Health Consultation

Evaluation of Reported Animal Health Issues

as part of the

MIDLOTHIAN AREA AIR QUALITY PETITION RESPONSE

MIDLOTHIAN, ELLIS COUNTY, TEXAS

JUNE 16, 2016

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

Health Consultation: A Note of Explanation

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

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

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For more information about ATSDR's work in Midlothian visit http://www.atsdr.cdc.gov/sites/midlothian/ or call 1-800-CDC-INFO.

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MIDLOTHIAN, ELLIS COUNTY, TEXAS

Prepared By:

Office of the Director
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry

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Acronyms and Abbreviations

APHIS	(USDA) Animal and Plant Health Inspection Service
ATSDR	Agency for Toxic Substances and Disease Registry
BRFSS	Behavior Risk Factor and Surveillance Survey
CDC	Centers for Disease Control and Prevention
CEDM	Corporation for the Economic Development of Midlothian
CO	carbon monoxide
COPD	chronic obstructive pulmonary disease
DHHS	(U.S.) Department of Health and Human Services
DSHS	(Texas) Department of State Health Services
EPA	(U.S.) Environmental Protection Agency
ERM	Environmental Resources Management
GFAAS	graphite furnace atomic absorption spectrometry
H_2S	hydrogen sulfide
ICP-MS	inductively coupled plasma mass spectrometry
µg/dL	micrograms/deciliter
mg/kg	milligrams/kilogram
MRL	minimum risk level
MSU	Michigan State University (Diagnostic Center for Population and Animal Health)
MTL	maximum tolerable level
NAAQS	National Ambient Air Quality Standards
NAHMS	National Animal Health Monitoring System
NOx	nitrogen oxides
NRC	National Research Council
PCB	polychlorinated biphenyls
$PM_{2.5}$	particulate matter up to 2.5 microns in size
PM_{10}	particulate matter up to 10 microns in size
ppb	parts per billion
ppm	parts per million
RR	relative risk
SO_2	sulfur dioxide
TAMU	Texas A&M University (College of Veterinary Medicine)
TCEQ	Texas Commission on Environmental Quality
TDSHS	Texas Department of State Health Services
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TVMDL	Texas Veterinary Medical Diagnostic Laboratory
TXI	Texas Industries, Inc.
USDA	United States Department of Agriculture
VMDB	Veterinary Medical Databases
VOC	volatile organic compounds
ZIP	zone improvement plan (code)

SUMMARY

INTRODUCTION

The Agency for Toxic Substances and Disease Registry (ATSDR) and the Texas Department of State Health Services (TDSHS) are conducting an extensive review of environmental health concerns raised by the community members in Midlothian, Texas. This health consultation, which examines animal health issues reported for the Midlothian area, is one of a series of six health consultations being prepared by ATSDR for this site.

The goal of this Health Consultation is to evaluate the animal health issues reported by residents living in the Midlothian area which they attribute to exposures from several facilities surrounding the community. While ATSDR does not traditionally address animal health issues, the agency decided to address this issue after recognizing that community members had concerns that the illnesses seen in their animals could indicate possible health problems for people.

The animal health concerns are summarized and an evaluation is made to put a perspective on the animal disease burden in the area. Since there are only limited animal disease registries and surveys and the rates of various animal health effects in Midlothian could not be determined, epidemiologic and statistical methods could not be used. Instead, the veterinary literature was reviewed for the known causes of these diseases and these diseases are discussed with respect to what is known about the chemicals of concern related to the cement kiln and steel facilities in the Midlothian area.

This Health Consultation provides the results from the exposure investigation conducted by ATSDR that looked at chromium and other metal concentrations in the blood and serum from dogs living in Midlothian and outside the Midlothian area. Community concerns on the comparison of animal and human health issues and the use of animals as sentinels are discussed.

CONCLUSIONS

ATSDR reached three main conclusions in this health consultation:

CONCLUSION 1
Animal health concerns

This animal health consultation does not and cannot determine cause and effect relationships between the reported animal health issues and the chemicals of concern identified at the site.

BASIS FOR DECISION

This health consultation summarized community concerns about animal health and provided information from the veterinary literature on the diseases. There are insufficient data to draw any conclusions

	about the cause of the reported animal health issues in Midlothian. ATSDR received reports of illness in dogs, horses, cattle, and other animals from residents of Midlothian. The rates of such animal health issues in Midlothian could not be determined from these reports. Additionally, there are only limited animal disease registries and surveys to serve as comparisons, so epidemiologic and statistical methods could not be used. In this health outcome data evaluation, geographical groupings serve as a surrogate for exposure data. All members in a group are treated as if they had the same exposure. This assumption cannot be verified and is typically untrue. Thus, this evaluation can suggest research questions to pursue, but cannot show cause and effect.
CONCLUSION 2 Exposure pathway analysis	There are several potentially completed exposure pathways for Midlothian area animals that could have posed a past, present, and future health concern. Irritant air pollutants such as sulfur dioxide, sulfuric acid aerosols, and cement kiln dust are a potential health concern to animals from inhalation or direct contact with chemicals deposited in the soil.
BASIS FOR DECISION	An evaluation of potential exposure pathways for animals in the Midlothian area was made by reviewing material included in the Midlothian Health Consultations that address environmental sampling of various media. Air emissions and deposition from air emissions may result in animals being exposed to contaminants via inhalation or ingestion and direct contact with soils. While concentrations of most of the chemicals analyzed were too low to anticipate a health effect, the irritant nature of sulfur dioxide, sulfuric acid aerosols, and cement kiln dust could present as mucus membrane and skin irritation to exposed animals.
CONCLUSION 3 Exposure Investigation	ATSDR's exposure investigation found that blood and serum concentrations of chromium and 16 other metals found in dogs from the Midlothian area were similar to the levels found in dogs residing beyond the Midlothian area.
BASIS FOR DECISION	ATSDR conducted an exposure investigation that compared blood and serum concentrations of chromium and 16 other metals in 10 dogs from the Midlothian area to the levels in 10 dogs residing beyond the Midlothian area. The results for both groups were similar for all metals. Statistical testing that looked specifically at chromium in blood found no significant difference between the two groups of dogs.

NEXT STEPS (All Conclusions)	ATSDR and TDSHS will present the findings of this health consultation to the community. As the remaining Midlothian health consultations that address environmental data are completed, ATSDR will discuss findings with respect to animal health issues, if they have not been addressed in this health consultation.
FOR MORE INFORMATION	If you have questions about this document or ATSDR's ongoing work on the Midlothian facilities, please call ATSDR at 1-800-CDC-INFO and ask for information about the "Midlothian, Texas evaluations." If you have concerns about your health, you should contact your health care provider.

1.0 Purpose and Statement of Issues

In July, 2005, a group of residents of Midlothian, Texas, submitted a petition to the Agency for Toxic Substances and Disease Registry (ATSDR). The petition expressed multiple concerns, but primarily that nearby industrial facilities were emitting air pollutants at levels that were affecting the health of residents. ATSDR accepted this petition, and the Texas Department of State Health Services (TDSHS), under a cooperative agreement with ATSDR, prepared a response.

Specifically, in December 2007, TDSHS, with ATSDR concurrence, issued a public comment draft Health Consultation that attempted to respond to many concerns outlined in the original petition. Many comments were received on the draft Health Consultation.

During the process of evaluating these comments, the ATSDR and National Center for Environmental Health Director requested that the ATSDR and TDSHS team take a more comprehensive look at the site. As outlined in its Midlothian Public Health Response Plan [ATSDR 2012a], ATSDR independently, but in coordination with TDSHS, will complete this reevaluation in a series of projects.

Purpose of this Document
ATSDR prepared this Health Consultation to review the animal health concerns reported by residents in the Midlothian area. Since, there are no standardized animal disease registries or surveillance systems, animal health reports and veterinary literature were reviewed to look for patterns of disease that fell outside the normal range. While this review cannot provide a cause and effect evaluation for the chemicals of concern at the site, this document discusses completed exposure pathways, possible chemicals of concern, and potential associations with animal health findings. Additionally, this document provides the results from ATSDR's exposure investigation involving blood and serum samples from dogs in the Midlothian area.

This document should be used in conjunction with the companion health consultations prepared or in preparation for the site in order to have a more thorough appreciation for the issues addressed.

This ATSDR Health Consultation on reported animal health issues is part of the series of ATSDR Health Consultations prepared or in preparation related to the Midlothian, Texas area air quality issues. As a public health agency, ATSDR does not traditionally address animal health issues, except as they relate to animals that may be consumed by humans. However, ATSDR decided to address this issue after recognizing that community members have many concerns about the health of their animals and concerns that these same illnesses seen in their animals could indicate possible health problems for people.

The goal of this Health Consultation is to address the animal health issues reported by residents living in the Midlothian area which they attribute to exposures from several facilities surrounding the community. To accomplish this, we reviewed information provided about the health problems seen in Midlothian animals and we searched current veterinary literature for evidence that these problems could be linked to industrial chemical exposure. Since the animal disease burden in the community could not be quantified, no standardized epidemiologic and statistical methods could be used.

2.0 Background

This section presents background information that ATSDR considered when evaluating the relationship between animal health concerns and industrial releases in the Midlothian area.

2.1 Location and Site Description

Midlothian is located in Ellis County, Texas, approximately 30 miles south of the Dallas/Fort Worth metropolitan area (Appendix, Figure A.2.1). The town consists of commercial/retail buildings and residential properties. With regard to air quality, the facilities of interest for this site are Gerdau Ameristeel, Ashgrove Cement, Holcim Texas, and Texas Industries[1] (TXI). These facilities are all located in Midlothian and its extra-territorial jurisdiction (Appendix, Figure A.2.2).

Much of the surrounding area is agricultural (Appendix, Figure A.2.3). Approximately 50% of the land within one mile of the facilities of interest is considered vacant or agricultural and available for development. There are many animals in the Midlothian area, including dog breeding operations; small horse, goat and cattle herds; wildlife; and many pet animals. The area in the southern section of Midlothian, south of US 67 and US 287, has a lower population density than the northern sections and is characterized by undeveloped property, family farms and ranches [Midlothian 2007]. In 2012, there were 613 agricultural facilities employing 3,719 workers in Midlothian and the extraterritorial jurisdiction [CEDM 2012].

2.2 History of Addressing Animal Health Concerns

Animal health issues have been a concern in Midlothian, Texas for over 20 years. Documents provided by community members show that citizens and some state agencies had reservations about the impact on public health, animal health, and agriculture of burning hazardous waste as fuel for cement kilns.

In 1994, in response to a rancher's inquiry about the potential for adverse health effects related to the agricultural field directly south of Chaparral Steel (now Gerdau Ameristeel) (Appendix, Figure A.2.1), the Texas Natural Resource Conservation Commission (TNRCC) (now known as the Texas Commission on Environmental Quality (TCEQ)) sampled pond water, forage vegetation, hay-bale, wheat, and soil for up to eighteen different metals [TNRCC 1994]. TNRCC's preliminary opinion was that grazing in the south hay field should be avoided due to the potential of impaired animal performance or in unsafe metal concentrations in food (e.g., milk or meat) for human consumption. TNRCC stated that metal concentrations in wheat from adjacent fields would be safe for human and animal consumption.

1 Texas Industries, Inc. (TXI) merged with Martin Marietta Materials, Inc. in January 2014. This document refers to this facility as TXI.

The results from the TNRCC environmental analyses described above were incorporated into a summary report on the "Critical Evaluation of the Potential Impact of Emissions from Midlothian Industries" prepared by TNRCC in October 1995. The report discussed the environmental monitoring in the Midlothian area that began in January 1991. At the time of the report, the south hay field had recently been purchased by TXI and was being used for industrial purposes, so the area was no longer considered a concern for cattle [TNRCC 1995].
As a response to residents' concerns about impacts on animal health from hazardous waste burning facilities in Midlothian, the United States Environmental Protection Agency (EPA) conducted an animal health survey. A work plan was prepared in January 1995, the voluntary survey was conducted in September 1995, and the final report was issued in January 1996 [EPA 1996]. This voluntary survey included the study area (Midlothian) and two comparison areas. Only 31 of 335 potential participants completed the animal health questionnaire. Response was so low, that it precluded EPA from making any statistical comparisons or conclusions [EPA 1996]. Due to confidentiality concerns of local veterinarians, no attempt was made to review veterinary records.

In July 2005, ATSDR was petitioned by Midlothian residents to evaluate health concerns that residents believed were caused by poor air quality due to industrial emissions. These concerns included the issue of area animals acting as sentinels (indicators or early warning system) of human exposure. In October 2005, the ATSDR and TDSHS met with several residents to listen to their concerns and discuss a plan of action.

The Texas Department of State Health Services prepared a letter health consult in January 2009 that evaluated contaminant results for five surface soil samples collected by TCEQ from a residential property near the Midlothian facilities [TDSHS 2009]. The soil data evaluated did not provide any insight into why the property owner or her animals were experiencing health effects.

In 2009, ATSDR conducted a formal community survey. During this survey, more residents expressed concern about their animals. These concerns were reported in the Public Health Response Plan prepared for the site [ATSDR 2012a]. Follow-up occurred with these specific residents in December 2009 when ATSDR veterinarians visited Midlothian animal owners, Midlothian area veterinarians, the Texas state veterinarian and various professors at the Texas A&M University (TAMU) College of Veterinary Medicine. Further follow-up took place in September 2010 when ATSDR veterinarians returned to Midlothian to meet with animal owners and the Texas Parks and Wildlife Department (TPWD) to gather additional information.

2.3 Chemicals of Concern

As mentioned in the introduction, this health consultation, examines reported animal health issues in the Midlothian area. It is one of a series of six health consultations being prepared by ATSDR to address health concerns related to the air quality in Midlothian. The four facilities of interest in Midlothian emit several pollutants at rates that have consistently ranked among the highest for Ellis County industrial facilities that submit data to TCEQ's Point Source Emissions Inventory. Aggregate air emissions include particulate matter (PM_{10} and $PM_{2.5}$), volatile organic compounds (VOC), nitrogen oxides (NOx), sulfur dioxide (SO_2), carbon monoxide (CO) and

combustion products from tires and hazardous waste used as fuel. Air sampling data evaluated in the Midlothian Health Consultation on National Ambient Air Quality Standards (NAAQS) criteria air pollutants and hydrogen sulfide (H_2S) [ATSDR 2016a] and on VOC and metal air emissions [ATSDR 2015b] identified several air pollutants of concern for sensitive individuals. The Midlothian Health Consultation on VOCs and metals in soil, water, and other media evaluated contaminants that may be of concern for humans and animals [ATSDR 2016b].

Air sampling data from 1997 through late 2008 show that there were some infrequent periods when breathing air contaminated with sulfur dioxide (SO_2) for short periods could have harmed the health of sensitive individuals [ATSDR 2016a]. Data since 2008 show SO_2 at levels below those of health concern. Sulfur dioxide can combine with water vapors to form sulfuric acid aerosols that can acutely irritate the eyes, nose, and skin. Mucous membrane irritation would be anticipated in the animal population as well. Modeled levels of sulfuric acid aerosols using worst case conditions, were found to be at levels that could harm people's health [ATSDR 2015b].

