific requirements to reduce/prevent exposures are the responsibility of Florida DEP. Florida DOH will change the fourth recommendation to the third recommendation and modify according to the following: "Reduce the threat of landfill fires and other sources of odors or chemical releases."

Comment #16: The Public Health Action Plan is good, but it simply outlines what actions are taking place now or have been taken such as placing the air purifiers in homes. There needs to be an action plan that goes well beyond these simple statements about what we're already doing. It should boldly outline where we are going to resolve these polluter induced health problems not just short term but for ultimate remediation and cleanup. (Requiring the polluter to immediately provide an impermeable cap to the mound would be an example of a short term mitigation of the problem.) It should call for funding to provide further distribution of air purifiers to those who are in need. This is a very important element of providing immediate relief for those who remain in need. Ideally air purifiers should prove to be a short term solution as more long term corrective actions are required and implemented. We recognize that is a rather broad subject that may require much discussion and planning. As always we will be available to the best of our ability.

Response #16: The Public Health Action Plan is an ATSDR-required section of the document and should include past, ongoing, and planned actions. Florida DOH will modify the report as follows:

Public Health Action Plan

1. To reduce exposures to hydrogen sulfide from the Coyote Landfill, the Santa Rosa County Health Department used PACE-EH grant funds to purchase 23 air scrubbers for residents to use in their homes. Florida DOH purchased an additional 10 air filters with ATSDR grant funds in December 2007. These scrubbers are able to remove hydrogen sulfide from indoor air in 30 to 60 minutes.

2. Based on the air quality results from 9 pairs of monitors installed by the U.S. EPA from November 21 to December 21, 2007 and January 14 to February 13, 2008, Florida DEP is requiring the Coyote Landfill owner eliminate odors and hydrogen sulfide emissions.

3. Florida DOH has reviewed the EPA sampling results above and will provide a public health evaluation in the near future.

Comment #17: Florida DOH received the following health concerns after an October 2007 mail-out to nearby residents. Florida DOH mailed approximately 160 fact sheets and comment forms to nearby residents. The post office returned 65 as undeliverable. Forty (40) residents mailed comments. Twenty-six (26) expressed health concerns:

Type of Concern	Number of Residents Expressing the Concern
Allergies	5
Asthma	2
Breathing problems (also referred to as respiratory/lung problems, congestion, COPD and bronchitis)	18
Crohn's disease	1
Cough	7
Digestive system problems	2
Eye irritation	8
Future health & development of children	1
Headaches/migraines	5
Heart problems (surgery, etc.)	1
Kidney failure	1
Loss of appetite	1
Nasal irritation	1
Runny nose	1
Pneumonia	1
Sinus	6
Skin problems	3
Sore throat/strep throat	2
Vomiting	1
Wheezing	2

In addition, some residents raised questions about the hydrogen sulfide possibly contaminating nearby ground and/or surface waters. They wondered about the health risks from drinking the ground water and/or eating fish from a nearby waterbody that may be contaminated.

Response #17: Florida DOH will add the following text at the end of the Community Health Concerns section: "Florida DOH received various health concerns following an October 2007 mail-out to nearby residents. Many

of these health concerns are similar to those recorded during the PACE Environmental Health Survey in 2006. Some additional concerns expressed during the 2007 comment period included skin problems, kidney failure, and heart problems. Also, a concern was raised about the health and development of children. Lastly, some of the residents had questions about drinking ground water and/or eating fish from a surface waterbody within the vicinity of Coyote Landfill that could possibly be contaminated with hydrogen sulfide."

Florida DOH will revise the section about "Health effects from breathing hydrogen sulfide" to include: "A person is primarily exposed to hydrogen sulfide through inhalation. Ingestion and absorption through the skin can also occur; however, these exposure routes contribute only small amounts to the overall body burden."

Lastly, Florida DOH will add the following to Child Health Considerations: "Children are likely exposed to hydrogen sulfide in a similar manner as adults, excluding adults that work around the chemical. However, children may be exposed to more hydrogen sulfide because it is heavier than air and children are shorter than adults. There is little information on possible health problems in children who are exposed to hydrogen sulfide. Exposed children will probably experience effects similar to those of exposed adults. Whether children are more sensitive to hydrogen sulfide than adults is not known. Animal studies have shown that exposure to low concentrations of hydrogen sulfide during pregnancy does not cause birth defects (ATSDR 2006)."

