

Health Consultation
El Paso Lower Valley Community
Juárez North Wastewater Treatment Plant
El Paso, El Paso County, Texas/Juárez, Chihuahua, Mexico

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The Texas Department of State Health Services
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Agency for Toxic Substances and Disease Registry

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Introduction

Residents of the El Paso Lower Valley Neighborhood have complained to various agencies and government officials about very strong odors of sewage and human waste that have occurred in their neighborhood since at least 2001. In response to these concerns, the Texas Commission on Environmental Quality (TCEQ) conducted mobile air monitoring downwind of the Juárez, Mexico, North Wastewater Treatment Plant (JNWWTP) – a likely source for the odors.

In February 2003, air samples were collected to measure levels of hydrogen sulfide (H₂S), sulfur dioxide (SO₂), and volatile organic compounds (VOCs). Results suggested that the bad odors in the neighborhood were due to high levels of H₂S in the air [1]. Hydrogen sulfide has a very low odor threshold and the unpleasant odor of ‘rotten eggs’. It is one of the major gases given off as sewage decomposes [2].

In August 2004, TCEQ collected additional data on H₂S levels, wind speed, and wind direction. Texas Department of State Health Services (DSHS) reviewed TCEQ air quality data collected from the El Paso Lower Valley Neighborhood in 2003-2004. Some H₂S levels were above the acute (200 ppb) and intermediate (20 ppb) Environmental Media Evaluation Guides (EMEGs) used by the Agency for Toxic Substances and Disease Registry (ATSDR). EMEGs are media specific concentrations used by health assessors to select contaminants for further evaluation.

Purpose

In June 2004, United States (US) Representative Sylvestre Reyes petitioned ATSDR to evaluate whether working or living near the JNWWTP might affect people’s health [3]. Through a cooperative agreement with ATSDR, the Texas Department of State Health Services (DSHS) initiated a health consultation to evaluate these concerns.

As part of this process, DSHS gathered information about the community and their concerns from the US census (Table 1), the El Paso City/County Environmental Health District (EPCCEHD), the DSHS Regional Office, and the community. DSHS obtained other historical information from the TCEQ, the International Boundary Water Council (IBWC)-a joint US and Mexico council, and the US Environmental Protection Agency (EPA). To evaluate current exposure levels, DSHS obtained available environmental sampling data from TCEQ’s continuous air monitoring station (CAMS) 36. This health consultation reports the methods, findings and conclusions of our evaluation of hydrogen sulfide levels associated with the JNWWTP.

Background

Site Description

The El Paso Lower Valley Neighborhood (where most of the odor complaints have originated) is located near the intersection of the Border Freeway with South Yarbrough Drive, within a few hundred yards of the United States - Mexico border [3]. This low to middle income residential area is adjacent to a large recreational park (JP Shawver Park) which is equipped with a pool, tennis courts, baseball diamonds, playgrounds, and hiking/jogging trails. The neighborhood is less than one mile east of the JNWWTP, which is located in Juárez, Mexico. The Rio Grande

River, with canals along US and Mexico banks, flows between the El Paso Lower Valley Neighborhood and the JNWWTP (Figure 1).

Population data for the area surrounding the intersection of Yarbrough Drive and River Road include census tracts 38.01, 38.03, and 38.04. Demographic statistics for those areas include a total population of 13,807 persons in 3,950 households. This population includes 1,038 children less than 5 years of age, 1,665 people over 65 years of age, and 4,264 females between the ages of 18-64. This population consists of about 6,170 whites, 52 blacks, 130 American Indians and Alaska Natives, 17 Asians, and 3,228 people of other races. Of all these, 13,131 are considered to be Hispanic or Latino within any race (Table 1).

Facility Description

The JNWWTP (Figure 2) is designed to treat 57 million gallons of sewage/wastewater per day [4]. The plant can be modified to include aerobic digestion (a secondary treatment process), but as of September 2004, it was operating through the Advanced Primary Treatment (APT) stage only. In the APT process, raw sewage comes into the plant, and solid materials such as trash, debris, and grit are removed from the wastewater by settling and skimming. Chemicals are then added to the wastewater to enhance settling of the smaller, finer particles of waste and bacteria remaining. The liquid waste is disinfected with chlorine and discharged to the Aguas Negras, an irrigation canal which parallels the Rio Grande and joins the river about 80 miles downstream [5-8]. The canal is considered to be part of the treatment process because oxidation and biological breakdown of nutrients occurs in the canal. Fecal coliform levels, however, are still high where the canal and the Rio Grande meet. Evidence of residual sewage has also been observed [6].

The settled material (particles/bacteria) is removed and run through a belt press, which lowers the moisture content to about 70%. The resulting sludge is land-applied or stockpiled on site until it can be hauled to a location about 20 kilometers southwest of JNWWTP.

Facility History (Timeline)

1992 - Planning for the JNWWTP project begins [8].

1998 - Construction of the plant commences and is completed in 1999 [7].

1999/2000 - The JNWWTP begins operating. Prior to this, raw sewage from Juárez flowed into the Aguas Negras canal. This canal parallels the Rio Grande River and empties into it about 80 miles downstream [7].

2001 - El Paso residents living closest to the JNWWTP complain of strong sewage odors to various agencies [9-13]. The El Paso City Council requests that the El Paso City County Health and Environmental District become involved in the odor issue [5].

2002 - Complaints to the TCEQ regional office in El Paso (1 March 2002) document the occurrence of offensive odors near the Lower Valley area, Ysleta High School, Riverside High School, South Yarbrough Drive, Pasodale Drive, Alameda Avenue, Padres Avenue, and Zaragoza Avenue. Reasons for the strong odors and high H₂S levels likely include the dumping of wet sludge piles on the wastewater plant property, and inadequate slopes of sewer lines from

homes to the treatment facility. Because sewage remains in the sewage lines longer, anaerobic bacteria have more time to produce H₂S and other gases as they break down the sewage.

2003 - TCEQ conducts air monitoring downwind of the JNWWTP in February to measure H₂S, SO₂, and VOCs (including carbonyls) [1]. In June, the municipal authority responsible for operating the plant (Junta Municipal de Agua y Saneamiento-JMAS) requests that US communications about the JNWWTP be coordinated through the IBWC. This request results because a large group of concerned El Paso and Juárez citizens marched on the JMAS to demand an unscheduled meeting at the WWTP [14].

2004 - Concerns expressed by residents about possible health effects related to exposure to the odors [9, 15-17] receive the attention of US Representative Sylvestre Reyes. In June, he petitions ATSDR to evaluate whether working or living near the plant could affect people's health [3].