Ozone was identified as a public health concern in the Midlothian Health Consultation on criteria (NAAQS) air pollutants and hydrogen sulfide [ATSDR 2016a]. Ellis County is part of the Dallas-Fort Worth ozone non-attainment area. Midlothian is crisscrossed by several major highways (Appendix, Figure A.2.2) and traffic is a major contributor to ozone levels. Since air monitoring began in 1997, ozone levels have occasionally been detected that would increase the likelihood of adverse respiratory effects for sensitive individuals. There were some rare occasions when ozone concentrations were above 100 parts per billion (ppb), a level that would be harmful to the general public, and most likely to animals, as well. Several studies have shown radiographic changes in the lungs of dogs that were exposed to particulates and ozone in urban environments [Reif 2011].

During the period 1993 to 1998, in a localized area north of the Gerdau Ameristeel fence line, airborne lead exposures could have harmed children who resided or frequently played in the area [ATSDR 2016a]. Since 1998, air levels of lead in this area have decreased. In animals, cattle are more commonly affected by lead poisoning than other species [Hoff 1998]; indiscriminate feeding habits might explain this finding. Lead poisoning is more common in cattle younger than 4 years of age and the peak occurrence of lead poisoning in cattle is in the late spring and summer [Mavangira 2008].

Based on available data, breathing air contaminated with fine particulate matter ($PM_{2.5}$) for a year or more was not determined to be a public health concern [ATSDR 2016a]. However, there have been infrequent, but potentially harmful, short term levels of $PM_{2.5}$ measured in Midlothian that would be especially concerning to sensitive individuals. Cement kiln dust, which includes particles of many sizes, is highly alkaline and can cause irritation of exposed skin, eyes, and mucous membranes from direct contact. ATSDR's health consultaton on NAAQS stated that it would not be inconsistent with the operations at the three cement plants operating in Midlothian where some releases of cement kiln dust could occur [ATSDR 2016a]. Particulate modeling [ATSDR 2015b; 2016a] and tapelift samples [ATSDR 2016b] that contained cement dust or limestone provide support that airborne deposition of cement kiln dust occured in the community.

Exposure routes that are more relevant for animals than people in the Midlothian area include direct soil contact and ingestion of vegetation. The Midlothian Health Consultation on volatile organic compounds and metals in media other than air reviewed the data available on soil and vegetation [ATSDR 2016b]. Sampling of vegetation and hay bales from fields surrounding Chaparral Steel was performed in 1994 and 2004 because of concerns about cattle grazing in those fields and the hay bales being used for animal feed. Iron, an essential mineral for animals, was found in hay bale and vegetation samples taken from fields surrounding the Chaparral Steel (now Gerdau Ameristeel) facility at concentrations above the National Resource Council's (NRC) maximum tolerable level (MTL) in cattle feed [TNRCC 1994]. Iron toxicity is not common in most domestic animals; uptake is limited when levels are high and iron from natural feed is more tolerable than soluble iron compounds [NRC 2005]. In 2004, vegetation sampling by Chaparral Steel in fields south of the facility found some samples with aluminum and iron concentrations above the MTL for cattle feed. Samples from hay bales from the fields were not above the MTL in cattle feed [ERM 2004]. Aluminum is not an essential mineral for animals; however, livestock occasionally exposed to high levels usually do not show signs of toxicity if their gut and kidney functions are normal [NRC 2005].

3.0 Approach to Reported Animal Health Issues Review

ATSDR is a public health agency. As noted previously in Section 1, ATSDR has not traditionally addressed animal health issues. Animal exposures to contaminants and body burden have typically been addressed only as they relate to the human diet, such as fish, game, and cow's milk.

3.1 Data Sources

The goal of this review is to determine whether chemical releases from local industrial facilities could have affected the health of animals in the Midlothian area. We did this by reviewing provided information about the health problems seen in Midlothian animals and reviewing current literature for evidence that these problems could be linked to industrial chemical exposure. We looked for abnormal patterns of disease in the animal population.

Unfortunately, there are limitations to using animal data:

- Animal data tends to be anecdotal, often without confirmatory veterinary records. Lay terminology used in these reports may not adequately describe the medical condition.
- Breeding and herd records are useful in some situations, but records often are not thorough or accurate and may depend on recall.
- Most people do not consult veterinarians about their animal's health issues as often as they consult medical doctors about their own health problems. This makes it difficult to track trends in animal health or compare animal and human health trends.
- Many breeding operations do much of their own veterinary care and rarely consult a veterinarian for a birth defect or a death.
- Most animal studies are done on small sample populations because of the difficulty of obtaining data from larger populations.
- There are few databases available for animal health problems to determine background rates, and they are limited in scope and coverage.

To get background rates on animal health issues for this health consultation, journal articles especially those citing the Veterinary Medical Databases (VMDB) as a source of their animal epidemiological data were reviewed to determine if relevant prevalence and incidence data were available for the animal health issues of concern. The VMDB was originally an initiative of the National Cancer Institute for the purpose of studying cancer in animals. The database has been collecting animal visits of any kind from over 26 university veterinary teaching hospitals in the North America since 1964. There are over 7 million abstracted animal medical records available as a resource for researching animal diseases and treatments. The Texas A&M University Veterinary Medical Teaching Hospital contributed over 325,000 records between 1976 and 2001. Currently, there are 9 active institutions and 5 additional institutions working with VMDB to send their data.

Data on livestock mortality, some birth outcomes, and some disease rates were obtained from reports prepared by United States Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS). Under USDA's National Animal Health Monitoring System

(NAHMS), APHIS conducts national studies on the health, health management, and productivity of United States domestic livestock and poultry populations. The monitoring program, initiated in 1983, is designed to include States that represent 70% of the targeted animal commodity. Commodities are studied at intervals of 5 years or more. Data from cattle, horse, sheep, and goats were used in this Health Consultation. Livestock operations in Texas were included in each of these reports. Additionally, USDA APHIS performs animal disease surveillance as part of the National Animal Health Surveillance System. This surveillance system focuses on communicable diseases to protect animal health, human health, and the agricultural industry from foreign and epidemic diseases.

In order to truly attribute an illness to an environmental point source, it is necessary to do a thorough evaluation of the animal and the animal husbandry to rule out other underlying causes [Poppenga 2000]. Having records of disease in herds in conjunction with veterinary records and environmental data analysis can sometimes be informative [Lloyd 1991], but we have limited data of this type for Midlothian.

The data we do have for this health consultation review include: anecdotal information from Midlothian animal owners, some veterinary records, some breeding records, environmental media testing (air, soil, water, and vegetation), biological testing results, laboratory cancer diagnoses from the Texas Veterinary Medical Diagnostic Laboratory (TVMDL), and scientific literature.

Even though the information is too limited to quantify animal health problems in the Midlothian area, we will attempt a review based on the current information and determine what data gaps exist that prevent a more thorough analysis. Human and some animal health effects of the chemicals of concern will be reviewed in more depth in the Midlothian Health Consultations that address environmental sampling of other media [ATSDR 2015a,b; 2016a,b].

3.2 Exposure Pathway Evaluation

When performing public health assessments, ATSDR uses an exposure pathway analysis and media-specific health based comparison values to determine if a public health hazard exists at a site [ATSDR 2005]. For this health consultation, the exposure pathway analysis was adapted for use in evaluating animal health concerns.

An animal must be exposed to chemical contaminants in the environment before an adverse health effect is possible. An exposure pathway consists of five parts that must be present to be considered a completed exposure pathway. If one or more of the parts are unknown, it may be considered a potentially completed exposure pathway. The five parts of the exposure pathway include:

- Source of the hazardous chemicals.
- Fate and transport— the method that allows the chemicals to move from the source and contact the animals (surface water, groundwater, soil, dust, vapors, soil gas);
- Point of exposure—the point where the animal comes in contact with the chemical.
- Route of exposure—the route through which the chemical enters the animal (drinking, eating, breathing, touching).

- Exposed population—the animals who come in contact with chemicals released from the site.

An evaluation of potential and completed exposure pathways for animals in the Midlothian area was accomplished by reviewing material included in the Midlothian Health Consultations that address environmental sampling of various media [ATSDR 2015b; 2016a,b]. Exposure pathways are further characterized by the exposure's timing as past, present, or future. All three time frames are relevant for Midlothian area animals. An analysis of potentially completed exposure pathways for animals in the Midlothian area in the past, present or future is described below (Table 3.1).

Table 3.1 Potential and completed exposure pathways for Midlothian area animals

Pathway	Source	Fate and Transport	Point of Exposure	Route of Exposure	Exposed animal population
Inhaling air	Stack and fugitive emissions from factories	Winds carry emissions downwind	Locations downwind from factories	Inhalation	Pets, livestock, horses and wildlife
Contacting cement kiln dust	Emissions from bag house, especially when ruptured	Winds carry dust downwind	Locations immediately downwind from factories	Inhalation and dermal contact	Pets, livestock, horses and wildlife
Contacting contaminated soil off-site	Air emissions deposited in soil	Winds carry emissions which deposit in the soil	Locations immediately downwind from factories	Dermal contact, incidental ingestion	Pets, livestock, horses and wildlife
Contacting water in creeks and ponds downstream from factories	Contaminant from the quarries where waste water, incinerator ash and bag house contents are dumped	Rain overflows the quarries and washes contaminants downstream, leaching from quarries into groundwater.	Locations downstream from factories	Ingestion, dermal, consumption of biota from the stream	Pets, livestock, horses and wildlife with access to ponds and streams
Contacting sediment in creeks downstream from factories	Contaminant from the quarries where waste water and bag house contents are dumped	Rain overflows the quarries and washes contaminants downstream, contaminants settle in sediment.	Locations downstream from factories	Incidental ingestion, dermal	Pets, livestock, horses and wildlife with access to ponds and streams

Contact with a chemical contaminant in and by itself does not necessarily result in adverse health effects. A chemical's ability to affect the animal's health is affected by a number of other factors, including:

- How much of the chemical an animal comes into contact with (the dose);
- How long an animal is exposed to the chemical (duration of exposure);
- How often an animal is exposed to the chemical (acute versus chronic);
- The chemical's toxicity and how it impacts the body.

Other factors include the animal's history of past exposure to chemicals, current health status, age and sex, or genetic predisposition.

After determining the existence or potential for a completed exposure pathway, evaluation is made by comparing the dose an individual may receive to a health screening value. For human exposures, ATSDR has derived media-specific comparison values from minimal risk levels (MRLs). These comparison values were not designed for animal health screening values and ATSDR does not have any MRLs or other health-based screening values for animals. As explained in Section 3.1, for this health consultation, ATSDR used a variety of data sources to address animal health issues; however, the comparisons made were primarily on incidence of disease and not on toxicity doses.

As described previously (Section 2.2), TNRCC has used the National Academies National Research Council's (NRC) Committee on Minerals and Toxic Substances in Diets and Water for Animals, maximum tolerable level (MTL) for a screening value for vegetation and hay. The MTL of a mineral is "the dietary level that, when fed for a defined period of time, will not impair animal health and performance." The toxicity threshold is dependent on the animal species and tolerance usually increases with age. The MTL is based solely on animal health and productivity and does not take into consideration the possible human toxicity from consuming food products of animal tissues where minerals might have accumulated [NRC 2005]. Since this document does not review environmental sampling data, MTLs are not used as ingestion comparison values, but are used to compare differences in mineral tolerance between species.

3.3 Exposure Investigation

For some sites, where critical data is missing or not available that preclude reaching a health conclusion, ATSDR may conduct an exposure investigation. Typically, this investigation may include environmental and/or biological testing with the goal of determining whether people have been exposed to hazardous substances. For the Midlothian site, ATSDR took the opportunity following the demise of a litter of puppies in 2011 to perform some blood analyses on some dogs related to the litter. ATSDR conducted an exposure investigation as a follow-up to these preliminary clinical findings. The exposure investigation is presented in Section 5.0 Biological Testing.

4.0 Animal Health Issues

The animal health concerns reported by the community encompass many organ systems. The majority of the issues in horses and livestock were reported in the early 1990s, and we do not have recent data regarding the horse and cattle populations. Reports of problems in dogs are heavily centered around 2005, but date back to the 1990s and continue to the present. Some residents have commented on decreased numbers of wildlife and expressed concerns about fish kills. We categorized the problems reported by the community according to body system or health concern (Table 4.1).

Table 4.1 Health problems in Midlothian area animals as reported by community members.

Health Problem	Dog	Horse	Goat/sheep	Cattle	Other*
Birth Defects					
Limb Deformities	X	X	X	X	O
Ocular Deformities	X	X		X	
Facial deformities	X	X	X	X	
Reproductive tract deformities	X	X		X	O
Fetus & Newborn mortality					
Spontaneous abortion/Stillborn	X	X	X	X	O
Decreased newborn survival	X	X			
Infertility & Reproduction problems					
Twinning		X	X	X	
Cystic ovaries		X			
Other reproduction problems	X	X		X	Hh
Other Health Issues					
Dermatologic Illness	X		X		
Immune System Disorders	X	X	X		
Neurologic Illness				X	
Respiratory Problems	X	X	X		C,Hh
Thyroid Problems		X			
Cancer/tumor formation	X	X			R
Sudden Death	X	X	X	X	C,Ch,F

* Other animals include: cat (C), chicken (Ch), fish (F), hedgehog (Hh), ostrich (O), and rabbit (R).

BIRTH DEFECTS

Birth defects are structural or functional abnormalities that are present in the newborn animal at birth. Community members have reported the following birth defects in Midlothian-area animals:

Birth defect	Species
Limb deformities	Dogs, horses, ostrich
Coloboma (one eye not developed)	Dogs, horses
Neural tube defects	Dogs
Incomplete body wall closure	Dogs
Craniofacial deformities	Dogs, goats, cattle, horses, donkeys, sheep
Schistosomus reflexus	Cattle
Hydrocephalus	Dogs
Cryptorchid (undescended testicles)	Dogs, cattle, horses
External reproductive organs at birth	Horse

For humans, TDSHS maintains the Texas Birth Defects Registry and has conducted surveillance for human birth defects in Midlothian and Ellis County since 1997. However, there are no birth defect registries for animals. Most animals born with a birth defect do not survive or are promptly euthanized and necropsies are rarely performed; hence there are often no veterinary records for cases of birth defects in animals. The majority of the reports of birth defects in animals in Midlothian are personal recollections. We are unable to quantify the number of defects that have occurred to determine if there is a higher incidence in the area. In the United States, the USDA reports that for foals born alive that died within the first 30 days of life, birth defects were the cause of death in about 9 percent of the cases [USDA 2006].

Birth defects occur due to a variety of reasons, many of which are poorly understood. The majority of birth defects occur during the earliest stages of pregnancy when organs and other body structures are being formed. Common causes that are known to cause birth defects include genetic problems, fever, infection, certain medications, and exposure to toxins.

Cryptorchidism, failure of the testicles to descend normally, is an inherited congenital defect in dogs. A study by Yates [2003] found that the overall prevalence of cryptorchidism at a Royal Society Prevention of Cruelty to Animals veterinary clinic was 6.8% and was significantly higher in pedigree dogs as compared to crossbreed dogs. An analysis of horse veterinary records from the Veterinary Medical Databases revealed that cryptorchidism was one of the ten most common diagnoses reported for horses with a rate of 20.7 per 1,000 patients [Priester 1970]. The USDA reported a lower rate: for foals born alive, 0.3 percent of the foals had reproductive tract problems such as cryptorchidism or hermaphrodism (having both male and female sex organs) [USDA 2006].