Comment #18: A formal site visit and discussion with the facility owners/operators has not been conducted. Such a visit would likely result in additional information regarding the operation of the facility and would be helpful to the authors in their analysis of potential health risks in the area.

Response #18: Evaluation of off-site air monitoring data did not require a meeting with the facility owner.

Comment #19: The source of the measured hydrogen sulfide was not conclusively identified. No information was provided regarding upwind and downwind concentrations. The presumed on-site origin of hydrogen sulfide and extent of release has not been confirmed.

Other potential sources of hydrogen sulfide have not been adequately excluded. No information was presented in the report regarding other industries or natural conditions near the air monitoring area which could affect hydrogen sulfide readings.

Air monitoring results are based on a single monitor. Limited information was provided regarding use of this monitor. In particular, no data were presented to indicate that the monitor was periodically calibrated/tested to insure accuracy of the readings and that potential sources of false-positive readings were excluded. Additional information regarding the monitoring that was performed is necessary in order to fully evaluate the validity of this testing.

No confirmatory data were provided when increased readings were recorded to verify the accuracy of the instrument and exclude the possibility of false-positive readings

Because an on-site source of hydrogen sulfide was not identified, the data do not establish a completed exposure pathway related to the facility.

Air monitoring results were not correlated with meteorological data to verify that the monitor was downwind of the site when increased levels were recorded.

Because air monitoring results are based on a single instrument in one location, they are not representative for the entire community or to individuals located further away from the monitoring site. No data were presented which attempt to model hydrogen sulfide levels occurring at varying distances from the monitor under relevant meteorological conditions

Response #19: In a future health consultation report, Florida DOH will address November/ December 2007 and January/February 2008 EPA data from nine sets of hydrogen sulfide monitors and daily wind roses. The purpose of the air monitoring evaluated in this document was to determine the potential for adverse impact on public health. From a public health perspective, the source of the contaminant is not important. Source identification is the responsibility of enforcement agencies.

Comment #20: The discussion of community health concerns is incomplete and potentially misleading. Health concerns were based on self-reported information from a survey with a relatively low response rate. Information was not provided regarding specific methodology of the survey (i.e., inclusion/ exclusion criteria, geographical boundaries of the survey, methods of administering the survey, etc.)

The methods of the survey are subject to numerous sources of bias including selection bias, non-response bias, and recall bias which makes it difficult to generalize the findings to the entire community. No discussion was provided regarding these limitations and the low response rate of the survey.

Most of the health symptoms described were non-specific with numerous causes. No discussion was provided regarding alternative causes of these types of symptoms or the plausibility of such symptoms occurring from hydrogen sulfide exposure or at the measured levels.

No discussion was provided regarding background rates of these types of symptoms in the general population and if the identified rates are elevated based on the methodology employed.

Response #20: Community health concerns are not presented as a formal survey or epidemiological instrument. Surveys were carried out by neighborhood residents going door-to-door to document the community health concerns. Using 2000 census data, roughly 300 adults and children lived within one mile of the landfill. The survey only tallied results for 118 adult survey respondents up to and including those living within 1 mile from the site. Therefore, it appears this survey canvassed primarily the local adults living closest to the landfill. Text changes to the Summary are shown below.

Studies comparing communities near paper mills, refineries and animal feedlots that emit hydrogen sulfide along with other chemicals, with communities that do not smell hydrogen sulfide and other odors have shown significantly higher rates of psychological symptoms such as tension, depression, and fatigue in the odor-exposed groups than in the control groups. The Protocol for Assessing Community Excellence in Environmental Health (PACE-EH) informal community health survey showed 20 to 30 % of the survey respondents had symptoms of fatigue, restlessness, and sleeplessness, and between 11 and 18% reported dizziness, inability to concentrate, nervousness, and feelings of confusion.

Comment #21: The time frame addressed by the survey for occurrence of symptoms is unclear. Also, the survey was conducted months before the air monitoring.

Response #21: The health consultation gives the web address where the survey results were listed. The results of the survey were listed in the July – August 2006 PACE EH Progress Report on that website. The Santa Rosa County Health Department Director noted most of the survey respondents had onset of symptoms after the October and November 2005 fires at Coyote Landfill; but the symptoms persist.