In July, the University of Texas El Paso (UTEP) presents H₂S data collected around the JN WWTP to the IBWC. A low-range OdaLog H₂S monitor continuously records 10-minute average H₂S concentrations (0.01 to 2 ppmv) at the plant property fence. Medium and high-range OdaLog H₂S monitors continuously record 60-second average H₂S concentrations (0.1 to 50 ppmv, 0.1 to 200 ppmv, and 0.1 to 1,000 ppmv) at sources of interest on the plant property [18].

In July, the IBWC meets with stakeholders to discuss the JNWWTP. Representatives from JMAS (the municipal authority responsible for operating the plant) state that they will remove sludge from the facility daily, and transport it to a location away from residential areas on the southwest side of Juárez. Prior to the fall of 2004, sludge was stockpiled in nearby fields owned by the treatment plant or trucked to a landfill southwest of Juárez. Residents of the nearby El Paso neighborhoods have reported that the piles of decomposing sludge near the facility have caused terrible odors. The TCEQ regional office indicates that the sludge is being burned [6].

JMAS acknowledges that improvements in plant operation are needed, and that adding aerobic sludge digesters is included in future plans. The IBWC plans to meet every 30 days to update stakeholders about ongoing efforts to reduce H₂S emissions and odors at the plant [14].

In August, TCEQ installs a 24-hour H₂S monitor (CAMS-36) in the neighborhood east of the plant. This monitoring station records date, time of day, wind speed, wind direction and H₂S level in ppbv every 5 minutes, 24 hours a day (except for periodic calibration).

In September, community members describe the odors as “excrement,” “rotten eggs,” “sewage smell,” “sulfur,” and “horrible when the winds are from the southwest” in conversations with DSHS staff. At a 29 September meeting of IBWC, JMAS, TCEQ and DSHS, it is reported that the plant is meeting water quality standards, but that Mexico does not have air quality standards for facilities which treat wastewater.

Community Health Concerns

Since 2001, members of the El Paso Lower Valley neighborhood have complained about odors from the JNWWTP. Health concerns such as allergies, upper respiratory problems, shortness of breath, asthma, headaches, and difficulty concentrating have been reported. Other concerns include diminished quality of life and reduced property values [15, 16, 19]. A public comment period was held from November 21 through December 23, 2005. No comments were received.

Site Visits

On 28 September 2004, DSHS and TCEQ staff visited the CAMS-36 station and toured the El Paso Lower Valley Neighborhood, located east-northeast of the JNWWTP, to learn about exposure pathways. We observed a children's playground, baseball diamonds, and other ball fields in a large, open park area between Independence Drive and Border Highway. We did not detect any significant sewage, rotten egg, or H₂S-like odors.

The following morning we accompanied TCEQ staff to visit the JNWWTP. As we neared the plant, we noticed H₂S odors. At the plant, sewage and rotten-egg odors were clearly present.

Reasons given for the strong odors and high H₂S levels included storing wet sludge piles at, and near, the wastewater plant and inadequate slopes of waste water lines carrying sewage to the treatment facility. Because sewage remains in the sewer lines longer, anaerobic bacteria have more time to produce H₂S, and other gases, as they break down the sewage. Steps to reduce H₂S emissions included reducing and/or eliminating on-site storage of sludge, odor containment using polyethylene covers over incoming waste streams and Archimedes screw lifts, and breaking down H₂S by using Sol-Air C16L & C48LF ultraviolet light generators.

DSHS team members contacted some residents by phone in September 2004 for an initial survey of when (time of day) odors were usually noticed, locations in the neighborhood where odors usually were noticed, and descriptions of the odors. DSHS team members met with residents on 12-14 November 2004 and 3 March 2005 to ask for help in gathering information for a two-week period with the intent of comparing reported bad odors with the TCEQ air monitoring data.

Methods

Environmental Monitoring

TCEQ conducted air monitoring downwind of the JNWWTP during 16-22 February 2003. Samples were collected to measure levels of H₂S, SO₂, and VOCs (including carbonyls). Seven locations along the Texas-Mexico border, and downwind of the JNWWTP, were monitored for H₂S and SO₂; SO₂ was monitored at one additional location. Five locations were selected for sampling VOCs. Only H₂S exceeded the TCEQ residential standard of 80 parts H₂S per billion parts of air (80 ppbv), which is defined as a 30-minute average H₂S level. The maximum H₂S level measured was 2,100 ppbv; the average level was determined to be 350 ppbv [1].

In August 2004, TCEQ installed a continuous air monitor station (CAMS-36) about 1 mile east-southeast of the JNWWTP and 0.5 mile south of the El Paso Lower Valley Neighborhood. This monitor collected wind speed, wind direction, and H₂S levels every 5 minutes, 24 hours a day, except for periodic calibration periods, from 8 August - 30 November 2004. Subsequently, DSHS staff received these data to supplement previous reports of H₂S exceedances (defined as 30 minute averages exceeding 80 ppbv) [20].

Quality Assurance and Quality Control

In preparing this health consultation on the public health significance of these data, we relied on information provided by TCEQ regarding adequate and appropriate quality assurance and quality

control (QA/QC) procedures. The QA/QC procedures used by TCEQ were thorough and appeared to be adequate and appropriate for our use of these data.

Data Analysis

DSHS staff reviewed air monitoring data from the CAMS-36 monitor operated by TCEQ from 12 August - 30 November 2004. DSHS staff imported text files from the CAMS-36 output into a Microsoft Excel 2000 spreadsheet and a Microsoft Access 2000 database. Maximum H₂S levels (5, 30, and 60-minute time periods) were considered in the context of concurrent wind direction, wind speed, and time of day.

Thirty-minute average H₂S levels at each given time generally were calculated as moving averages of seven recorded, 5-minute, H₂S levels starting at fifteen minutes before the nominal time and ending at fifteen minutes after the nominal time. Similarly, 60-minute average H₂S levels at each given time were calculated as moving averages of thirteen recorded, 5-minute, H₂S levels starting at thirty minutes before the nominal time and ending at thirty minutes after the nominal time. This method was chosen to avoid the positive or negative temporal shift in the moving average curve with respect to the underlying 5-minute data curve, as occurs when historical-only or future-only data, respectively, are used to calculate the moving average. Data were evaluated using various plots, charts and graphs.

Discussion

Results

Major findings are presented here. More detailed results are presented and discussed in Appendix B. Appendix B includes various supporting information including text, figures, graphs and plots.

From 12 August – 25 November 2004, 5-minute H₂S levels recorded at the CAMS-36 monitoring station ranged from non-detectable to 683 ppbv. About 9.3% of the 30-minute average H₂S levels were elevated above TCEQ target exceedance level (80 ppbv), 3.4% exceeded 160 ppbv, and 0.8% exceeded 320 ppbv (Figure 3). Additionally, 1.7% (549 of 31,968 calculated, 30-minute-average, H₂S levels) exceeded the acute-duration inhalation MRL of 200 ppbv recommended by the ATSDR.