Fetal exposure to some chemicals, especially during the first trimester, has been associated with abnormal development. There are no confirmed reports in the literature of birth defects in mammals exposed to industrial toxins in the wild, but it is theorized that exposure to environmental toxins could be influencing an increased rate of birth defects in wildlife, birds

and aquatic species [Vos 2000]. Laboratory animal studies have been used as a model for human birth defect risks for certain chemicals, although doses and delivery route are often not comparable to environmental exposures. While it is plausible that exposure to toxins in the environment contributed to the birth defects in Midlothian animals, more information on the specific exposures and the nature and quantity of defects from breeding or veterinary records is needed to test this link.

FETUS AND NEWBORN MORTALITY

Spontaneous abortion was reported in Midlothian area dogs, goats, horses, cattle and sheep. A perceived increased newborn mortality rate was reported in dogs, horses and cattle. We do not have numbers to evaluate the rate of abortion and loss in many of these species; however, we do have breeding records from a dog breeding facility.

Some records were provided from a dog breeding facility adjacent to two of the Midlothian industrial facilities that breeds both Miniature Pinschers and Doberman Pinschers. Spontaneous abortion and puppy mortality were not differentiated in the records; however, the owner reports that the majority of the losses were live puppies who died within two months of birth and that there were very few cases of spontaneous abortion and stillborn puppies. Not all losses were recorded in these records; some entire litters were lost and not recorded. The exclusion of this data will cause the calculated mortality rate to differ from the actual rate. There is a marked discrepancy between the mortality rates of the two breeds. These rates from records provided from the owner for 1993 through 2010 are defined in the following chart:

	Doberman Pinschers	Miniature Pinschers
Total puppies born	703	378
Average litter size	6.2	2.8
Puppies lost before two months of age	321	62
Mortality rate before two months of age	47.5%	17.7%
Puppies lost between two and four months of age	27	28
Mortality rate before four months of age	49.5%	23.8%

While residing on the same property, the two breeds in effect have different living environments. The Miniature Pinschers are confined to kennels with attached runs. These runs are covered with purchased sod each year so the dogs have very little contact with the soil. The Doberman Pinschers are allowed to roam the property; they have access to most of the yard and the property's pond. Due to the karst (landscape formed from soluble rocks) geology in the area, it is hard to predict patterns of ground water flow; however, the stream running on the backside of the property is downstream from the TXI and Gerdau steel facilities. When they are due to whelp, the Doberman Pinschers are moved to an environment similar to the Miniature Pinschers, which are kennels with attached sodded runs. The dogs remain there until the puppies are over two months of age. While veterinary records have not been examined, the breeder's veterinarian does not think that animal

husbandry contributes to puppy losses. His opinion is that the dogs are well cared for, including appropriate nutrition and a good preventive care program.

Average puppy mortality rates could not be found specifically for Doberman Pinschers, however, the mortality rates found in the literature for other breeds (including large and small breeds) range from 12% to 33% [Potkay 1997; Nielen 1998]. The Doberman Pinscher average mortality rate seen at this facility between 1993 and 2010 is above that range. Puppy loss can occur from a wide range of problems including: difficult labor or birth, lactation or nursing problems, accidental suffocation by the mother or other puppies, trauma, inadequate nutrition, extreme temperatures, poor sanitation, overcrowding, stress, birth defects and (most commonly) by infection with a variety of viral, bacterial or parasitic agents [Mandigers 2006; Van der Beek 1999].

There were no journal articles found showing an association between industrial exposure and increased neonatal mortality relating to dogs. These differing death rates given similar care and different living environments could suggest an association between maternal environmental exposures and mortality. There are insufficient environmental data to confirm or refute this potential association.

No rates could be determined from the neonatal mortality reports for livestock in the Midlothian area. To provide some context for the reader, information from the USDA National Animal Health Monitoring System (NAHMS) on neonatal mortality of domestic livestock is provided in the chart below:

	Percent (%) Born alive	Percent (%) Born dead or aborted	Reference
Foals	93.5	6.5	USDA 2006
Calves*	89.2	9.4	USDA 2010b
Lambs	96.0	4.0	USDA 2012
Kids	94.6	5.4	USDA 2010c

* Other (1.4%)—includes cow died, sold, or lost before calving.

Similarly, there was not enough data to evaluate death of young livestock in the Midlothian area. Nationally, in their national surveys, USDA found that 3.6% of calves born alive in 2007 died or were lost prior to weaning [USDA 2010a]. Calf deaths were higher in smaller herds. About one third died in each time category: within 24 hours, between 24 hours and 3 weeks, and between 3 weeks or more before weaning. About half of the calves that died that were less than 3 weeks old died of either birth-related or weather-related causes. Digestive or respiratory problems were the leading causes of death in calves older than 3 weeks.

In the NAHMS 2005 Equine study, 2.6% of the foals born alive died within the first two days and 2.3% died within the subsequent 28 days [USDA 2006]. The leading causes of foal deaths during these first 30 days were injury/wounds/trauma unrelated to birth (18.6%), unknown causes (17.9%), and failure to get colostrum or milk from mare (14.9%). As stated previously, 8.9% of the foal deaths were from birth defects and 10.7% of foal deaths were related to difficult delivery, trauma, or complications at birth [USDA 2006].

INFERTILITY AND OTHER REPRODUCTION PROBLEMS

The following problems have been reported by Midlothian community members about area animals: infertility in dogs, goats and horses; cystic ovaries in horses; and twinning in horses and cattle.

Infertility has many causes, including genetics, injury, infection, systemic or endocrine disorders and exposure to drugs or chemicals. It is suspected that endocrine disrupting chemicals released by incineration and other industrial processes can lead to fertility problems in animals and humans [Hutz 2006]. Numerous studies have demonstrated the effect of various industrial toxicants on fertility (male and female) in laboratory animals. One study of a sick cattle herd in Chile found decreased fertility with increased exposure to heavy metals from a copper smelting factory [Parada 1987]. No other reports of industrial exposures and infertility among domestic animals could be found in the literature.

Twinning was reported in cattle and horses in the area. Twinning rates vary widely by species, breed and herd. The twinning rate for beef cattle is 0.5% and 2% for dairy cattle and the rate increases with age [cited in Lloyd 1988]. Multiple ovulations that produce twinning are more common in Thoroughbred and Draft mares and in barren or maiden mares [Miller 1988]. Twinning in both species has a strong genetic influence, but can also be affected by medications and chemical exposures. Two studies were found that linked increased rates of twinning in cattle to industrial activities [Buckley 2007; Lloyd 1988]; no such reports could be found for horses.

We have been unable to examine veterinary or breeding records to determine fertility or twinning rates in Midlothian animals. Without knowledge of these rates and a thorough examination of the animal's health, husbandry and breeding conditions, we are unable to attribute these reported cases to possible chemical exposures.

DERMATOLGIC ILLNESS

Community members reported the following dermatologic conditions in Midlothian area animals: severe generalized demodex mite infection (demodicosis) in dogs; severe bacterial skin infection (pyoderma) in dogs; dermatitis of the paws (pododermatitis) in dogs; conjunctivitis in dogs and horses; and hair loss (alopecia) in dogs, squirrels, goats, and sheep.

With the exception of demodex, which is discussed below, all of the dermatologic symptoms are non-specific and can be caused by a variety of conditions. Allergies commonly cause pododermatitis, conjunctivitis, pyoderma and alopecia. Many of these conditions can also develop due to external or internal parasites, endocrine disease, hereditary disorders or other factors which cause immunosuppression, including exposure to toxins in the environment. Exposure to chromium has been shown to cause hypersensitivity reactions in many species, including dogs. Most of these studies have been done in a laboratory setting, but one dog study reported sensitivity of hairless dogs to chromium in metal cages [Kimura 2007]. It is

possible that chromium on the soil or water could cause a similar hypersensitivity reaction in dogs.

Dermatologic conditions are common in animals. Analysis by Priester [1970] of one year of veterinary records from the Veterinary Medical Databases found that the rate of skin-related diagnoses in horses was 140.5/1,000 patients. The USDA reported that 5.4% (54/1,000) of horse operations reported at least one horse affected with skin problems [USDA 2006]. Skin related diagnoses made up 11% (110/1,000 patients) of the total number of diagnoses for Swedish horses insured for veterinary care [Penell 2005]. Dermatitis due to infection (47.5/1,000 patients), allergic dermatitis (34.4/1,000 patients), and conjunctivitis (23.2/1,000 patients) were all among the ten most common diagnoses reported for dogs at 12 veterinary hospitals [Priester 1970].

Demodectic mange is a common skin disease in the southeastern United States [Sischo 1989]. It is caused by a mite, which resides in the hair follicles of all dogs. In some dogs, overgrowth of mites can cause localized or generalized demodicosis. Generalized demodicosis causes scaling and hair loss and can lead to a secondary bacterial infection and pododermatitis. The secondary infection can present with pustules, hair loss, and a severe pyoderma which needs to be treated with antibiotics. Dogs often recover from this condition with aggressive treatment, but in severe cases it can lead to infection of the connective tissue of the skin (cellulitis), lethargy, decreased appetite, swollen lymph nodes, sepsis and even death [Lemarie 1996]. Demodicosis is not a well understood disease. It is unclear why some dogs are able to fight the infection and others develop severe disease. It is theorized that a hereditary immunodeficiency, a T-cell defect, can lead to generalized demodicosis, however not all animals with this condition develop disease and it is thought that other immune suppressive factors contribute to its development [It 2010]. These factors can include concurrent disease, immunosuppressive medications, stress, poor husbandry, exposure to immunosuppressive chemicals, or other unknown factors.

There was no literature found that estimated the rate of disease in specific dog breeds or litters; however, the veterinarian of the Doberman Pinscher breeding facility in Midlothian believes that they have a high rate of demodicosis. In particular, there were two litters in early 2005 in which all of the puppies (same sire and different dams) developed severe generalized demodicosis at six or seven months of age. The puppies became severely ill within a few weeks. Several of the puppies died, the ones that survived had permanent follicular damage and never regrew their coats. Consultation with two board certified veterinary dermatologists and the regular veterinarian revealed that this rate of severe generalized demodicosis is very uncommon and that there is likely another factor causing immunosuppression in the dogs. The regular veterinarian indicated that the dogs are very well cared for and that animal husbandry did not contribute to the problem. It is plausible that an environmental exposure to toxins which suppress the immune system (see immune disorders discussion below) could cause enough immunosuppression to allow this severe form of the disease to develop in puppies with a predisposition to demodicosis. However, we are unable to establish a link between the exposure and disease. In part, this is because of inadequate environmental and biological sampling and information regarding underlying conditions in these dogs.

IMMUNE SYSTEM DISORDERS

Community members have reported the following immune disorders in animals in the Midlothian area: demodicosis in dogs; allergies in dogs and horses; swollen lymph nodes in dogs, horses and goats.

Immune disorders in animals have many causes. It is often possible to determine that an animal has an immune disorder with biological testing, but the cause and mechanism cannot always be determined. There are many known hereditary immunodeficiencies in various species and breeds [DeBay 2010]. Allergies usually have a hereditary component but primarily develop due to sensitization to allergens in the animal's diet or environment. Allergies have increased in humans and animals in recent years and it is hypothesized that air pollution may contribute to this increase. Swollen lymph nodes can develop in response to infectious agents, allergens, or cancer. Demodicosis is discussed above under dermatologic illness.

Studies in laboratory animals have shown that many industrial chemicals and byproducts, such as dioxins and heavy metals, can alter the immune system. These studies are the basis for several ATSDR minimal risk levels (MRLs) for chemicals. There is little data concerning industrial and environmental exposures and immune modulation in animals. However, a study of beef cattle residing near oil and gas production and processing facilities demonstrated decreased T-cell production with increased exposure to toluene; this finding was not observed with sulfur dioxide or hydrogen sulfide [Betchel 2009]. Clinical symptoms were not seen in the animals in this study.

There is currently a wide range of understanding of the effects of individual chemicals on the immune system, and rudimentary knowledge of the combined effect of multiple exposures. The immune disorders have not been quantified in the Midlothian area animals, and there are no biological testing data and limited environmental testing. Therefore, we are unable to draw any conclusions about the possible role of exposure to environmental contaminants in the immunosuppression reported for the area animals.

NEUROLOGIC ILLNESS

A farmer reported death of his cattle that grazed on a 1,000 acre-property leased from TXI. Approximately 400 head of cattle began grazing on the land in 1998. Cattle started dying over a period of time and two cows reportedly had neurologic symptoms and "yellow livers". Dr. Murl Bailey Jr., DVM, PhD reviewed the laboratory analysis of hay, vegetation, water and soil taken from the area. He reported that all but two chemicals were "considerably lower than the safe levels as described in various reports." He identified the maximum level of sulfate in hay and selenium in the sediment as being slightly elevated but well below the levels known to cause symptoms in cattle. His analysis concluded that the most likely cause of the deaths, liver disease and neurologic symptoms (hepatic encephalopathy, secondary to liver failure) was a highly toxic plant, *Senecio ampullaceus*, otherwise known as Texas ragwort, Texas groundsel, or Texas squaw-weed [Bailey 2004]. This plant was identified in the hay samples by TVMDL.

Ingestion of several different species of this plant is known to cause liver failure and cattle will eat it when it is mixed with hay [Lloyd 1991]. Most livestock losses are from chronic exposures with cattle and horses consuming as little as 0.25 percent of their body weight (http://essmextension.tamu.edu/plants/). Using epidemiological methods, Lloyd [1991] determined that cattle deaths initially attributed to ragwort at two dairy operations in Scotland were more likely due to exposure to industrial waste. At one operation, runoff from a waste dump containing PCB (polychlorinated biphenyls), dioxin, chromium and selenium was the likely explanation. At the second facility, PCB deposition in the soil was the proposed explanation for toxicity.

In this case, Dr. Bailey's interpretation of the environmental media data and his conclusions about the cause of the illness appear sound. However, given the lack of veterinary records or necropsy reports and limited information about the herd we are unable to confirm or refute his conclusions.

RESPIRATORY PROBLEMS

Midlothian community members have reported the following respiratory conditions in area animals: respiratory distress of unknown origin in dogs, horses, donkeys, goats and cattle; heaves in horses; chronic cough in dogs and horses.

Heaves, a respiratory condition in horses, is otherwise known as chronic obstructive pulmonary disease. It is often identified by a distinct muscular line across the abdomen caused by chronic labored breathing and is an inflammatory lung disease often caused by allergens in the animal's living environment. Allergies are a leading cause of asthma in animals and can be caused by many different environmental allergens, such as dust, mold, pollen and other particulate matter.

Acute respiratory symptoms can be caused by many factors, including reversible airway obstruction, infectious disease, exacerbation of underlying cardio-pulmonary disease and exposure to respiratory irritants. The incidence of acute respiratory disease in area animals has not been quantified and, so we do not know the rate or whether the rate is increased in the Midlothian area.

Air pollution, particularly high levels of particulate matter, sulfur dioxide and sulfuric acid can cause an increase in airway inflammation and can exacerbate the symptoms of chronic and allergic airway disease in both animals and humans [D'Amato 2010; ATSDR 1998a,b]. A review of canine studies with long-term exposure to air pollutants identified sulfur dioxide as a causative agent in bronchitic lesions and ozone as an agent in fibrotic lung lesions [Heyder 1996]. No studies were found in the literature related to industrial pollution and respiratory effects on horses. A Canadian study of calves exposed to emissions from the oil and gas industry indicated an increased risk of respiratory problems with increasing exposure to benzene and toluene; data on sulfur dioxide was suggestive of an association with respiratory lesions [Waldner 2009].