Comment #22: No further information, such as review of medical records or surveys of area health providers, was provided to confirm an actual increase in significant adverse health effects in the community.

A relatively high background rate of these types of symptoms in communities without any environmental concerns has been reported. No data were provided to characterize whether the symptom reporting rates in the community are higher than background levels.

Response #22: The PACE-EH survey was a compilation of reported symptoms but was not designed to indicate an increase over background. Florida DOH's cooperative agreement with ATSDR provides funding to conduct public health assessment activities and not to evaluate individual health records, survey local physicians, or determine background rates of symptoms and diseases.

Comment #23: Based on the limitations of the data presented, it is not possible to demonstrate a causal relationship between the reported symptoms and air monitoring results. This should be clarified in the health consult.

Response #23: This report does not attempt to demonstrate a causal relationship; rather it concludes that health effects have been shown at the measured hydrogen sulfide levels (in other community studies) that are similar to those reported by this community.

Comment #24: The discussion of hydrogen sulfide toxicology is incomplete and potentially misleading. Additional information should be provided on background levels in the environment and levels which occur naturally in the human body (i.e., breath and intestinal gas) for perspective. Also, dose-response information should be provided to provide perspective on levels which have been shown in experimental studies to result in health effects.

Response #24: Hydrogen sulfide (H_2S) from natural sources in the environment has been estimated between 0.1 and 0.3 parts per billion (ppb). Background levels in the US are approximately 0.02-0.07 ppb. Hydrogen sulfide is produced in humans. The toxicological measurement of import for exposure to H_2S is alveolar H_2S. Suarez (2000)[+] showed that increases in mouth H_2S did not lead to increases in alveolar H_2S above background levels, implying that even with high concentrations in the mouth, actual inhaled quantities of H_2S can be quite low. A similar situation is seen with mercury exposure from dental amalgams. This may be a reflection of the insignificant volume of air in the mouth relative to the volume of air inhaled during normal breathing. Normal breathing of ambient air could thus be a far greater contributor to lower airway exposures.

Hydrogen sulfide is the leading chemical agent causing human fatalities following inhalation exposures. Although lower concentration acute exposures have been quantitatively studied with human volunteers, the dose-response relationship for human toxicity due to hydrogen sulfide exposure is not known. Thus, a major area of uncertainty is the lack of adequate long-term human exposure data.

[+]Suarez FL, et al (2000). Morning Breath Odor: Influence of Treatments on Sulfur Gases. J. Dent. Res. 79(10): 1773 - 1777.

Comment #25: The use of the acute MRL of 70 ppb is extremely conservative and does not accurately reflect the clinical findings of the study on which it is based. The suggestion that health effects may occur at levels even below this value is not warranted or supported by scientific study.

Response #25: Standard risk assessment practice has always utilized safety factors when extrapolating an exposure level resulting in a health effect to a level thought safe for sensitive members of the population. Most Minimal Risk Levels (MRLs) contain some degree of uncertainty because of the lack of precise toxicological information on the people who might be most sensitive (e.g., infants, elderly, and nutritionally or immunologically compromised) to effects of hazardous substances. ATSDR uses a conservative (i.e., protective) approach to address these uncertainties consistent with the public health principle of prevention. This was the case in developing the acute H_2S MRL. As summarized in the health consultation, this MRL (70 ppb) included a safety factor of 27 (3 for the use of a minimum lowest observable effect level, 3 for human variability, and 3 for database deficiencies).

Comment #26: The study used for the derivation of the MRL (i.e., Jappinen et al., 1990) should be reviewed. This study showed no clinically significant changes in respiratory function among either workers or asthmatics with exposures ten or more times higher than the highest recorded level during air monitoring. It is not appropriate to imply that significant "bronchial obstruction" was observed in the participants of this study.

Response #26: The Jappinen et al., 1990, study did not observe statistically significant changes in airway resistance (Raw) or specific airway conductance (SGaw) in the ten asthmatic participants exposed to H_2S. However, the average Raw increased by over 26% and the SGaw decreased by over 8% after exposure. In two of the 10 asthmatics, changes exceeded 30% for both Raw and SGaw. Although not statistically significant, changes in resistance and conductance are of clinical importance; they indicate bronchial obstruction.