Frequency distribution, cumulative frequency distribution, and exceedance distribution plots of the 30-min averages (expressed in percentages of all values measured) are shown in Figures 4, 5. The H₂S exceedances exhibited a clear cyclical pattern, with over 99% occurring between the hours of 6:00 PM and 8:00 AM (Figure 6).

Between the hours of 8:00 AM and 6:00 PM (Appendix B, Figure B3a), levels generally are very low (less than 9 ppbv). From 6:00 PM to 8:00 PM, H₂S levels tend, on average, to be elevated to near 60 ppbv when the winds are out of the WNW or when they are out of the SE/SSE directions (Appendix B, Figure B3b). For other times of the night and early morning, most H₂S elevations appear to have occurred when winds were anywhere from the SE clockwise through the NW (Appendix B, Figures B3c-h).

The greatest number of the exceedances occurred when the winds are out of the WNW direction - the direction of the JNWWTP (Appendix B, Figures B4a, b). There were three peaks when winds were out of this direction: 9:00 PM, 3:00 AM, and 6:00 AM. There was a secondary set of peaks when winds were out of the SE: 9:00 PM and 4:00 AM (Appendix B, Figures B4c-h). Plotting 5-, 30-, and 60-minute average H₂S levels, show a somewhat more muddled picture, with irregular elevations, generally between 12:00 AM and 7:30 AM and wind directions between SSE and NNW. Winds are generally from the WNW or the ESE in the Lower Valley Neighborhoods of El Paso during August - November (Appendix B, Figures B4i, j).

The most likely source of the hydrogen sulfide levels when the wind is out of the WNW is the Juarez North Wastewater Treatment Plant. The source of odors when the winds are out of the SE is unknown; however, two possible sources, the El Paso Wastewater Treatment Plant and the Juarez South Wastewater Treatment Plant, are on either side of the river approximately 5 miles from the CAMS-36 monitoring station.

Contaminants of Concern

Hydrogen Sulfide

Hydrogen sulfide (H₂S) is a colorless, flammable, poisonous gas with a characteristic odor of rotten eggs. Some individuals can smell H₂S at concentrations as low as 0.5 ppbv, but, for most of the general population (68%), the detection threshold is between 2 and 30 ppbv. Signs and symptoms of H₂S exposure are listed in Table 2. Natural sources of H₂S include crude petroleum, natural gas, volcanic gases, hot springs, and decaying organic matter. It also is released from human and animal waste and can be found in sewage treatment facilities, sediments of fish aquaculture, and in livestock barns or manure areas. Industrial sources of H₂S include petroleum refineries, natural gas plants, petrochemical plants, coke oven plants, pulp and paper mills, food processing plants, and tanneries [2, 21].

Health Effects

As mentioned in the prior Facility History and Site Visit sections, residents have reported to DSHS that they have experienced health effects associated with H₂S exposure. Symptoms mentioned to DSHS staff included chronic headache; nausea; unexplained chronic cough; wheezing; increased asthma; shortness of breath; and irritated, watery eyes.

Acute Exposure

Short-term exposures to high levels of H₂S may cause a variety of adverse health effects. For example, a number of occupational studies have reported respiratory distress in workers with exposures to H₂S at levels higher than 40,000 ppbv. These studies also document changes in oxygen uptake and shortness of breath in subjects with short-term exposure to H₂S at levels between 5,000 and 10,000 ppbv [22-27].

At high concentrations, H₂S gas can be a significant eye irritant, causing keratoconjunctivitis, punctuate corneal erosion, blepharospasm, lacrimation, and photophobia [28,29]. A retrospective study of 250 Canadian workers who submitted workers' compensation claims for H₂S exposure found that 18% had developed conjunctivitis, some cases of which persisted for several days [30]. Although acute exposure to H₂S may clearly result in eye irritation, none of these instances of ocular exposure have reported permanent eye damage [2, 29-33].

Prolonged exposure to high levels of H₂S (greater than 100,000 ppbv) can cause a condition known as “olfactory fatigue,” in which the exposed individual is no longer able to smell the gas. Under these circumstances, the person may not be aware of increasing H₂S levels [2].

Other studies have shown measurable effects at considerably lower levels. For example, a controlled exposure study has reported that 2 out of 10 asthmatics exposed to H₂S at 2,000 ppbv for 30 minutes had >30% changes in airway resistance and specific airway conductance, implying bronchial obstruction [22]. This study was used by ATSDR to derive the Minimal Risk Level (MRL) of 200 ppbv for acute-duration inhalation exposures to H₂S [2]. In this derivation, they divided the Lowest Observed Adverse Effect Level (LOAEL) of 2,000 ppbv by an uncertainty factor of 10 (3.16 for use of a minimal LOAEL and 3.16 for human variability).

Tearing of the eyes has been noted in Fischer-344 rats exposed to H₂S at 400,000 ppbv (but not 200,000 ppbv) for 4 hours [34]. Furthermore, guinea pigs exposed to H₂S at 20,000 ppbv, 1 hour per day for 20 days, showed signs of eye irritation during the exposure [35]. However, no ocular lesions were found on microscopic examination of the eyes of crossbred pigs exposed to H₂S at 8,500 ppbv 24 hours per day for 17 days [36]. Also, no exposure-related histopathological changes were detected in the eyes of F-344 or Sprague-Dawley rats or B6C3F₁ mice exposed to Time Weighted Average (TWA) concentrations 10,000; 30,000; or 80,000 ppbv of H₂S for 6 hours/day, 5 days/week, for 90 days [37]. ATSDR has derived an MRL for intermediate duration exposure of 20 ppbv [2]. The intermediate MRL is based on an identified NOAEL of 10 ppm and a LOAEL of 30 ppm for olfactory neuron loss and basal cell hyperplasia in the olfactory epithelium of the nose in male Sprague-Dawley rats [2]. This MRL was derived by dividing the estimated human equivalent dose for the NOAEL of 0.46 ppm by an uncertainty factor of 30 [2].

Chronic Exposure

ATSDR has not yet derived a chronic MRL; however, long-term exposure to H₂S also may result in adverse health effects. For example, workers in the shale industry, with chronic-duration exposure to H₂S at levels often exceeding 20,000 ppbv, have reported chronic neurological symptoms, including fatigue, loss of appetite, headache, irritability, poor memory, and dizziness [28].

A recent study examining health effects in a community exposed to low levels of H₂S noted that, after days when H₂S levels are consistently above 30 ppbv, there is an increase in asthma-related hospital visits among children [38]. Several studies of communities exposed to low levels of malodorous sulfur compounds (including H₂S, methyl mercaptan, and methyl sulfides) reported an increase in nasal symptoms, coughs, and breathlessness or wheezing with increasing air concentrations of these compounds [2]. However, it is not known if these symptoms can be attributed solely to H₂S, because other potentially irritating compounds were present as well. Two New York communities and an Indiana community, with chronic exposure to H₂S originating from landfills, reported eye, throat, and lung irritation; nausea; headache; nasal blockage; sleeping difficulties; weight loss; chest pain; and asthma attacks. The levels of H₂S measured in these communities ranged from 300 ppbv to 4,000 ppbv in ambient air [21, 39].