USDA NAHMS [2006] reported that 1.9% of horses experienced respiratory problems in 2005, although most likely many cases were infectious in origin such as strangles or pneumonia. One year of veterinary records from the Veterinary Medical Databases found that the rate of respiratory diagnoses in cows, horses, and dogs was 123.9, 46.0, and 72.0 per 1,000 patients, respectively [Priester 1970]. The cause of the respiratory diagnosis was not listed. In the Swedish dog population, dogs display a pattern of respiratory illness that is similar to that seen in humans; more risk is seen at younger and older ages [Bonnett 2010]. During the four year period evaluated, 5% of all diagnoses in Swedish horses insured for veterinary care were related to the respiratory system [Penell 2005].

The Dallas-Fort Worth area has a high level of airborne allergens [AAFA 2015] and air pollution, some of which comes from the industries in the Midlothian area. Based on environmental sampling findings reported in the health consultation that addressed criteria air pollutants (NAAQS) [ATSDR 2016a], it is plausible that, especially in the past, sensitive animals directly downwind from the facilities emitting sulfur dioxide could experience an increased incidence of respiratory conditions due to the exposure. We are unable to evaluate this link based on the information available.

THYROID PROBLEMS

Cases of hypothyroidism, a condition in which the thyroid gland does not produce enough thyroid hormone, have been reported in horses in the Midlothian area. While hypothyroidism is the most common type of thyroid gland problem reported in horses, the condition is sometimes incorrectly diagnosed [Frank 2002]. Priester [1970] reported a rate of 2.7 cases/1000 patients for endocrine-related diagnoses in horses seen at 12 veterinary teaching hospitals. The rate of hypothyroidism among horses in the Midlothian area has not been quantified, and no conclusions can be made about a potential relationship between hypothyroidism and exposure.

CANCER and TUMOR FORMATION

Various types of cancer have been reported in all species. In particular, the community reported cancers of the bone, sinuses, mammary glands, thyroid, skin (mast cell tumors) and white blood cells (lymphoma) in animals.

A query of laboratory confirmed animal cancer cases proved inconclusive. We ran a query of the incidence of animal cancer cases in the Midlothian area from 2000 to 2010, including all species and neoplastic diagnoses. There are three primary veterinary diagnostic laboratories to which Midlothian veterinarians can submit biopsies for histopathology. The two private laboratories, Antech Diagnostics and Idexx Laboratories, would not agree to give us the data, but the Texas Veterinary Medical Diagnostic Laboratory (TVMDL) ran the query on the Midlothian ZIP code and a comparable ZIP code outside of the possible exposure area. The data only returned three cases from Midlothian for the ten year period. This is clearly not an accurate representation of the incidence of cancer in the area. Veterinarians tend to favor using one laboratory for biopsies. There are few veterinarians in Midlothian; therefore, the discrepancy is most likely related in part to the local veterinarians

using predominantly the private laboratories from which we could not get data. Another reason for the discrepancy is that laboratories do not always have data on the animal owner's address; therefore, the query was run on the veterinarian's ZIP code, not the animal's physical address. Many citizens of Midlothian use veterinarians in neighboring towns, such as Cedar Hill and Waxahachie. These cases would not have been reported in our query.

Human cancer rates can often be quantified by cancer registries. Every state and some cancer organizations have a cancer registry, most of which have mandatory reporting of cancer cases. No mandatory reporting for animal cancers exists, however, the Veterinary Medical Databases (VMDB), an initiative of the National Cancer Institute, was established in 1964 for the purpose of studying cancer in animals. Currently, 9 veterinary teaching hospitals voluntarily contribute records to the database. Research articles that used VMDB records were reviewed to find rates of cancer in animals seen at participating veterinary hospitals. As stated previously, the Texas A&M University Veterinary Medical Teaching Hospital contributed records between 1976 and 2001.

VMDB records from 1964 to 1969 showed that 5.5% of the total dog patients had tumors, with the leading four tumors were skin, mammary glands, digestive system and hemic/ lymphatic system [Priester 1971]. Doberman Pinschers had a slightly elevated relative risk of getting tumors (RR: 1.4) compared to all dogs [Priester 1971]. Data from VMDB found that thyroid cancers made up 1.1% of all cancers diagnosed in dogs [Wucherer 2010] and the incidence of cardiac tumors was 0.1% in all dogs seen at VMDB participating hospitals between 1982-1995 [Ware 1999]. These studies found that older dogs were more likely than younger dogs to have cardiac tumors or thyroid cancer. Data on insured Swedish dogs found that the risk of tumors increased with age [Bonnett 2010].

Data from the VMDB on cutaneous tumors in dog patients seen between 1964 and 2002 found that lipoma, adenoma, and mast cell tumors were the top three skin tumor types [Villamil 2011]. Dogs older than 7 years of age had significantly higher odds of having cutaneous tumors than dogs younger than 7 years of age. Doberman Pinschers had higher odds of having melanoma and lower odds of having mast cell tumors as compared with all other dogs.

The VMDB records from 1964 to 1969 for bovine and equine patients found 4.0% and 2.5% of the patients had tumors, respectively [Priester 1971]. The leading two tumor sites for bovines were the eyes and the hemic and lymphatic systems, and these tumors were predominantly malignant. Tumors of the skin and genital system were the next most frequent tumors, but only about 10% of these tumors were malignant. For horses, tumors of the skin, eye and genital system were the most frequently diagnosed tumors. USDA NAHMS Equine 2005 survey [2006] found that 1.1% of the horse operations reported a horse with cancer; 0.1% of all horses were affected.

While it is known that some industrial emissions contain toxins which can cause cancer at high doses and frequent exposure, it is very difficult to prove an association between an exposure and cancer, particularly without more data about the cancer rates in the area.

SUDDEN DEATH

Community members have reported sudden death in dogs, cats, cattle and goats. There are many causes for sudden death, including trauma, infection and various causes of organ failure. However, without a necropsy there is no way to determine the exact cause of death, and many necropsies are inconclusive.

There were some reports of livestock dying after drinking from a stream near the cement factories; however, no environmental data for this stream were identified. It is possible that extremely alkaline water, high sulfate levels, caustic chemicals, heavy metals, other chemical contaminants or even bacteria (such as Leptospirosis) at very high levels could have caused the death. Poor water quality due to high sulfate levels and salinity has been blamed for an outbreak of sudden deaths and diarrhea in a herd of horses [Burgess 2010]. Some deaths in a herd of dairy cattle in Scotland were likely due to exposure to runoff from a neighboring waste dump [Lloyd 1991]. Since we do not have details about the livestock deaths in Midlothian, veterinary records, necropsy data, or water testing data from the stream, we are unable to confirm an association between the exposure and the deaths.

USDA NHAMES studies provide some information on livestock mortality rates at facilities surveyed, but not on sudden death. In 2005, 1.8% of the horses from operations surveyed had horses die, lost, or euthanized [USDA 2006]. Old age, the leading cause of death, was the cause of death in 28.9% of the cases. The next four leading causes of horse death or loss were injury/wounds/trauma (16.3%); colic (14.6%); lameness, leg, or hoof problems (7.7%); and unknown causes (6.6%).

For cattle, 1.5% of the cattle were reported to have died or been lost or euthanized in 2007 [USDA 2010a]. The top 4 reported causes of death in cattle were unknown causes (23.4%), other known causes (such as old age) (22.2%), calving-related (17.3%), and weather-related (16.2%). Non-predator sheep deaths or losses reported in operations surveyed in 2009 were 4.4% [USDA 2010d]. The top 5 non-predator causes of death in sheep were old age (24.7%), weather-related (15.7%), unknown causes (13.9%), digestive problems (13.2%), and lambing problems (12.5%).

Fish kills were reported in a pond near the industrial facilities in Midlothian. Fish kills can occur due to many human-related or natural factors including toxic spills (industrial or agricultural), climatic factors, infectious disease, and pond mismanagement. While low dissolved oxygen in ponds is the most common cause of fish kills, they can occur due to many other natural and human-related factors [TPWD 2003].

According to the Texas Parks and Wildlife Department, almost any industrial chemical or pesticide can cause a fish kill at high enough levels. The pond in question is downstream from the TXI and Gerdau steel facilities and it is possible that runoff from the quarry used as a waste site could have contaminated the pond. Review of sampling data obtained on two occasions found that concentrations of metals were not high enough to cause a fish kill [ATSDR 2016b]. Without an investigation of the fish kills including details of the management and condition of the pond and climatic conditions, there is no way to determine

if these fish kills were brought about by contamination from the nearby industrial facilities or by other causes.

5.0 Biological Testing

As discussed in Section 3.3, ATSDR conducts exposure investigations at some sites to obtain biological or environmental sampling data that is not available.

In 2011, after the demise of a litter of puppies within three days of birth on a property adjacent to the TXI cement facility and the Gerdau Ameristeel facility, ATSDR took the opportunity to perform biological testing on three dogs related to that litter and property. A complete necropsy (similar to an autopsy in people) was performed on one deceased puppy from the litter by the Texas Veterinary Medical Diagnostic Laboratory (TVMDL). There were no abnormal findings and the cause of death could not be determined. The puppy was tested by TVMDL for the following chemicals in the liver: dioxins (17 types including furans), arsenic, chromium, lead, cadmium, mercury, iron, zinc, selenium, and molybdenum. All values fell within the normal reference ranges; however, there are no normal reference ranges for chromium levels in canine liver, and no studies that reported canine chromium liver values were found. We therefore had to use other species as a reference. Reference ranges were obtained from the Wisconsin Veterinary Diagnostic Laboratory: the puppy's liver chromium level of 0.06 parts per million (ppm) fell below or in the low end of the comparison reference ranges, and therefore it is unlikely that this chromium liver level was significant. Reference ranges for liver chromium: bovine 0.04-3.8 parts per million (ppm), rabbit 0.3-1.0 ppm, and bear 0.01-0.53 ppm.

Blood samples were taken from the four year old dam that lost the puppies and a seven year old dog with a chronic skin condition (demodex) that had been living on the property its entire life. The serum samples were tested by TVMDL for arsenic, chromium, lead, mercury, iron, zinc, selenium, magnesium, and molybdenum. These chemicals were targeted because they were deemed to be possible chemicals of concerns from the industrial nearby facilities and because it was feasible to perform this testing in the animals. All values were within normal reference ranges with the exception of iron and chromium discussed below.

The four year old dam's iron level was elevated at 438.6 micrograms per deciliter (µg/dL) (TVMDL reference range: 30-180 µg/dL). The post partum status of the dog can cause elevated iron levels. The serum sample was hemolyzed, which can falsely elevate the iron level. Therefore this result does not appear to be significant.

The whole blood chromium levels reported were 68.9 parts per billion (ppb) in the four year old dam and 73.4 ppb in the seven year old dog. Chromium is an essential mineral for animals and must be in the diet for optimum health [NRC 2005]. High concentrations of chromium can cause irritation, hypersensitivity reactions, anemia, and decreased fertility in animals [ATSDR 2012b]. One dog study reported a sensitivity of hairless dogs to chromium in metal cages [Kimura 2007]. The NRC maximum tolerable level in feed for horses, cattle and sheep is 3,000 milligrams per kilogram (mg/kg) for chromium oxide and 100 mg/kg for soluble trivalent chromium [NRC 2005]. Soil samples taken at the property where the dogs resided ranged from 6.2 to 48 ppm (ppm is equivalent to mg/kg for soil), which falls within the range of Texas background soil chromium concentrations [TCEQ 2006].

There are numerous issues and considerations in collecting and analyzing chromium in human biological samples and the quantification of chromium is difficult and not well standardized [ATSDR 2012b]. This holds true for animal biological specimens as well. The TVMDL blood samples were analyzed by graphite furnace atomic absorption spectrometry (GFAAS). There are no normal reference ranges available for canine whole blood chromium levels, but a reference was found which tested the serum level of 152 dogs with no known chromium exposure. The highest chromium levels were in the healthy dog population, with a mean of 4.7 +/- 2.8 ppb, and dogs with cancer had a slightly lower level [Kazmierski 2001]. Serum levels tend to be lower than whole blood levels because chromium accumulates in the red blood cells; however, the ratio of chromium levels in serum to blood for canines could not be found in the literature. All of the blood available was used during the original analysis, making retesting impossible.

Because of the uncertainty in the interpretation of the chromium blood testing from the two dogs, ATSDR conducted a more formal exposure investigation in April 2011. The protocol was submitted to CDC Animal Care and Use Program Office for review and approval. The investigation was performed on the two adult dogs initially tested as well as six other randomly chosen Dobermans and two randomly chosen Miniature Pinschers from the same breeding facility. Ten comparison adult dogs of various breeds were selected from surrounding towns outside the possible exposure area. Consent for the blood draw was obtained from the dogs' owners.

Whole blood and serum samples were taken from the dogs and submitted to two laboratories for chromium analysis: the TVMDL and the Michigan State University (MSU) Diagnostic Center for Population and Animal Health. The two laboratories reported very different whole blood chromium concentration ranges, most likely due to following different protocols and the challenges inherent in analyzing for chromium. For instance, TVMDL uses GFAAS for analyses while the MSU laboratory uses inductively coupled plasma mass spectrometry (ICP-MS). The conclusions drawn from the results from the two laboratories were similar: there was no statistically significant difference between the exposed and unexposed dogs whole blood chromium levels (Mann-Whitney U test on TVDML data: p=0.53). Table 5.1 presents the results from the TVDML analyses.

Table 5.1 Whole blood chromium levels* (ppb) in the blood of dogs from Midlothian and outside Midlothian, May 2011.

	Whole Blood Chromium Levels (ppb)	
	Range	Mean
Midlothian area	17.3-126.0	41.23
Outside Midlothian	18.8-91.8	44.99

*Results from samples analyzed by TVMDL using GFAAS.

Very little is known about chromium levels in dogs due to the limited testing that has been done previously. Typically, for animal blood chemistries, laboratories determine their own reference ranges based on their own methodologies and animal population. Further study would be necessary to determine normal ranges in dogs and the most appropriate technique for determining chromium levels in dogs.

In addition to the laboratory analysis for chromium, whole blood and serum samples in the twenty dogs were analyzed by the MSU laboratory by ICP-MS for 16 additional analytes. Results on the range of values and mean value for cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, and zinc for the samples from dogs in the Midlothian area and the dogs from outside of the potential exposure area are provided in Table 5.2. For the most part, results for both groups of dogs showed a similar range and mean. All these minerals except nickel and lead are considered essential to the diet and have well defined biochemical roles in animals [NRC 2005]. Nickel is often found to be beneficial when supplemented to the diet, but specific functions have not been identified.

Table 5.2 Whole blood and serum concentrations* of various analytes in dogs from Midlothian and outside Midlothian, May 2011.