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Proposed MRLs undergo a rigorous review process. They are reviewed by the Health Effects/MRL Workgroup within the Division of Toxicology and Environmental Medicine; and expert panel of external peer reviewers; the agency wide MRL Workgroup, with participation from other federal agencies, including EPA; and are submitted for public comment through the toxicological profile public comment period. Each MRL is subject to change as new information becomes available concomitant with updating the toxicological profile of the substance.

Comment #27: Use of the intermediate MRL comparison value is not warranted based on the data presented.

Response #27: Comparing the H_2S results to the intermediate MRL of 20 ppb is appropriate. H_2S values exceeded the intermediate MRL. Contaminant levels above MRLs warrant further evaluation.

Comment #28: The use of comparison values such as 30 ppb or 4.3 ppb for evidence of potential health effects is not appropriate and is not consistent with the definition of the acute MRL of 70 ppb. ATSDR has previously noted that these levels do not cause adverse health effects.

Response #28: Campagna et al, 2004, found H_2S values of 30 ppb lasting 30 minutes or more were associated with an increase in unplanned respiratory-related hospital visits for children. A summary of the amount of time values exceeded 30 ppb near the Coyote Landfill was provided in the health assessment. The inference of "could have increased the risk of respiratory related hospital visits for exposed children." has been removed.

In addition, the inference that daily average values above 4.3 ppb could have caused certain health effects has been removed.

Comment #29: ATSDR's previous MRL for hydrogen sulfide was 500 ppb. No new evidence has been presented to demonstrate that levels below this are associated with health effects. Lowering of this standard was based on questionable reinterpretation of an existing study and application of safety factors.

Response #29: The Jappinen et al., 1990, study did not observe statistically significant changes in airway resistance (Raw) or specific airway conductance (SGaw) in the ten asthmatic participants exposed to H_2S.

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Comment #30: References listed in the health consultation do not correspond to the document text.

Response #30: References not cited in the text were removed.

Comment #31: Therefore, based on our review, ATSDR's conclusion that hydrogen sulfide was at levels that can adversely affect health is not supported based on validity questions regarding the air monitoring, inability to generalize monitoring results from a single monitor to the entire community, inappropriate use of the MRL as a threshold level for health effects, an absence of data showing actual adverse health effects at levels <1 ppm; and incomplete analysis of self-reported health data. Based on these limitations, it is not possible to make a reliable determination as to whether the facility represents a public health hazard as defined by ATSDR. Additional air monitoring as currently planned under the guidance of the USEPA, including monitoring at multiple sites around the facility, may better characterize hydrogen sulfide levels near the facility and the health significance. We suggest that the consultation base any public health conclusions on independently collected data which has been systematically designed to fully characterize hydrogen sulfide levels around the facility.

Response #31: Public health agencies do make decisions based on limited data. To be protective of public health, agencies routinely make conservative conclusions. If additional data becomes available, conclusions and recommendations may change. In this case, additional air sampling from USEPA taken in late 2007 and early 2008 will be reviewed in a separate, future report.

The H2S MRL was not used as a threshold for adverse health effects. MRLs were used to screen test results for further assessment. As both the acute and intermediate MRLs were exceeded during the air sampling event evaluated in the consultation, the results underwent further assessment. The air monitor sensor became saturated several time periods during the monitoring period. Maximum values prior to instrument saturation were 233 ppb. We do not know the maximum H2S concentrations during these time periods.

There are few community-based hydrogen sulfide exposure studies. The ones that exist consistently report community member concerns about respiratory problems, fatigue along with other symptoms considered to be adverse health impacts. This held true with the informal PACE-EH survey. Several exposure guidelines as well as the frequency and length of exposures are used when evaluating data.

Certification

The Florida Department of Health, Bureau of Community Environmental Health prepared this Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. FDOH followed approved methodologies and procedures existing at the time the health consultation was begun. The Cooperative Agreement Partner completed editorial review.

Jennifer Freed
Technical Project Officer
CAT, CAPEB, DHAC, ATSDR

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

Alan Yarbrough
Team Lead
CAT, CAPEB, DHAC, ATSDR