Public Health Implications

The highest 5-minute peak H₂S level measured in this El Paso community was 683 ppbv, which is about three times below the LOAEL for H₂S (2,000 ppbv), but 1.7% (549 out of 31,968 of the

calculated, 30-minute-average, H₂S levels) exceeded the acute-duration inhalation MRL of 200 ppbv recommended by the ATSDR. Consequently, it is possible that a few sensitive individuals with asthma may occasionally experience diminished lung function as a result of their H₂S exposures in the affected neighborhoods. It is also possible that some individuals may experience stuffy or runny nose, neuropsychological symptoms, or eye irritation when H₂S levels are sufficiently elevated. Depending on how sensitive the community is on average to the odor of H₂S, levels in the El Paso Lower Valley neighborhood exceeded the odor threshold 17–54% of the time during the period from 12 August – 5 November 2004.

Child Health Considerations

Information on the toxic effects of H₂S primarily pertains to animals and adult humans. It is important to note that children may be more sensitive to certain toxicants than adults [40, 41]. In communities faced with potential exposure to contaminants, the many physical differences between children and adults may require special emphasis. Because children play outdoors and exhibit behaviors that increase their exposure potential, they could be at greater risk than are adults from certain kinds of exposure to hazardous substances. A child's lower body weight and higher relative intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Also, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

We also recognize that the unique vulnerabilities of children demand special attention. Windows of vulnerability (critical periods) exist during development, particularly during early gestation, but also throughout pregnancy, infancy, childhood and adolescence periods when toxicants may permanently impair or alter structure and function [42]. Unique childhood vulnerabilities may be present because, at birth, many organs and body systems (including the lungs and the immune, endocrine, reproductive, and nervous systems) have not achieved structural or functional maturity. These organ systems continue to develop throughout childhood and adolescence. Children may exhibit differences in absorption, metabolism, storage, and excretion of toxicants, resulting in higher biologically effective doses to target tissues.

Conclusions

Levels of H₂S measured in this area of El Paso are above odor thresholds for normal healthy adults. The most likely source of the hydrogen sulfide levels when the wind is out of the WNW is the Juarez North Wastewater Treatment Plant. The source of odors when the winds are out of the SE is unknown; however, two possible sources, the El Paso Wastewater Treatment Plant and the Juarez South Wastewater Treatment Plant, are on either side of the river approximately 5 miles from the CAMS-36 monitoring station.

Exposure to levels of H₂S measured in the El Paso Lower Valley neighborhood could result in adverse health effects (coughs, diminished lung function, wheezing, stuffy or runny nose, eye irritation, neuropsychological symptoms, nausea, headaches, and sleeping difficulties) for sensitive individuals. We therefore, conclude that the site poses a public health hazard for sensitive adults and children.

Recommendations

The TCEQ should consider identifying other sources of H₂S to the SE of the affected neighborhoods and, through air monitoring, try to quantify their contribution to H₂S levels.

Depending on the results of these investigations, the TCEQ should take additional steps as needed to reduce H₂S emissions.

The IBWC should continue working with the JNWWTP to reduce releases of H₂S.

Public Health Action Plan

Actions Completed

1. Technical staff from the TNRCC, the Water Environment Association of Texas, NADBANK, and various volunteer engineering and operations professionals met in April 2002, to develop a resolution to the problem and determine the feasibility of providing wastewater treatment plant operator training.
2. In the summer of 2002, JMAS piloted the use of Sol-Air C16L, CF32LF, &/or C48LF ultraviolet light generators to reduce H₂S emissions from the wastewater stream at the treatment plant.
3. In July 2004, JMAS began transporting sludge from the JNWWTP to a remote landfill area approximately 12 miles to the southwest.
4. The TCEQ installed an H₂S air monitor (CAMS-36) in August 2004, and, except for a few down periods, they have been monitoring H₂S levels at 5-minute intervals since then.
5. Applied Environmental Services, an El Paso company, has piloted an odor control treatment system at the facility [16]. Under this system, areas of high emissions are identified and covered with an opaque, nylon-fiber-reinforced, polyethylene sheet. The confined emissions are treated with UV light, which breaks down the H₂S according to the reactions outlined in Figure 8d. This process has reduced H₂S levels in some areas by as much as a factor of 10.

Actions Planned

1. AES, an El Paso company, is planning to install permanent cover over the wastewater influent pretreatment canal and over the wastewater lift screws. The installation of the odor control treatment system is planned [16].
2. The BECC plans to repair and replace 13 miles of sewage pipes as well as to install 36 miles of pipes to convey wastewater to the North and South WWTPs.
3. The JMAS plans to get funding to build a pipeline between the two facilities in order to transport sludge from the north plant to the more remote south plant.

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Table 1. Demographic Data for the Lower Valley Neighborhoods, El Paso, TX, Based on Year 2000 U.S. Census.

Category Description	2000 Census Tract Number			
	38.01	38.03	38.04	Total
Total Population	6,147	3,564	4,096	13,807
Under 5 Years	392	270	376	1,038
65 and Above	878	400	387	1,665
Females 18 to 65	1,949	1,068	1,247	4,264
White alone	455	2,679	3,036	6,170
Black alone	21	11	20	52
Am Indian and Alaska Native	42	35	53	130
Asian alone	3	7	7	17
Some other race	1,317	831	980	3,228
Hispanic or Latino	5,944	3,333	3,854	13,131
Total Households	1,805	986	1,159	3,950

Table 2. Signs or Symptoms of Hydrogen Sulfide Inhalation Exposure at Various Air Levels (ppbv).