Analyte	Specimen type	Midlothian Area		Outside Midlothian	
		Range	Mean†	Range	Mean
Cobalt (ppb)	Blood	0.16 - 0.76	0.32	0.26 - 0.77	0.42
	Serum	0.13- 0.84	0.33	0.22 - 0.59	0.38
Copper (ppm)	Blood	0.53 - 0.71	0.64	0.45 - 0.68	0.57
	Serum	0.30 - 0.62	0.47	0.37 - 0.55	0.44
Iron‡ (ppm)	Blood	315.5 - 429.7	386.00	410.3 - 584.0	474.67
	Serum	1.25 - 20.99	6.67	1.67 - 24.20	8.92
Lead (ppb)	Blood	1.6 - 73.6	11.30	2.9 - 51.0	20.53
	Serum¶	<1		<1	
Manganese (ppb)	Blood	13.89 - 33.30	23.32	27.21 - 76.54	44.73
	Serum	2.59 - 5.53	3.54	2.28 - 5.58	3.55
Molybdenum (ppb)	Blood	3.51 - 6.42	4.89	5.43 - 59.79	18.68
	Serum	3.39 - 6.67	5.04	3.69 - 22.8	11.60
Nickel (ppb)	Blood	1.69 - 3.05	2.29	1.43 - 16.61	4.98
	Serum	1.83 - 2.78	2.24	1.66 - 2.83	2.18
Selenium (ppb)	Blood	308.5 - 366.7	326.99	341.9 - 379.1	360.41
	Serum	205.3 - 328.6	252.76	232.2 - 312.5	277.38
Zinc (ppm)	Blood	4.20 - 5.36	4.78	3.97 - 5.41	4.86
	Serum	1.89 - 3.72	2.70	2.35 - 3.93	3.04

*Samples analyzed by MSU laboratories using ICP-MS.
†For dogs in Midlothian, 2 of the 10 blood samples could not be analyzed, so the mean is based on 8 samples.
‡ Iron blood samples are for total iron in a hemolyzed sample. ICP-MS methodology, which was used in this special study, is not the standard method for blood and serum iron determination.
¶ All serum lead concentrations were below the detection limit of 1.0 ppb.

In all samples, results in both whole blood and serum for antimony, arsenic, beryllium, cadmium, mercury, thallium, and vanadium were all below the MSU laboratory detection limits of 1.00 ppb for these chemicals. Serum lead was below the MSU laboratory detection limit of 1.0 ppb in all samples. While arsenic and vanadium are not essential minerals, some studies indicate beneficial effects of these minerals when supplemented to the diet [NRC 2005]. Antimony, cadmium, lead, and mercury have no known benefit in animals; however, there are maximum

tolerable levels of these minerals that can be present in the diet before animal health is impaired [NRC 2005].

Animal hair metal analyses were provided to ATSDR by residents for analyses performed in 1993 (3 samples), 2006 (1 sample), and 2007 (5 samples) on six dogs, a chicken, a horse, and a cow. ATSDR chose not to evaluate these results. No sample collection or laboratory procedures were provided, and two laboratory reports stated that readings were inaccurate due to extremely dirty samples. ATSDR finds only a limited usefulness of human hair analyses for evaluating potential environmental exposures. Many scientific issues need to be resolved before hair samples can be used confidently to assess exposure [ATSDR 2001]. In addition to the lack of standardized methods, interpretation of animal and human hair analyses have similar limitations, including the lack of reference ranges to frame results, difficulty in distinguishing internal and external contamination, lack of correlation between levels in hair and blood or other target tissues, and lack of epidemiologic data linking hair levels with adverse health effects.

6.0 Community Concerns Evaluation

Since 2005, ATSDR and TDSHS have been collecting and documenting community concerns regarding the Midlothian facilities. The agencies have learned of these concerns through various means, including a door-to-door survey of residents, a community survey, and multiple public meetings and availability sessions held in Midlothian. The concerns expressed by community members have addressed many topics, including human health, animal health, and the adequacy and reliability of ambient air monitoring data collected in the Midlothian area.

The following are responses to community concerns related to animal health that were evaluated in this document.

1. **Do the animal health issues parallel human health issues in the community?**

Response: There were insufficient animal epidemiological data available and limited animal survey data to determine any rates of occurrence for health outcomes in animals from the Midlothian area. Thus, while the concerns people raised about animal and human health might be similar, it is not possible to compare them quantitatively.

There were three major categories of human health concerns by residents of Midlothian that overlap somewhat with their concerns about area animals: birth defects, cancer, and respiratory complaints. The Midlothian Health Consultation on the Evaluation of Health Outcome Data [ATSDR 2015a] used the Texas Birth Defects Registry, Texas Cancer Registry and other validated databases to explore the rates of occurrence of these health outcomes in the Midlothian area. A summary of the human health outcome data on these health concerns follows and a discussion about the use of animals as sentinels is covered in response to the next question of this section.

With a few exceptions, human birth defect rates in the Midlothian area are comparable to the rates in Ellis County and Texas. TDSHS provided data from the Texas Birth Defects Registry for 185 birth defects and any monitored birth defect for 1999-2008. The vast majority of the 185 human birth defects examined had either zero cases reported or had prevalence rates that were not statistically significantly different from background rates. Reproductive tract birth defects in animals were a general category of concern. In people, hypospadias (a birth defect in which the urinary outlet is on the underside of the penis) was a specific reproductive anomaly of concern. Registry data found that after adjusting for maternal age and race, hypospadias rates in male children in the Midlothian area were not significantly different from rates in the state of Texas.

Based on Texas Cancer Registry data from 1999-2008, the occurrence of new human cancer cases and the death rates from cancer in the Midlothian ZIP code 76065 were similar to the corresponding rates for the state of Texas. Cancers evaluated included all cancer sites combined, total childhood cancers (age 0-19), total childhood leukemia, 5 leukemia sub-types, and 25 additional cancers grouped by site. The additional cancers evaluated in humans included the cancer sites of concern raised about animals in Midlothian (bone, sinus, breast, thyroid, melanoma, and lymphoma). No statistically significant differences were found for rates of these cancers in people in Midlothian as compared to rates for people in the state of Texas. Mast cell

skin tumors, a common tumor in dogs and cats, are a rare cancer in people and was not evaluated.

Asthma and chronic obstructive pulmonary disease (COPD) were the primary respiratory diseases addressed in the Midlothian Health Consultation that evaluated human health outcome data. Based on data from the Behavior Risk Factor and Surveillance Survey (BRFSS) provided by TDSHS for the years 2001 to 2010, the occurrence of human adult and childhood asthma and other chronic respiratory diseases is comparable in Midlothian ZIP code 76065, Ellis County, and Texas. Human mortality data from TDSHS Center for Health Statistics for 1999-2010 showed that the death rates due to COPD and asthma and to other respiratory diseases were not significantly different in the Midlothian ZIP code than in Ellis County and Texas. It is difficult to ascribe these chronic respiratory conditions to animals. As discussed in Section 2.0, periodic acute respiratory symptoms in both humans and animals can result from exposure to high concentrations of irritants such as sulfur oxides, ozone, and particulates.

2. Can animals act as sentinels to human health?

Response: Animals have long been recognized as sentinels or as a sensitive indicator or early warning system, for human exposure and disease. Under appropriate conditions, the use of domestic and wild animals can help identify environmental chemical exposures before the exposures may become harmful to humans [NRC 1991]. One iconic example is the canary in the coal mine to detect dangerous carbon monoxide levels. Unfortunately, research in this area is limited.

Animals can make good sentinels for human exposures for the following reasons:

- animals often share the same environment as people, drinking the same water, breathing the same air and are exposed to the same soil;
- animals respond to most toxic chemicals in ways similar to humans; and
- animals often respond more quickly due to in part to their shorter life spans and lower body weight [NRC 1991].

Other advantages of animals as sentinels include restricted mobility and lower frequency of migration over the animal's shorter lifespan [Reif 2011]. Animal studies are not as strongly influenced by life-style exposure hazards such as smoking or occupational exposures. Animals often have higher exposure rates than human adults because they spend more time outside, are closer to the ground, and have higher rates of soil contact and incidental ingestion. This relative overexposure may be valuable when serving as an early warning signal.

Animal sentinels have been successful in detecting environmental hazards in several circumstances, for example:

- A CDC investigation found that birds and horses could function as sentinels of dioxin exposure in a horse arena sprayed with waste oil, even before severe human health effects occurred [Carter 1975; EPA 1975].
- Pet dogs have been shown to serve as good predictors of blood lead levels in children [Ostrowski 1990].
- Geographical mapping has shown a similar distribution of canine and human bladder

cancer in industrial areas [Hayes 1981].

Conversely, animals and humans have anatomical, physiological and behavior differences that make some health effects from animal species not directly comparable to humans. No animal species used for risk assessment can respond in exactly the same way as humans [NRC 1991]. Animal laboratory studies usually include a ten-fold or more safety factor when extrapolating data for human health based values. Most pet owners are familiar with the advice to not feed chocolate, onions, or garlic to their dog or cat. The active chemicals in chocolate are slowly metabolized in dogs making them susceptible to prolonged abnormal heart rhythms. The sulfur compounds in raw and cooked onions and garlic can result in hemolytic anemia (ruptured red blood cells) in dogs and cats, which might not be apparent until days afterward when the pet appears tired and weak [Kovalkovičová 2009].

For some chemicals, humans have a lower tolerance for a chemical than animals. While methanol poisoning causes drunkenness in dogs and cats that is similar to ethanol (alcohol) poisoning, blindness is typically only seen in humans and other primates. The NRC maximum tolerable level (MTL) for dietary iron for animals could result in excessive, harmful intake for humans if protein-rich foods such as livestock liver or kidneys are eaten regularly [NRC 2005].

Additionally, there is variation of tolerance among animals. Ruminants (cattle, sheep, goats, deer) are sometimes more tolerant of high levels of dietary minerals than animals with one-compartment stomachs. This has been attributed to ruminant microflora and the relatively low food intake of ruminants [NRC 2005]. Sometimes the reverse is true, for example, the NRC MTL for copper is 250 mg/kg feed for horses and 40 mg/kg feed for cattle [NRC 2005].

In their evaluation of the use of animals as sentinels of environmental health hazards, the National Research Council found that factors that contributed to the under use of animal sentinel systems included the lack of coordinated and standardized data collection systems and that the predictive value of animal data for human health has not been evaluated sufficiently [NRC 1991]. As mentioned throughout this document, there are only limited databases to examine the rates of health concerns in animals and the underlying rates for animal illnesses in Midlothian were not known. Thus, we were unable to relate information on animal health concerns in Midlothian to possible human health concerns.

7.0 Conclusions

ATSDR reached three main conclusions in this health consultation related to community concerns about animal health issues, the exposure pathway analysis, and the exposure investigation.

There was insufficient data to draw any conclusions about the cause of the reported animal issues in Midlothian. Residents have reported numerous health related issues in animals living around the Midlothian area. Comprehensive breeding records and veterinary records would be necessary to determine the exact extent and nature of the problems. We have been unable to obtain this kind of information in most cases. These data gaps prevent us from making an association between the possible exposure to environmental contaminants and the reported health problems. Additionally, lack of information on exposure doses and biological mechanisms of disease by many of these chemicals prevents conclusions about the animal health problems. Thus, this animal health consultation does not and cannot provide a cause and effect evaluation related to the chemicals of concern identified at the site. Animal owners are encouraged to keep thorough veterinary, animal husbandry and breeding records and to perform appropriate biologic testing and necropsies as problems arise to rule out other possible causes of observed health effects.

There are several completed potential exposure pathways that may have in the past and could present a possible current and future threat to area animals. However, there was insufficient environmental data and dose-response information in animals to confirm or reject many of the animal health concerns related to these exposures. The irritant nature of sulfur dioxide, sulfurous acid, and cement kiln dust could cause mucus membrane and skin irritation to exposed animals, and these air pollutants are potential health concerns for animals through inhalation of airborne contaminants or ingestion or direct contact of airborne contaminants deposited in the soil.

ATSDR's exposure investigation found that blood and serum concentrations for chromium and the other 16 metals analyzed were similar in the 10 dogs from the Midlothian as compared to 10 dogs residing beyond the Midlothian potential area of exposure. Statistical testing that looked specifically at chromium in blood found no significant difference between the two groups of dogs.

8.0 Recommendations

Based on the conclusions in this health consultation, ATSDR recommends that:

1) Animal owners keep thorough veterinary, animal husbandry and breeding records and request appropriate biologic testing and necropsies of their animals as problems arise to rule out other possible causes of observed health effects.
2) As explained in the Midlothian Health Consultation on criteria (NAAQS) air pollutants and hydrogen sulfide [ATSDR 2016a], ATSDR and TDSHS work with TCEQ to insure that levels of air pollutants remain below health levels of concern.
3) At this time, no additional animal blood and serum be collected and analyzed.

9.0 Public Health Action Plan

This health consultation is one of the several evaluations being conducted by ATSDR under the overall Public Health Response Plan developed to address community concerns. The following are public health actions planned specifically related to the findings from this health consultation:

ATSDR or TDSHS will:

- ATSDR and TDSHS will present the findings of this health consultation to the community.
- As the remaining Midlothian health consultations that address environmental data are completed, ATSDR will discuss any findings related to animal health issues that have not been addressed in this health consultation.