H₂S Level (ppbv)	Signs or Symptoms of Exposure
0.5 – 30	Odor threshold
30 – 100	Stuffy or runny nose, neuropsychological symptoms, respiratory symptoms exacerbated in some sensitive asthmatics
100 – 300	Nasal irritation, increasing stuffiness, increased neuropsychological symptoms, eye complaints, increased hospital visits for respiratory complaints including asthma
300 - 1,000	Increased nasal irritation & stuffiness, increased eye complaints, shortness of breath in some sensitive individuals
1,000 - 3,000	Eye irritation, cough, nasal congestion, increased signs of bronchial obstruction in asthmatics (increased airway resistance & decreased specific airway conductance)
3,000 - 10,000	Increasing eye & nasal irritation, sleeping difficulties, weight loss, increased blood lactate concentrations, decreased skeletal muscle citrate synthase activity, decreased oxygen uptake
10,000 - 30,000	Fatigue, loss of appetite, headache, pronounced eye & nasal irritation, irritability, poor memory, nausea, dizziness, slowed reaction time, short-term mood changes, poor color discrimination
30,000 - 100,000	Impaired neurologic function; increasing eye, nose, & throat irritation; stinging eyes; conjunctivitis; nausea; breathing difficulties; sleepiness
100,000 - 300,000	Olfactory fatigue, severe eye/nose/throat irritation, keratoconjunctivitis (sometimes with subsequent infection), punctuate corneal erosion, blepharospasm, lacrimation, photophobia, headache, visual & memory impairment, rigid movements, reduced motor function, slight tremor, ataxia, psychosis, abnormal motor function
300,000 - 1,000,000	Muscle cramps, low blood pressure, severe respiratory distress, respiratory paralysis, loss of consciousness, death in 30 minutes or less
>1,000,000	Death from respiratory paralysis in less than 20 minutes

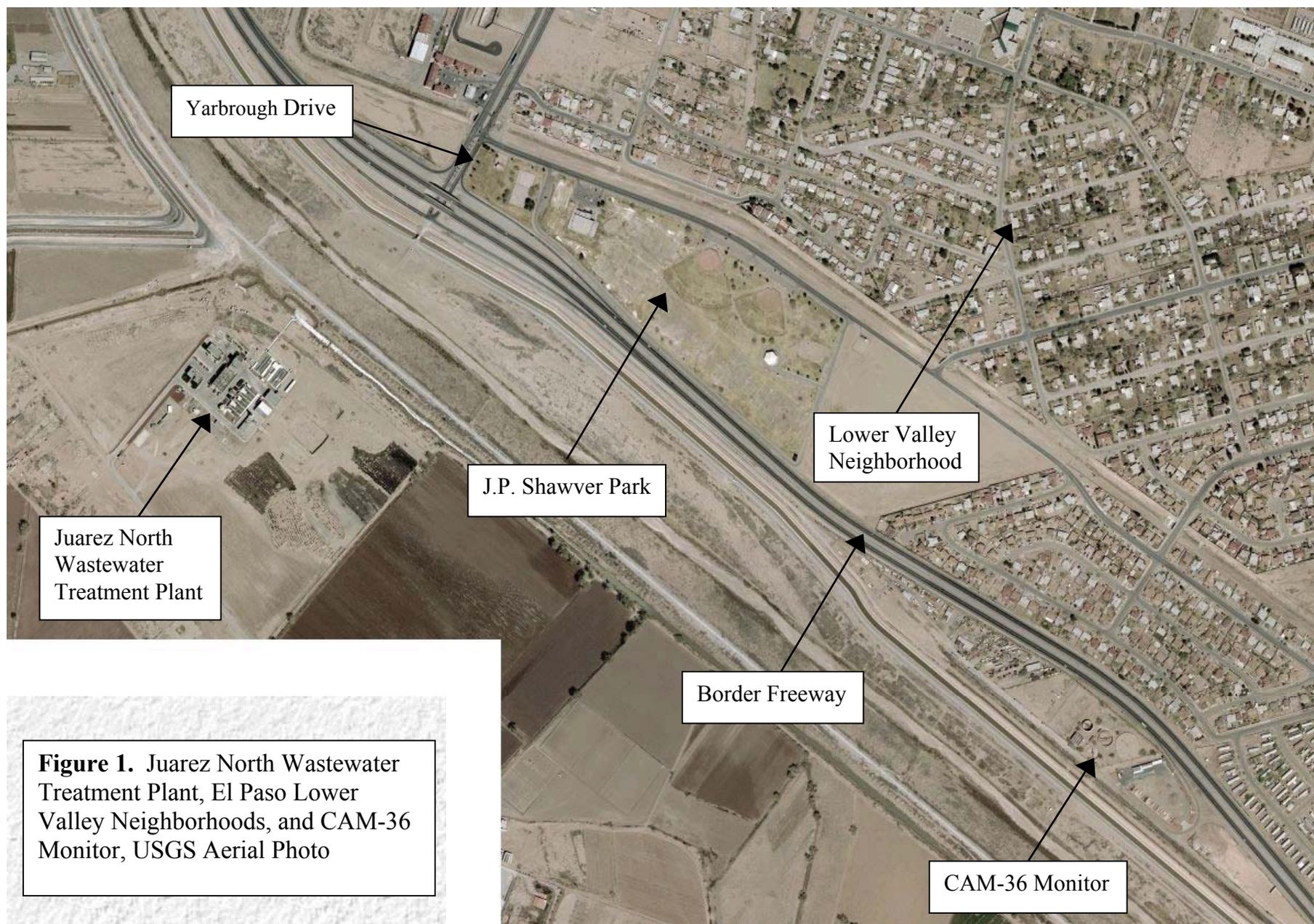


Figure 1. Juarez North Wastewater Treatment Plant, El Paso Lower Valley Neighborhoods, and CAM-36 Monitor, USGS Aerial Photo

Figure 2. Model of the Juarez North Wastewater Treatment Plant



Figure 3. Percent of 30-min Average H₂S Levels Exceeding Specified Value, CAMS-36 Monitor, El Paso, 8/14/04-11/31/04

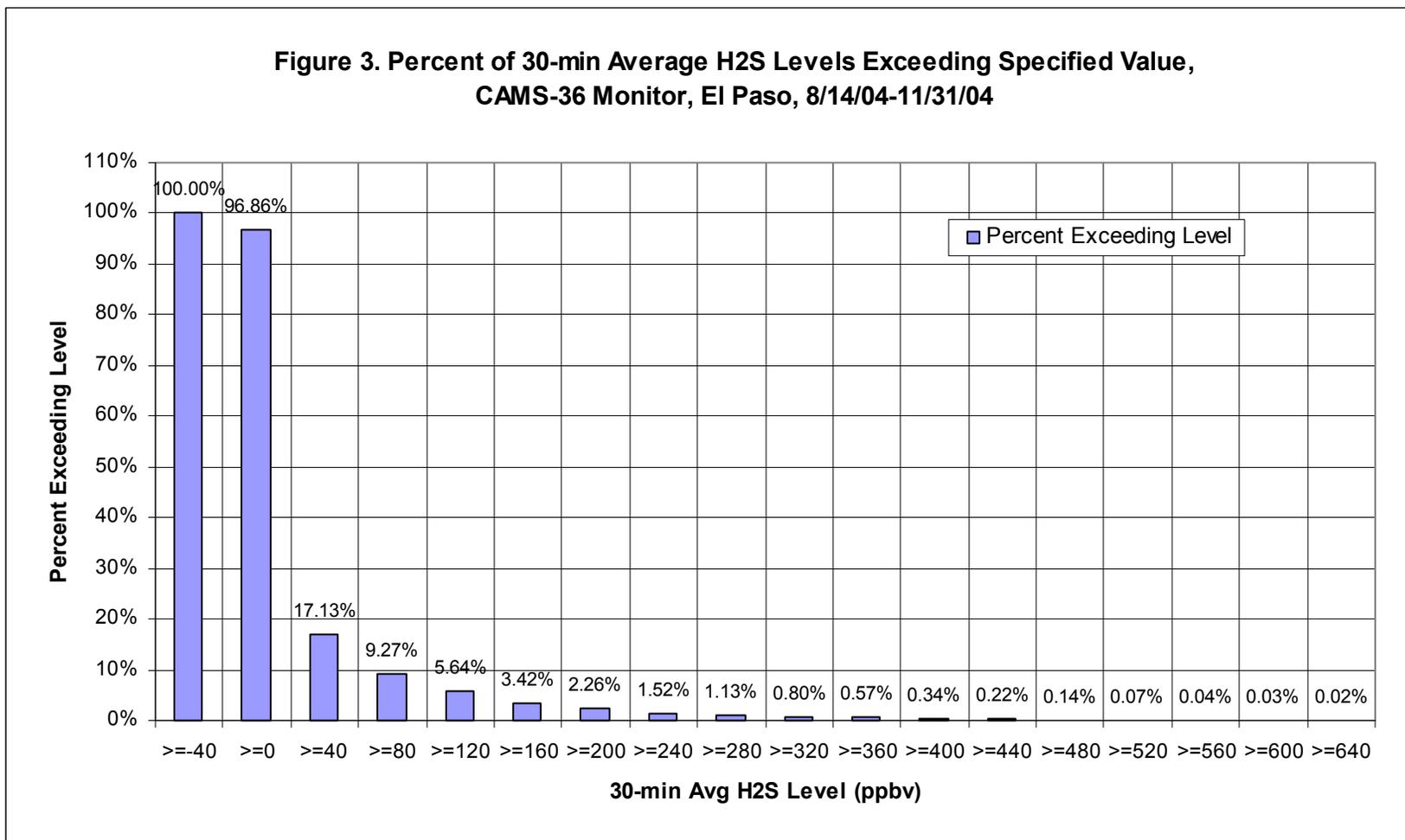


Figure 4. Percentile Frequency Distribution of 30-min Avg H₂S Levels, CAMS-36, El Paso, 8/14/04-11/31/04