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Appendix A – Figures

List of Figures

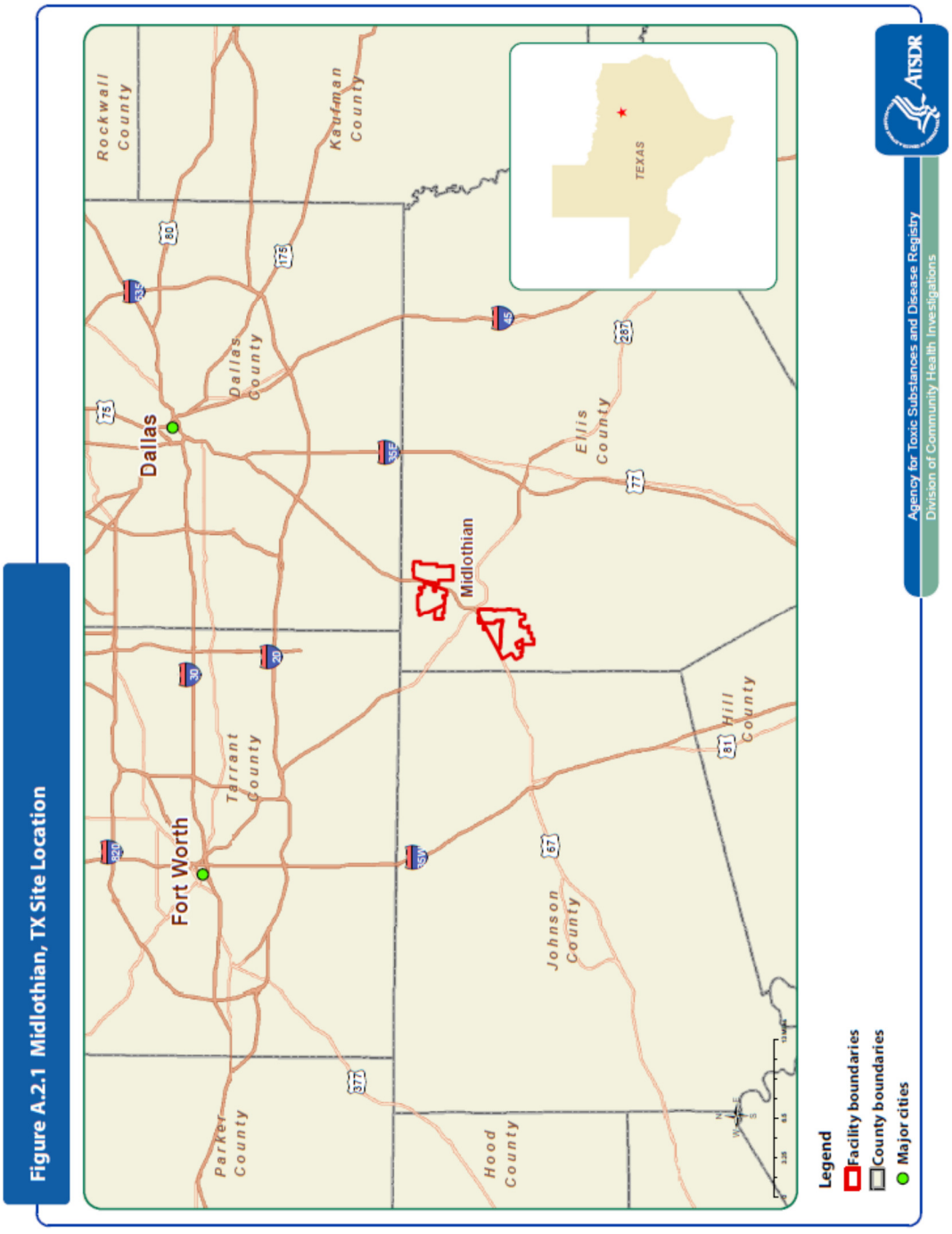


Figure A.2.1 Midlothian, TX Site Location
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
ATSDR
TEXAS
Rockwall County
Kaufman County
Dallas
Dallas County
Ellis County
Midlothian
Fort Worth
Tarrant County
Hill County
Johnson County
Parker County
Hood County
Legend
Facility boundaries
County boundaries
Major cities

Figure A.2.2 Facilities of Interest in Midlothian, TX and Extraterritorial Jurisdiction

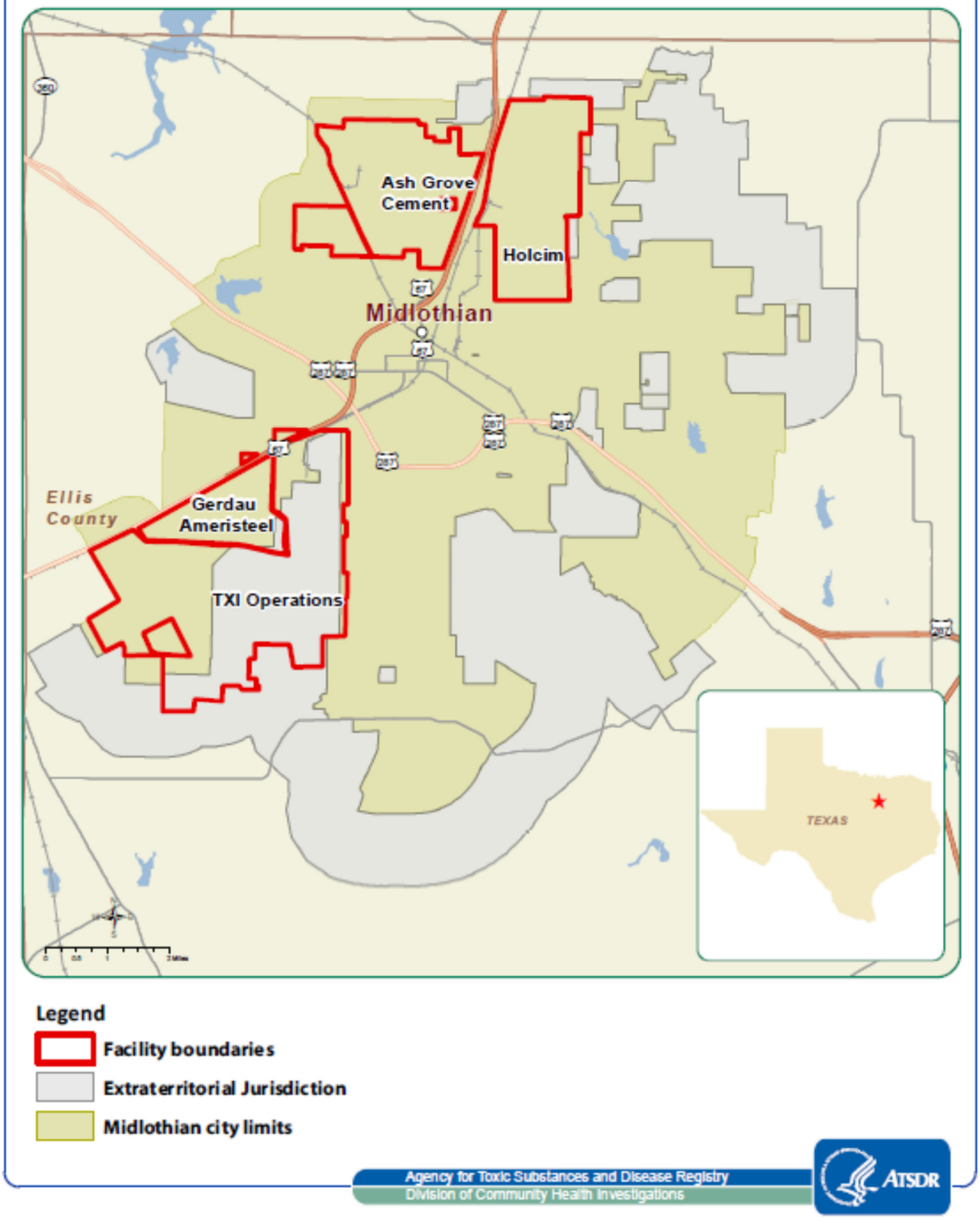
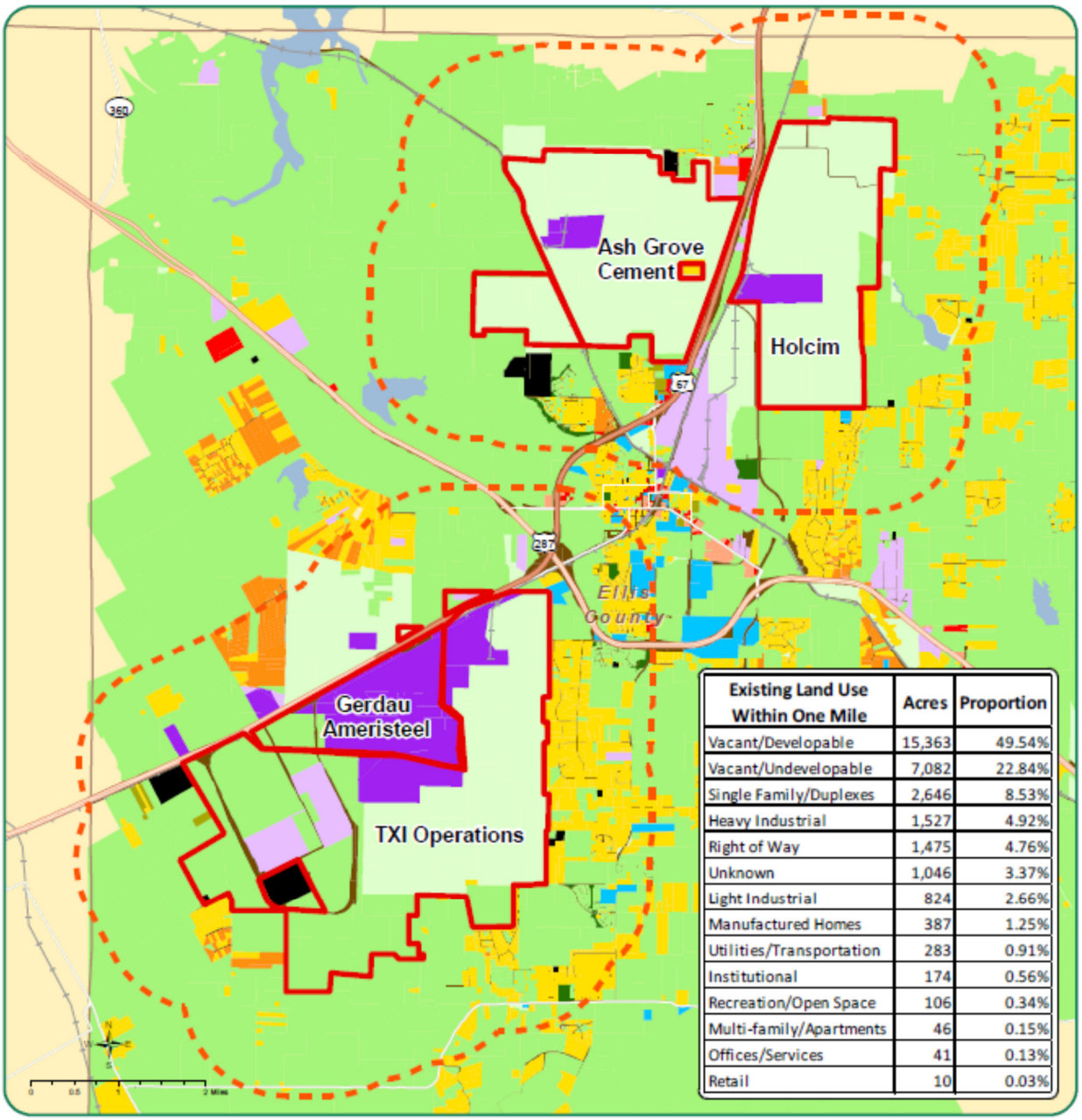


Figure A.2.3 Existing Land Use, Midlothian, TX



Existing Land Use Within One Mile	Acres	Proportion
Vacant/Developable	15,363	49.54%
Vacant/Undevelopable	7,082	22.84%
Single Family/Duplexes	2,646	8.53%
Heavy Industrial	1,527	4.92%
Right of Way	1,475	4.76%
Unknown	1,046	3.37%
Light Industrial	824	2.66%
Manufactured Homes	387	1.25%
Utilities/Transportation	283	0.91%
Institutional	174	0.56%
Recreation/Open Space	106	0.34%
Multi-family/Apartments	46	0.15%
Offices/Services	41	0.13%
Retail	10	0.03%

Legend

Existing Land Use
- Vacant/Developable
- Vacant/Undevelopable
- Light Industrial
- Heavy Industrial
- Utilities/Transportation
- Right-of-Way
- Recreation/Open Space
- Single-family/Duplexes
- Multi-family/Apartments
- Manufactured Homes
- Institutional
- Retail
- Office/Services
- **Facility boundaries**
- **One - mile buffer**

Data Source: Midlothian, TX, Planning Division (September 2012)

Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations

ATSDR

Appendix B – ATSDR Response to Public Comments

In this section we present comments received during the 90 day public comment period, from 8/26/15 through 11/23/15, for the Midlothian Area Air Quality Health Consultation titled, "Evaluation of Reported Animal Health Issues", and our responses to those comments. Section A includes general comments received and Section B contains comments received on specific sections or page numbers. Comments are numbered by section letter, followed by the comment number. ATSDR responses directly follow each comment. All page numbers referenced in this section refer to the public comment version of this health consultation.

Section A. General Comments

Comments submitted from the public, industry, and other agencies that are general or overarching comments about our approach, background information, findings, and requests for considering additional information are included in this section.

A.1 Comment:
As a general issue of concern in the draft health consultation, the reader is lead to believe the air quality may have caused adverse health effects in the past when air monitoring in the Midlothian area indicates acceptable air quality. Further, air quality in Midlothian is better than most monitored areas of the country. This could lead to undue anxiety for the citizens of Midlothian.

We also note that the level of any given screening value does not constitute a bright line where health effects are expected to occur. On the contrary, these screening values are set at a level that protects the general population as well as sensitive subpopulations, incorporating an adequate margin of safety. Therefore, the simple fact that ambient air at a community monitoring site or modeled value exceeded a given screening value does not indicate that (1) citizens were actually exposed to that concentration, (2) the concentrations measured at that monitor constitute unsafe exposures, or (3) health effects would be expected from exposure to that concentration.

As the state environmental agency, the role of TCEQ is to protect our state's public health and natural resources. Therefore, TCEQ considers protection of public health not only when evaluating ambient air data, but also when issuing air (or other media) authorizations. We use methods and models that are protective of public health with an adequate margin of safety. The TCEQ looks forward to continuing to work with ATSDR to address the findings and recommendations made in this report and to sharing additional data and information that will produce the best possible product for the public and for policymakers.

Response to comment A.1: Comment noted. As stated in our conclusions, this health consultation on reported animal issues, "does not and cannot determine cause and effect relationships between reported animal health issues and the chemicals of concern identified at the site."

A.2 Comment: *(Note: the same comment was received from two reviewers.)*
ATSDR incorrectly states that it is plausible that animals located directly downwind from the industries in the Midlothian area could experience an increased incidence of respiratory conditions and skin irritation due to exposure to sulfur dioxide and particulate matter (see pages v and 18.) ATSDR appears to base this statement simply on the fact that these substances are emitted by the Midlothian industrial facilities. No analysis was presented to support ATSDR's statement that animals could have been exposed to irritating concentrations of sulfuric acid, not even an erroneous air dispersion modeling analysis such as was performed to support ATSDR's incorrect conclusions regarding human exposure to sulfuric acid.

Response to comment A.2: Sulfurous acid aerosols and cement kiln dust are irritant pollutants and would affect human and animal populations. Based on modeling results in the health consultation that addressed VOC and metal exposures from air emissions [ATSDR 2015b], ATSDR concluded that sulfuric acid aerosols could have been released in substantial quantities to affect the health of

sensitive individuals. Further, in addition to the modeled concentrations, measurements from 1997 through late 2008 identified infrequent periods when breathing air contaminated with sulfur dioxide (SO_2) for short periods could have harmed the health of sensitive individuals [ATSDR 2016a]. Particulate modeling [ATSDR 2015b; 2016a] and tapelift samples [ATSDR 2016b] that contained cement dust or limestone provide support that airborne deposition of cement kiln dust occurs in the communtiy. This health consultation addresses reported animal health issues and does not directly address environmental sampling. The commenter is referred to the health consultations that specifically address environmental sampling for a more detailed explanation of methods and approach [ATSDR 2015b; 2016a,b].

A.3 Comment: *(Note: the same comment was received from two reviewers.)*
It was also apparent that ATSDR did not even consider the deposition of noted area veterinarian Dr. Jim Rook, which was provided to ATSDR during Health Consultation No. 1, or even contact any other local veterinarians to determine if they had observed any unusual incidence of respiratory symptoms or skin irritation in animals.

Response to comment A.3: As discussed in the background section of this health consultation, ATSDR veterinarians met with Midlothian animal owners, Midlothian area veterinarians, the Texas state veterinarian, several professors at the Texas A&M University College of Veterinary Medicine, and the Texas Parks and Wildlife Department to discuss animal health issues. ATSDR veterinarians also reviewed any provided veterinary records and reports. Based on the information provided, no rates of disease could be determined for animals in the Midlothian area; when available, ATSDR provided either national rates or rates from specific studies for animal health issues of concern.

A.4 Comment:
Everything that is important is covered in the following statements. ATSDR's press release should state there is insufficient data to draw any conclusions about the cause of animal health issues in Midlothian. Once again, insufficient data for a definitive answer. This could be remedied by door to door interviews with animal owners.

Conclusion 1: Animal Health Concerns
"This animal health consultation does not and cannot determine cause and effect relationships between the reported animal health issues and the chemicals of concern identified at the site."

"There are insufficient data to draw any conclusions about the cause of the reported animal health issues in Midlothian."

Conclusion 2: Exposure Pathway Analysis
"There are several potentially completed exposure pathways for Midlothian area animals that could have pose a past, present, and future health concern. Irritant air pollutants such as sulfur dioxide, sulfuric acid aerosols, and cement kiln dust are a potential health concern to animals from inhalation or direct contact with chemicals deposited in the soil."

"Air emissions and deposition from air emissions may result in animals being exposed to contaminants via inhalation or ingestion and direct contact with soils. While concentrations of most of the chemicals analyzed were too low to anticipate a health effect, the irritant nature of sulfur dioxide, sulfuric acid aerosols, and cement kiln dust could present as mucus membrane and skin irritation to exposed animals."

Response to comment A.4: Similar to the conclusions cited above, the bottom line of the consumer summary for this health consultation pointed out that we did not have enough data to look at animal disease rates. Door to door interviews with animal owners would be insufficient to answer

the questions on disease rates. As stated in the approach section of the document, there are few and limited veterinary databases available to compare the counts in an area to a background rate. The ATSDR press releases for this health consultation did not discuss findings, they were used to announce the availability of the document for public comment and notification of the public meeting.

Section B. Specific Comments on the Document

This section presents comments and responses for specific sections or page numbers of the document. The comments are arranged by page number.

B.1 Comment:

Page 4: The document states that "Air sampling data and from 1997 through late 2008 show sulfur dioxide (SO2) at concentrations that could have harmed sensitive individuals [ATSDR 2012c]." There are no data presented to back up this statement in the document. On the contrary, as TCEQ stated previously in our February, 2013, comments on the Health Consult: *Assessing the Public Health Implications of the Criteria (NAAQS) Air Pollutants and Hydrogen Sulfide*, Midlothian has been, and continues to be, in compliance with the applicable SO2 NAAQS (the following is from the TCEQ Comments).

> The SO2 NAAQS are set at a level that includes an adequate margin of safety to protect public health. The phrase margin of safety indicates that the NAAQS must include a safety factor to compensate for the inherent uncertainties in available scientific data, making the level conservative. During the most recent review of the SO2 NAAQs, after extensive consideration of the exposure duration, EPA determined that a 1-h standard was most appropriate. This 1-h standard is considered protective of human populations that are particularly susceptible to health problems associated with breathing SO2.
>
> The Midlothian area has been, and continues to be, in compliance with the applicable SO2 NAAQS (see Figure 2). Thus, SO2 levels in the Midlothian area, as defined by the NAAQS, are not of concern to public health.

The document also states "In a localized area north of Gerdau Ameristeel, breathing air contaminated with fine particulate matter (PM2.5) for a year or more was determined to be a public health concern during the time period 1996 through 1998 [ATSDR 2012c]." There are no data presented to back up this statement in the document. On the contrary, as TCEQ stated previously in our February, 2013, comments on the Health Consult: *Assessing the Public Health Implications of the Criteria (NAAQS) Air Pollutants and Hydrogen Sulfide*, Midlothian has been, and continues to be, in compliance with the applicable SO2 NAAQS (the following is from the TCEQ Comments).

> First, we note that the Midlothian area has been and continues to be in compliance with the PM NAAQS (see Figure 3), which is set at a level that protects public health (including sensitive subpopulations) with an adequate margin of safety. Therefore, we disagree with the conclusion that health effects were likely to occur as a result of potential exposure to these levels of PM2.5 on either an annual or a 24-hourbasis.
>
> Second, on page 30, concentrations of PM2.5 were estimated from PM10 measurements, based on a conversion factor of 0.47-0.52, with an adjustment of 2 μg/m3, for data prior to 2005. We note that when assessing potential health effects following this conversion from PM10 toPM2.5, additional uncertainty is introduced into the analysis. This source of uncertainty should be acknowledged in the draft consultation. Furthermore, the available PM10 and PM2.5 measurements were not taken from collocated monitors, but from different sites on the same day. These sites are much farther from potential PM sources than fence-line monitors, such as the one at Gerdau Ameristeel. Consequently, the ratio of PM2.5 to PM10 should be lower nearer to a dust source. In high dust areas throughout Texas, it is not unusual to observe ratios of 0.3 or less.
>
> Therefore, the ATSDR estimated PM2.5 levels are likely to be too high for some sites, such as the Gerdau Ameristeel fence-line site. Finally, dust concentrations decrease rapidly with distance from a source; fence-line measurements may significantly over-estimate concentrations that would occur even a relatively short distance away, on the order of a tenth of a mile or more.

Response to comment B.1: This health consultation does not directly address environmental sampling, this section of the report provides background information of the conclusions and findings from the three health consultations that evaluate environmental sampling data. Because of the timing of the release of the other health consultations prepared for the site, the text in this health consultation reflects the summary and conclusions of the public comment version of the health consultation on criteria (NAAQS) air pollutants and hydrogen sulfide that was released in 2012 [ATSDR 2012c]. Based on comments received on that health consultation, the NAAQS health consultation was revised [ATSDR 2016a]. The commenter is referred to that revised document for a more detailed explanation on the environmental sampling evaluation. This health consultation on reported animal health issues incorporates the summary and conclusions from the revised NAAQS health consultation.

B.2 Comment:
Page 4: The document states "The Midlothian Health Consultation on volatile organic compounds and metals in media other than air reviewed the data available on soil and vegetation [ATSDR 2015c]." This referenced document has not been released for public comment yet, but it is being quoted in this document as final. This seems to be inappropriate, at a minimum the document should acknowledge they are quoting a draft document that has not been released for public comment yet.

Response to comment B.2: Although the citation in the reference section states that the health consultation on media other than air is anticipated for release in the winter of 2015, ATSDR acknowledges that in the text, we should have more clearly stated that the document was undergoing internal review and clearance. A footnote has been added to more clearly explain the status of that health consultation. Citations in the text have been updated to reflect its current status.

B.3 Comment:
Page 5: The document refers to vegetation sampling that occurred in 2004 by Chaparral Steel in fields south of the facility. However, there is no characterization provided for these fields. For instance, are these fields accessible by citizens, or are they private property? This is important to determine whether or not the potential for exposure would exist. No exposure equals no risk.

Response to comment B.3: This health consultation addresses animal health issues and does not address exposures to the public. To make this clear, an explanation has been added in the text that cattle grazed in those fields and hay bales from the fields were used for animal feed.

B.4 Comment:
Page 12: The document references that a dog breeding facility adjacent to two industrial facilities "appears to have had a higher than normal rate of puppy loss since the late 1990s." However, this is based on records provided by the breeder for 1993 through 2010, with the knowledge that the records are not complete. Drawing conclusions from incomplete data, and from only once source, is speculative at best.

Response to comment B.4: ATSDR agrees that no conclusion should be drawn from the incomplete veterinary records. After the statement about the rate of puppy loss, we point out that the records provided were incomplete. Text has been revised to remove the suggestion of a conclusion.

B.5 Comment:
Page 18: The document states "The Dallas-Fort Worth area has a high level of airborne allergens and air pollution, some of which comes from the industries in the Midlothian area." The document does not quantify what "high level" means in this context. With statements like this, the document fails to put into context the overall air quality in Midlothian. Routine air monitoring by TCEQ (and its predecessor

agency, TNRCC) began in the Midlothian area in 1981 and has continued through to the present time. Overall, the air monitoring data from the Midlothian area compose an impressively rich data set. Monitored air toxics concentrations in Midlothian are not only acceptable and in compliance with federal regulations, but are much lower than concentrations measured in many other areas of the nation.

Response to comment B.5: Text has been revised and a citation to the health consultation and Asthma and Allergy Foundation of America (AAFA) site and the health consultation on NAAQS [ATSDR 2016a] has been provided as references.

B.6 Comment:
Page 19 & 26: Page 19 refers to 9 veterinary teaching hospitals voluntarily contributing records to the VMDB database, but page 26 indicates the number as 6. This discrepancy should be corrected.

Response to comment B.6: There is no discrepancy. As described on pages 6 and 19, since its inception in 1964, over 26 university veterinary teaching hospitals have participated in the Veterinary Medicine Databases (VMDB); at the time of the writing of this health consultation, there were 9 active institutions. Research articles that use VMDB differ in the number of veterinary hospitals cited because of the years of data examined or the purpose of their study. We could not find any reference to the VMDB on page 26.

B.7 Comment:
Page 23: The document states "There are numerous issues and considerations in collecting and analyzing chromium in human biological samples and the quantification of chromium is difficult and not well standardized [ATSDR 2012b]." Since this document is referring to animal data, and it appears as though the rest of this section refers to animals, did ATSDR mean to say "…in animal biological samples…" rather than human?

Response to comment B.7: The toxicological profile for chromium [ATSDR 2012b] discusses difficulty in analyzing human samples. Text has been added to explain that these difficulties are found in analyzing animal blood and serum samples as well.

Appendix C – ATSDR Response to Peer Review Comments

Evaluation of Reported Animal Health Issues as Part of the Midlothian Area Air Quality Petition Response Midlothian, Ellis County, Texas
HEALTH CONSULTATION
FEBRUARY 2016
GUIDE TO REVIEWERS:

The objective of peer review conducted by the Office of Science is to ensure the highest quality of science for NCEH/ATSDR studies and results of research; therefore, your comments should be provided with this goal in mind. Unlike other peer review processes in which you may have participated, the questions to be addressed for NCEH/ATSDR are broadly based so that each reviewer may have a wide latitude in providing his/her comments. Any remarks you wish to make that have not been specifically covered by the General Questions Section may be included under question # 2 in the Additional Questions Section. Please note that your unaltered comments will be sent to the investigator for a response. You should receive a copy of the response to the peer review comments when they are available.

This health consultation, which examines animal health issues reported for the Midlothian area, is one of a series of six health consultations being prepared by ATSDR for this site. For information on other health consultations, please visit http://www.atsdr.cdc.gov/sites/midlothian/health_consultations.html.

Reviewer #1

1. **Does the health consultation adequately address the animal health concerns raised by community members?**

Reviewer Answer: The wide range of animal health concerns identified by community members, namely birth defects, fetus/newborn mortality, infertility, dermatitis, respiratory issues, cancer, etc. were addressed comprehensively in this report. The literature review was relevant and exhaustive. However, the consultants were hampered by lack of existing and directly applicable research and lack of objective data regarding local animal health concerns (definitive diagnoses, extensive toxicology or other laboratory reports, necropsy results, etc.). Also, there was no way for the consultants to draw conclusions about any increase in disease rates when baseline rates were unknown.

ATSDR Response: Comment noted.

2. **Does the health consultation adequately describe the existence of potential pathways of animal exposure?**

Reviewer Answer: Table 3.1 clearly depicts the various exposure pathways and related exposure issues for animals in the Midlothian area. It is similar to an analysis used in human health investigations and appears thorough and complete. In their conclusions, the consultants state that several exposure pathways could have threatened or may threaten animal health in the area, but once again there is insufficient data to confirm or refute causative connections between potential toxins and animal health. However, the report does state that three irritants (i.e. sulfur dioxide, sulfurous acid, and cement kiln dust) could cause harm to animals through inhalation or ingestion exposure pathways.

ATSDR Response: Comment noted.

3. **Are the findings of the exposure investigation clearly presented**?

Reviewer Answer: Yes, but the findings are limited. The consultants stated minimal risk levels (MRLs) and other health-related screening levels were not intended to be applied to animals. Also, environmental sampling data—purported to be "inadequate"—was not reviewed for this report. Biological testing of tissues from a litter of dead puppies did not point toward the causative involvement of toxic chemicals, heavy metals or other agents.

The document generated for the public (available at http://www.atsdr.cdc.gov/HAC/pha/MidlothianAreaAirQuality/Factsheet_Animal_Health_Issues_2015.pdf) is clear, concise, and written with language making it accessible to and understandable by the general public.

ATSDR Response: Comment noted.

4. **Are the conclusions and recommendations appropriate in view of the animal health issues discussed in the health consultation?**

Reviewer Answer: Yes. The authors do not stray from recommendations that can be supported by the data and previous research. They consistently state that conclusions cannot be drawn from insufficient data or when there is no pre-existing data to which one can compare current animal health issues. Complainants were specifically concerned about chromium levels so potential involvement of this element was investigated in detail to the extent possible without known normal reference ranges for chromium in dogs. Table 5.1 includes data from Midlothian and non-Midlothian dogs, showing comparable chromium blood level ranges and means.

ATSDR Response: Comment noted.

5. **Is the reviewer aware of additional databases on animal health conditions that could have been evaluated to address the animal health concerns presented in this health consultation?**

Reviewer Answer:
https://www.aphis.usda.gov/ws/nwrc/chem-effects-db/nwrcToxicology_Browse.html
http://www.cdc.gov/niosh/docs/97-119/pdfs/97-119.pdf
http://cfpub.epa.gov/ecotox/
http://toxnet.nlm.nih.gov/
http://alttox.org/resource-center/databases/#CT (many listed here)

ATSDR Response: Thank-you for these suggestions. ATSDR explored these and other applicable databases along with our own Toxicological Profiles to evaluate possible animal health effects. As discussed in this health consultation, we were unable to identify many resources for animal disease surveillance.

6. Are there any other comments about the health consultation that you would like to make?

Reviewer Answer: p. 11. Birth Defect table—could incidence rates be determined and included?

ATSDR Response: Unfortunately, the prevalence of birth defects could not be determined. Our list of birth defects were primarily from anecdotal reports from community members, so we could not ascertain the number of birth defects in animals in the area. There were also only limited databases available to determine comparison rates.

Additional Questions:

7. Are there any comments on ATSDR's peer review process?

Reviewer Answer:
How were reviewers selected?
What educational background and experience did reviewers possess?
Besides an external peer review, how many other types of review were there and how were those reviewers selected?

ATSDR Response: For this health consultation, veterinary medicine was identified as expertise that would be required of reviewers. ATSDR requested that the petitioner, industries, and community members submit names of possible peer reviewers; no names were received. Thus, ATSDR's Office of Science selected external peer reviewers based on a search of published papers and a search of research faculty at academic institutions that identified veterinarians who have done research on air-related or respiratory issues in animals. All three reviewers were veterinarians (DVM) and also held a doctor of philosophy (PhD); two were from academia, while the third was from another federal agency.

Before being sent for external peer review, this health consultation went through several levels of internal review. First, the Midlothian team leads reviewed the document and then two independent peer reviewers selected by the author for their expertise (a veterinarian with APHIS and a medical epidemiologist at ATSDR) provided comments. The health consultation was then submitted to ATSDR's internal review process which includes divisional review by the associate director of science and agency review by the office of science. The revised health consultation was then made available for public comment (see Appendix B).

8. Are there any other comments?

Reviewer Answer: Midlothian animal owners should be commended for their concern for their animals' health and well-being and the energy they have devoted to this issue for so many years. There is probably a small core group of animal owners committed to this issue; sadly, less than 10% of potential stakeholders completed a survey about animal health at the start of this investigation two decades ago.