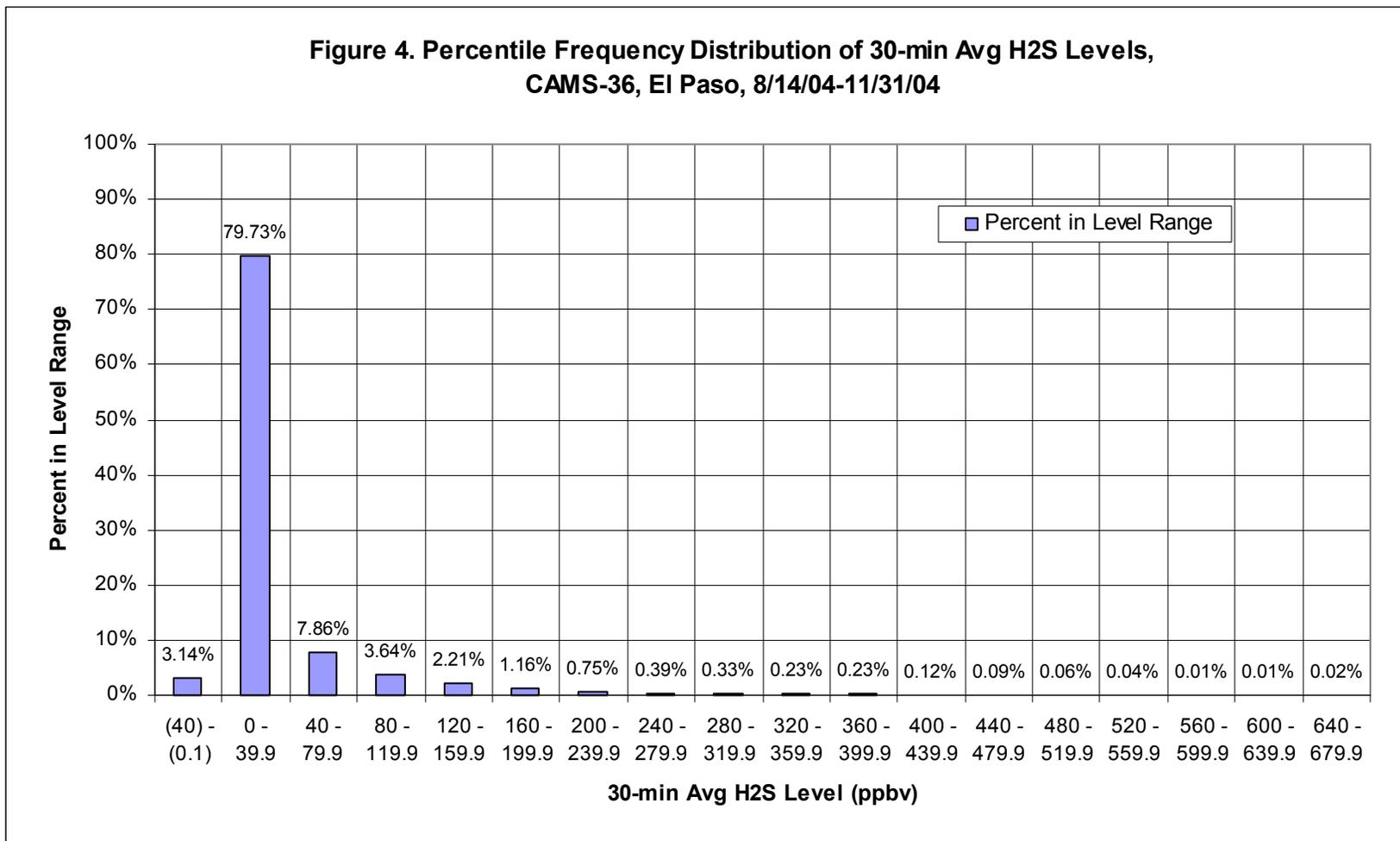
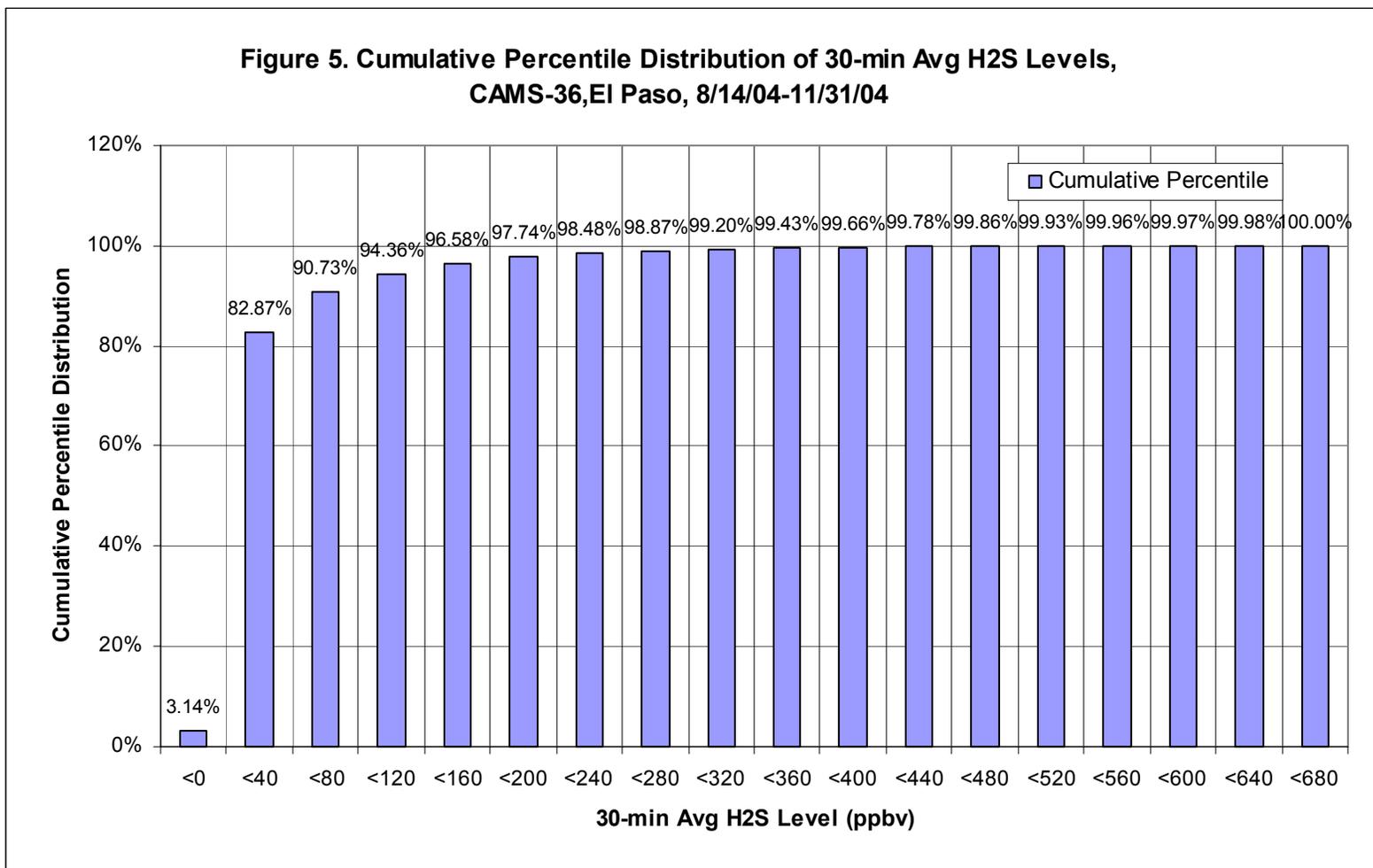
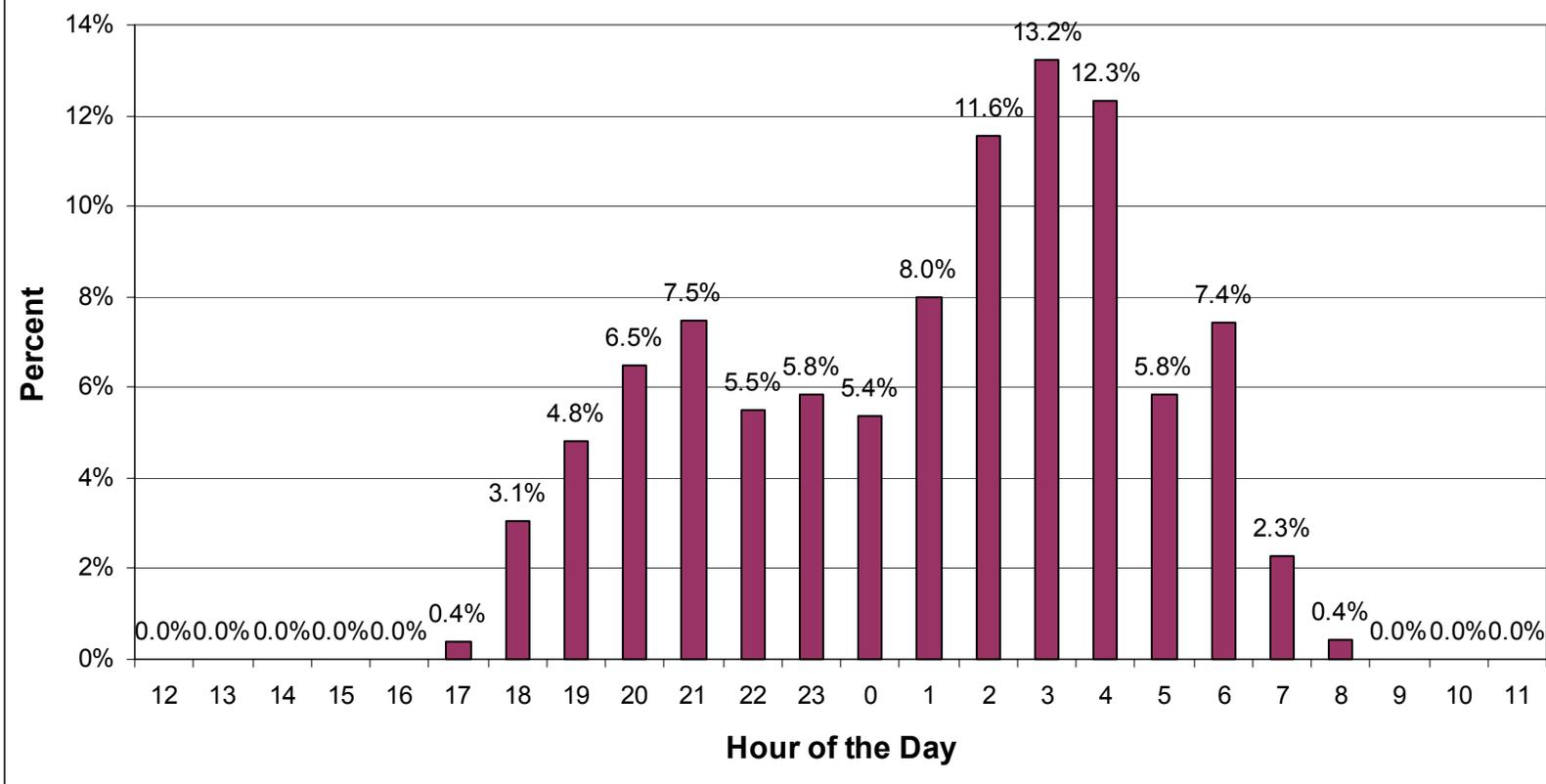