Sulfur dioxide (SO2) has an unpleasant smell. Area citizens would certainly be able to detect when SO2 concentration in the air was above a certain level and it is easy to understand how they could equate this unpleasant smell with a health hazard, both to themselves and their animals.

The average citizen is not educated about sample size, statistical significance, how to interpret data, and the difference between correlation and causation. The data shared in this report are insufficient to draw any conclusions about causation, but that will not provide consolation to owners of sick animals. As recommended by the consultants who wrote this report, concerned animal owners should pursue a diagnosis when animals are ill, including laboratory testing and necropsies when needed. They could also collect and document environmental samples (air, soil, water, plants) to help deepen the pool of knowledge about the area. Data from such investigations would either lend credence to or rule out the idea that environmental toxins are affecting animal health in the Midlothian area.

It must be very frustrating for animal owners/caretakers to think that environmental contaminants from local industry have affected their animals' health, but conclusions can only be drawn from facts, not suppositions. Animal owners might consider obtaining pet insurance, which could help them with disease investigation and treatment in the future should animals become ill.

I hope this long-term situation is resolved soon to the satisfaction of all parties and animal health in the Midlothian area is on par with other similar areas.

ATSDR Response: Comments noted.

Reviewer #2

1. **Does the health consultation adequately address the animal health concerns raised by community members?**

Reviewer Answer: The animal health concerns reported by the community are not provided in detail but as a summary of reports back to early 1990's (mostly horses and livestock) to 2005 (mostly dogs) to present day. There is a summary of health problems give in Table 4.1 but no indication of the incidence or prevalence of such problems in the past or present. Are there submitted community reports or other data available?

The most concerning reports for investigating possible environmental exposure-related diseases are the reproductive problems such as multiple deformities (skeletal and visceral), neonatal survival, abortions, cystic ovaries, etc. Increases would be most notable and perhaps semi-quantifiable by surveying experienced breeders, farmers, and veterinarians. This might be related to endocrine disruptors in the environment.

The other health issues (i.e. Dermatologic, immune system, neurologic, respiratory, thyroid, cancer and sudden death) appear to be sporadic and provide too few data to implicate environmental-exposure-related disease. Animal tumor & birth defect registries as well as including involvement of the state diagnostic labs would benefit future investigations. It was disheartening to hear that Idexx and Antech labs would not cooperate with the investigation. Can arrangements be made at a higher level of management to ask for compliance with these important issues? It may provide a wealth of information and also request that veterinarians submitting samples always fill out the request forms completely (ie. Name and address of veterinarian and owner). Also consider starting a tissue bank for future use (blood, serum, body fluids and histopath).

There should be a clearer discussion of the environmental and toxicological significance of Chromium III vs. Chromium VI.

ATSDR Response: As stated in the health consultation, the incidence and prevalence of the various health conditions could not be determined by the information obtained by ATSDR. The reports were anecdotal or were extracted from some veterinary and breeding records provided. Unfortunately, we had no knowledge of the number of animals in the area to calculate rates, nor were there adequate databases to make comparisons of rates.

ATSDR did approach local veterinarians and laboratories for information. Unfortunately because of client confidentiality, information was not shared. ATSDR is not a regulatory agency, and was unable to insist upon cooperation. While your suggestion for a tissue bank may be useful, ATSDR is a public health agency and will not be considering involvement in tissue banking.

In the exposure investigation described in this health consultation which included whole blood and serum concentrations of chromium in dogs, the chromium was not speciated. No differences between chromium levels in dogs from Midlothian and outside Midlothian were found. Thus a discussion about this chemical was not included. Discussions about the environmental and toxicological significance of trivalent and hexavalent chromium in air and other environmental

media can be found in the other Midlothian health consultations that evaluate environmental sampling data.

2. **Does the health consultation adequately describe the existence of potential pathways of animal exposure?**

Reviewer Answer: Yes.

3. Are the findings of the exposure investigation clearly presented?

Reviewer Answer: Yes.

4. Are the conclusions and recommendations appropriate in view of the animal health issues discussed in the health consultation?

Reviewer Answer: Yes.

5. Is the reviewer aware of additional databases on animal health conditions that could have been evaluated to address the animal health concerns presented in this health consultation?

Reviewer Answer: No.

6. Are there any other comments about the health consultation that you would like to make?

Reviewer Answer: Nice job.

Additional Questions:

7. Are there any comments on ATSDR's peer review process?

Reviewer Answer: No.

8. Are there any other comments?

Reviewer Answer: No.

Reviewer #3

1. Does the health consultation adequately address the animal health concerns raised by community members?

Reviewer Answer: Yes, the report describes that community members have reported health problems in horses and livestock as well as problems in dogs since the early 1990s. Around 2005 a clustering of health problems in dogs was said to have occurred. Furthermore, problems with game animals and fish mortality were also reported. Presumed problems are tabulated on page10 (Table 4.1). The listed health problems, however, are rather nonspecific and the role of air or soil pollution thereby cannot be determined unambiguously. From the listed birth defects, only limb deformities and neural defects might indicate pollution as a possible contributing factor. The other listed defects rather could have occurred by chance or by genetic factors or even by suboptimal management. The involved concerned persons, however, were unable to collect or dispose objective data to support their claims. Thus, any profound analysis on the role of potential local air and soil pollution is hindered by lack of objective data.

Although 21 years ago potential health issues could have occurred due to soil contamination of an agricultural field immediately next to the TXT operation, this issue is not actual anymore today. In 1994 the TNRCC sampled water, forage vegetation, hay-bale, wheat and soil from the field in question. The critical chemicals were lead and cadmium in the soil and aluminum, cadmium and iron in hay. For more than 20 years this field has no longer been used for grazing or crop production.

The authors have investigated every health issue brought up by the animal owners but could not definitively determine if the reported signs were caused by environmental pollution.

The only suitably documented case is on puppy mortality on a dog breeding operation in 2011. The facility was close to the yard of Gerdau Ameristeel. The problem was investigated by ATSDR, but the generated data did not allow a conclusion on causation. Chromium was considered as a potential cause of puppy mortality, but due to lack of reference data for blood chromium levels, no conclusions could be drawn. Therefore, ASTDR performed a study on blood chromium levels in Midlothian and non-Midlothian dogs later in 2011. No differences in potentially exposed and non- exposed dogs could be detected. Thus chromium exposure and uptake was not the likely cause of the puppy mortality (see also 8.).

It was discussed to use actual and historical hair and feathers samples of various Midlothian animals for further analysis of metal exposure, but due to systemic errors in analysis and inadequate data for interpretation of results this action was not useful.

ATSDR Response: Comments noted.

2. Does the health consultation adequately describe the existence of potential pathways of animal exposure?

Reviewer Answer: Yes, the location and site description are on page 2 and maps are given on pages 40 and 41. The 4 production facilities could occasionally emit substantial levels of pollutants. The chemicals of concern are given on page 3 and supplementary information is given in an on-line ATSDR report from 2016. Furthermore, exposure pathways are described adequately in chapter 3.2 and 3.2. (pages 7-9).

In respect to what the authors reported, the use of canines as sentinels for pollution induced cancer development must be interpreted with caution. Thee major types of canine cancers are lymphoma, osteosarcoma and other sarcomas, whereas the leading causes of cancer deaths in people are lung, breast, colon and prostate cancers. This suggests that the process of carcinogenesis between species could be influenced by differing gene–environment interactions or epigenetic modifications to such an extent that the patterns of cancer may not be comparable. Examples are tobacco smoke and lung cancer in humans, the role of obesity in cancer etiology in humans and the absence of such evidence in dogs, estrogen ablation in female dogs spayed before puberty and the resulting low breast cancer burden (Guy MK, Page RL, Jensen WA, Olson PN, Haworth JD, Searfoss EE, Brown DE. 2015 The Golden Retriever Lifetime Study: establishing an observational cohort study with translational relevance for human health. Phil. Trans. R. Soc. B 370: 20140230. http://dx.doi.org/10.1098/rstb.2014.0230).

ATSDR Response: Comments noted.

3. Are the findings of the exposure investigation clearly presented?

Reviewer Answer: Yes, they are summarized qualitatively in Table 3.1 (page 8). Regrettably, no epidemiologic data could be obtained from the stakeholders.

ATSDR Response: Comment noted.

4. **Are the conclusions and recommendations appropriate in view of the animal health issues discussed in the health consultation?**

Reviewer Answer: All three conclusions in the summary are correct and the rationale for these conclusions is well described in the report.

Briefly, there is insufficient epidemiological data. Epidemiology is a strong tool for determining association of pollutant exposure by air, water, soil and food and the development of disease. If residents are worried about the pollution exposure effects on their health and that of their pets, they must invest some effort in acquiring and supplying objective and reliable information. Practicing veterinarians must take their responsibility as specialists of the "One Health" concept and should strive to produce accurate clinical observations and notes.

All potential exposure pathways and most likely pollutions are described.

ASTDR assessed that blood chromium and 16 other metals in Midlothian dogs are not different from other dogs.

ATSDR Response: Comments noted.

5. **Is the reviewer aware of additional databases on animal health conditions that could have been evaluated to address the animal health concerns presented in this health consultation?**

Reviewer Answer: An extensive search using PubMed did not produce useful facts which have not been discussed already. Useful studies answering the questions whether a high incidence of birth defects is caused by environmental industrial pollution are extremely scarce. Furthermore, it must be established first whether a high incidence of birth defects was indeed true. For monitoring lead exposure of children, the dog seems to be a useful sentinel. Blood levels of metals in animals could indicate increased uptake from soil and feed. In herbivorous animals deficiencies (Se, Cu) may also be detected.

If carefully selected for each scenario, domestic animals, game animals, bird, fish and even worms can be used as sentinels. The authors correctly warn that simple extrapolation of levels and facts from animal to man must be critically evaluated prior to the use of animals as sentinels (for carcinogens see also 2.).

ATSDR Response: Comments noted.

6. **Are there any other comments about the health consultation that you would like to make?**

Reviewer Answer: The monitoring of the Midlothian air, watering and soil pollution has been performed intensively over the last 25 years. Risk assessment of the 4 major industrial polluters was adequate. Compared to other communities in Texas, Midlothian air quality is generally better.

ATSDR Response: Comment noted.

Additional Questions:

7. **Are there any comments on ATSDR's peer review process?**

Reviewer Answer: The process is clear and open. Other reports are easily found on-line at http://www.epa.gov/ace.

ATSDR Response: None needed.

8. Are there any other comments?

Reviewer Answer: This reviewer has understood that Midlothian is a small industrial city in Ellis Country in the North of Texas. Its formal nickname was "Cement Capital". Three of the top ten largest cement factories in the United States operate in the city. Furthermore, scrap steel is produced by Gerdau Ameristeel. The raw materials for this are car wrecks. Processing of this could possibly lead to releases of chromium from the car dies. Although chromium deposition on a field and its grass and crop has historically been shown, current data do not indicate high environmental chromium exposure. Pet dogs enrolled as environmental sentinels from three different areas of Campania (Italy) with different degrees of pollution, showed elevated Cr levels (mean 2.45 µg/mL) in their blood. This is 33-fold of the highest value measured in a dog in Midlothian.

Adequate environmental risk assessments and monitoring of hazardous substances have been performed in the past. In order to evaluate the potential impact of emissions from Midlothian industries on the surrounding community, the TNRCC initiated an intensive environmental monitoring program in January of 1991. Air quality of Midlothian has been found to be better that in many other communities of Texas.

The region of North of Texas with Dallas as its centrum has traditionally been dominated by heavy industry. In the 20th century, air quality must have been as bad as in other comparable areas over the world. It seems that all 4 plants use techniques to minimize pollutants in exhaust.

Historical pollution could have contaminated fields and water, but intensive sampling showed that Midlothian water and soil levels of metal pollutants were below acceptable levels on most sites in 1995. One contaminated field is no longer used for agricultural purposes.

Despite adequate monitoring there is concern about industrial air pollution among the inhabitants. Perceived health problems of domestic animals, game animals and fish are believed to be related to air, water and soil pollution. In order to evaluate the situation, the Agency for Toxic Substances and Disease Registry (ATSDR) and Texas Department of State Health Services (DSHS) conducted an extensive review of environmental health concerns raised by the community members in Midlothian. Regarding the animals living in the area, this reviewer has evaluated a Health Consultation report titled “Evaluation of Reported Animal Health Issues as part of the Midlothian area air quality petition response Midlothian Ellis Country Texas.”

In order to give a balanced judgement on animal health effects of environmental pollution, extensive data are needed at least on results of pathology and chemical analyses of tissues and organs from representative animals that occupy the different ecological systems. Furthermore, feed stuff and water must also be included in the analyses.

Different animal species could be used as sentinels for human exposure. The authors of the above mentioned report followed this approach, but had to conclude that, regrettably, data on sentinels and other potentially exposed animals in Midlothian were not available. Thus, evidence for possible pollution effects was sought in literature. Plausible links of the perceived complaints by animals owners and inhaled or ingested industrial pollutants were discussed. The reported problems in pets were too anecdotal to be linked with absolute certainty to the exposure to pollutants.

Curiously, animal health issues have been attributed to the industrial activities for over 20 years but a useful data base on pathologies has never been produced by the parties of interest, despite the facilitation of activities by ATSDR.

Midlothian air quality is also affected by superimposed pollution of traffic and back ground pollution produced by more distant industrial activities in Ellis country. Incidentally Ozone levels are over the maximal limit, but this was ascribed to heavy traffic which seems a plausible argument.

The four industrial facilities in Midlothian produced air pollutants such as PM10, PM2.5, VOC, NOx, SO2, CO and combustion products of tires and hazardous waste according to an ATSDR report of 2015, while ATSDR (2016) also reported potentially toxic levels of VOC´s and metals in soil and water samples. However, data appear to relate to sampling periods between 1997 and 2008 and cannot be related to the situation after 2011.

Potential chronic lead poisoning of a few children playing near Gerdau Amisteel could have occurred between 1993 and 1998, but no evidence of this is given. Only very speculative associations of puppy mortality in 2011 and increased levels of lead, chromium, Iron and aluminum in soil could be made. However, there is no reported literature to substantiate this association. The potential role of chromium could not be proven, since blood from 6 Doberman pinchers and 2 Miniature pinchers was well below the levels of Italian polluted dogs. Further blood levels of all relevant metals were compared with a cohort of non-exposed dogs, but no significant difference could be found for the metals.

PM10 Cr6+ represents a small percentage of the total chromium measured in the Midlothian area. In an overall study the average percent of Cr6+ of total chromium was calculated to be 1.07%, which is well below the USEPA as well as the DSHS assumption for toxicity.

In conclusion, based on the current facts, the alleged exposure problems such as birth defects, cancers and respiratory complaints in animals cannot be related to increased levels of pollution. Regarding cancers, an overview of the most significant risk factors currently known for cancer development in dogs include: reproductive hormone exposure and the development of mammary cancer, breed associations for several cancers including Scottish Terriers with bladder cancer and Bernese Mountain dogs with histiocytic sarcoma, large or giant body size with osteosarcoma and environmental exposures such as asbestos with mesothelioma and tobacco smoke exposure with lymphoma or nasal cancers in dolichocephalic dogs. Midlothian pet owners or veterinarians have not supplied any unambiguous data on tumors types of their dogs, thus evaluation of environmental carcinogens for animals is impossible.

ATSDR Response: Comments noted.