Figure 5. Cumulative Percentile Distribution of 30-min Avg H₂S Levels, CAMS-36, El Paso, 8/14/04-11/31/04



**Figure 6. Percent Distribution of H₂S Exceedances by Hour of the Day,
CAMS-36, El Paso, 8/12/04 - 11/30/04**



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Certification

This public health consultation on hydrogen sulfide exposures in El Paso (El Paso County), Texas and JNWWTP, Chihuahua, Mexico was prepared by the Texas Department of State Health Services (DSHS) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with methods and procedures approved at the time the public health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

Technical Project Officer, CAT, SPAB, DHAC, ATSDR

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

Team Lead, CAT, SPAB, DHAC, ATSDR

APPENDIX A. Acronyms and Abbreviations

AES	Applied Environmental Services
ATSDR	Agency for Toxic Substances and Disease Registry
BECC	Border Environment Cooperation Commission
CAMS	Continuous Air Monitoring Station
CILA	Comisión de Límites y Aguas (the Mexican Section of the International Boundary and Water Commission)
DSHS	Texas Department of State Health Services (formerly TDH)
EPA	United States Environmental Protection Agency
EPCCEHD	El Paso City/County Environmental Health District
EPLVN	El Paso Lower Valley Neighborhood
H ₂ S	Hydrogen sulfide
IBWC	International Boundary Water Council
JMAS	Junta Municipal de Agua y Saneamiento
JNWWTP	Juárez North Wastewater Treatment Plant
NJWTP	North Juárez Wastewater Treatment Plant
ppbv	Parts per billion by volume
ppmv	Parts per million by volume
RfD	Reference Dose
SO ₂	Sulfur Dioxide
TCEQ	Texas Commission on Environmental Quality (formerly TNRCC)
TDH	Texas Department of Health
TNRCC	Texas Natural Resources Conservation Commission
VOC	Volatile Organic Compound

APPENDIX B. Additional Data Evaluation and Results

Initial display of the data consisted of a series of 15 charts (Figures B1a-o) plotting 30-min average H₂S levels (ppbv) by date and time of day, each chart spanning 7 days of the 15-week measurement period from August 12 - November 25, 2004. For each 30-min average H₂S level, the corresponding 30-min average wind direction (0-360 degrees) was plotted as a separate series using the same numeric scale (0-700) used for H₂S levels. In some of the charts, when the wind direction repeatedly crossed the 0°/360° direction (i.e., due north), 360° was either added to or subtracted from the wind direction value in order to reduce the apparent but misleading dramatic fluctuations in wind direction. For reference, the TCEQ 30-min average H₂S Target Exceedance Level of 80 ppbv was plotted as a third series on each chart.

Review of the preceding 15 charts showed a clear cyclical pattern for H₂S emissions with nearly all of the significant elevations occurring between the hours of 6:00 pm and 8:00 am. Based on the data reviewed, the H₂S levels at the CAMS-36 station exhibit a two phase peak during the night time hours. The first occurred at 9:00 pm (range, 6:00 pm to 11:00 pm) and the second at 3:00 am (range, 1:00 am to 5:00 am). The average level during the period from 6:00 pm to 8:00 am was 10 times higher than the period from 8:00 am to 6:00 pm (43.3 vs. 4.38 ppbv).

Although it appears that many elevations coincided with winds from the west or northwest, other elevations occurred when winds were out of the south, southwest, and southeast. In an attempt to identify these temporal and directional patterns, all data points were coded to one of the 8 major points of the compass (i.e., N, NE, E, SE, S, SW, W, or NW). Mean H₂S levels were calculated for each 5-min period of the day from August 12 - November 25, 2004 and for winds coming from each of the 8 major points of the compass. The wind directions most commonly associated with elevated H₂S levels also demonstrated a biphasic peak, with one directional peak occurring when winds are from the west-northwest (292.5°, range 270° – 315°) and the other directional peak occurring when the winds are from the southeast (135°, range 112.5° - 157.5°).

These data were then used to generate 30-min average and 60-min average H₂S levels. These data are shown in Figures B2a-i along with the 5-min average levels and the TCEQ 30-min average H₂S Target Exceedance Level (80 ppbv).

For better directional analysis, all data points were coded to one of the 16 standard points of the compass (i.e., N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, or NNW). Average H₂S levels were calculated for each 2-hour period of the day from August 12 - November 25, 2004 and for winds coming from each of the 16 standard points of the compass.

These data were plotted as an Excel 2000 “Radar Plot” showing the magnitude of the average H₂S level by wind direction for each 2-hour period of the day. The resulting “Radar Plots” were then superimposed over an aerial photo of the area of concern taken by the US Geological Survey on 26 March 2002.

The CAMS-36 monitoring station is located at the origin of the plots, and the JNWWTP is located at the end of the WNW radial grid line (Figures B3a-i). The most likely source of the H₂S levels when the wind is out of the WNW is the JNWWTP, which lies at a bearing of 292° from the CAMS-36 station. The source of the odors when the winds are out of the SE is unknown, however, two possible sources include the Juárez South WWTP and the El Paso WWTP, both of which lie about 5 miles SSE of the CAMS-36 monitoring station, but are on opposite sides of the river. Elevated H₂S levels, when the winds are from the south to the west (180° to 270°), could be arising from the partially treated sewage as it passes down the Aguas Negras canal parallel to the Rio Grande River.

To further illustrate temporal and directional patterns, 3-dimensional contour plots of H₂S levels were generated with hour-of-the-day on the x-axis, wind direction on the y-axis, and number of exceedances, 5-minute H₂S levels, 30-minute average H₂S level, or 60-minute average H₂S level on the z-axis (Figures B4a-h). Similar contour plots showing wind direction frequencies were generated, with hour of the day on the x-axis, wind direction on the y-axis, and 5-minute wind direction counts on the z-axis (Figures B4i-j).

The contour plots of H₂S exceedances (Figures 4a, b) clearly show that the greatest number of the exceedances occur when the winds are out of the WNW direction - the direction of the JNWWTP. There are three temporal peaks when the winds are out of this direction, one at 9:00 PM, another at 3:00 AM, and a third minor peak at 6:00 AM. There is a secondary set of peaks when the winds are out of the SE, one occurring at 9:00 PM and another at 4:00 AM.

Plotting 5-, 30-, and 60-minute average H₂S levels (Figures 4c-h) shows a somewhat more muddled picture, with irregular elevations, generally between 12:00 AM and 7:30 AM and wind directions between SSE and NNW. The winds are generally out of the WNW or the ESE in the Lower Valley Neighborhoods of El Paso from August – November (Figures 4i, j).