Health Consultation

HIGHWAY 71/72 REFINERY SITE
VAPOR INTRUSION EVALUATION
BOSSIER PARISH, LOUISIANA
EPA FACILITY ID# LAD981054075

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PREFACE

A draft version of this Vapor Intrusion Evaluation was extensively reviewed through a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). This final document, which gives consideration to comments received from ATSDR, is being released through LDHH.

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List of Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethylbenzene, xylene
COPCO	CanadianOxy Offshore Production Company
CREG	cancer risk evaluation guide
CSC	Cities Services Company
CSF	cancer slope factor
CSR	cancer statistics review
CVs	comparison values
DPE	dual phase extraction
EMEG	environmental media evaluation guide
FID	flame ionization detector
GSHI	Glenn Springs Holdings Inc.
HC	Health Consultation
IRIS	integrated risk information system
IUR	inhalation unit risk
LA TAPAAS	Louisiana toxic air pollutant ambient air standard
LDEQ	Louisiana Department of Environmental Quality
LECR	lifetime excess cancer risk
LDHH	Louisiana Department of Health and Hospitals
LNAPL	light non-aqueous phase liquid
mg/m^3	milligram per cubic meter
MCL	maximum contaminant level
MRL	minimal risk level
NAAQS	national ambient air quality standard
ND	not detected
NIOSH	National Institute for Occupational Safety and Health
NS	not sampled
OPH	Office of Public Health
PAHs	polycyclic aromatic hydrocarbons
PHA	Public Health Assessment
PID	photo-ionization detector
PM	particulate matter
ppb	parts per billion
ppbv	parts per billion volume
ppm	parts per million
PRP	potentially responsible part
RA	Remedial Action
RAO	remedial action objective
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
ROD	record of decision
SEET	Section of Environmental Epidemiology and Toxicology

SONRIS	strategic online natural resources information system
TAGA	trace atmospheric gas analyzer
TEAM	total exposure assessment methodology
ug/dL	microgram per deciliter
ug/L	microgram per liter
ug/m^3	microgram per cubic meter
US EPA	United States Environmental Protection Agency
VI	vapor intrusion
VOC	volatile organic compound

Summary and Statement of Issues

Introduction

At the request of the U.S. Environmental Protection Agency (EPA), the Louisiana Department of Health and Hospitals/Office of Public Health/Section of Environmental Epidemiology and Toxicology (LDHH/OPH/SEET) has evaluated residential and commercial community requested indoor and ambient air data collected from 2007-2012 and the most recently available groundwater monitoring well data (2012) collected from multiple locations throughout the Highway 71/72 Refinery site.

The purpose of this Health Consultation (HC) is to determine if exposures to site-related contaminants in indoor and ambient air, and/or groundwater at the site could harm people's health. This HC was prepared under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Conclusion 1

Due to inadequate and limited data including but not limited to contaminants detected at or near comparison values and contaminants with insensitive laboratory detection limits, SEET cannot determine that benzene levels detected in onsite residential indoor air has not or will not harm people's health. Furthermore, due to a lack of commercial indoor air sampling data, SEET cannot currently determine whether exposures to benzene in indoor air in onsite hotel guest rooms could harm occupant or service industry worker health.

Basis for Decision

Indoor air samples collected from twelve onsite residential locations (2007-2012) provided limited data to evaluate the vapor intrusion pathway. There were slight increases in adult cancer risk related to indoor air benzene exposures at a number of residences; however, significant data limitations prevented a prudent indoor air evaluation. SEET strongly recommends that a comprehensive evaluation of the vapor intrusion pathway to collect relevant data to eliminate concern or locate potential areas of concern at the Highway 71/72 Refinery site.

Conclusion 2

Low levels of benzene detected in ambient air and residential and commercial soil is not likely to pose a health concern for residents or construction workers in an occupational setting.

Benzene concentrations in ambient air and all soil samples were detected below Louisiana Toxic Air Pollutant Ambient Air Standards

Basis for Decision	(LA TAPAAS) and the ATSDR Cancer Risk Evaluation Guide (CREG) comparison values.
Conclusion 3	SEET concludes that on-site residents or workers do not have direct contact with the groundwater; therefore dermal contact with contaminated groundwater is not a completed route of exposure. However, due to a lack of data, SEET cannot conclude if offsite residents or industrial workers are exposed to contaminated groundwater migrating from the site to offsite areas not covered by the groundwater ordinance. There is also concern that contaminant vapors from the groundwater may migrate up through the soil and into homes and other buildings.
Basis for Decision	The aquifer beneath the site is not used for drinking water or irrigation. Drinking water is obtained from the Red River. The Bossier City ordinance requires connection to the city water supply for all property owners. However, elevated levels of benzene has been detected in monitoring wells located south-southeast of area D and may be migrating offsite to industrial and residential areas not covered by the groundwater use restriction. Further delineation of the contaminated groundwater area is recommended. Enforcement officials are recommended to exercise caution when reviewing well permits until further investigation is conducted.
Conclusion 4	Lack of recent soil gas data prevents SEET from evaluating the current potential for soil gas migration and impact on indoor air levels of benzene and other site-related contaminants. Historical soil gas concentrations (1992) noted that approximately 25 percent of the southern half and 10 percent of the northern half of the site have elevated soil gas concentrations which may be an underlying source of indoor air vapor intrusion at the Highway 71/72 Refinery site. Historical soil gas datasets are unable to capture current site conditions. It is strongly suggested that a representative number of soil gas (preferably subslab gas, when permission can be obtained) samples be collected concurrently with indoor air from a variety of potentially impacted onsite structures in proximity to known contaminant sources.
Basis for Decision	
Next Steps	SEET will review any future data collected from the Highway 71/72 Refinery and to ensure that exposures are not occurring at levels of health concern. SEET will assist EPA in providing health education materials to the residents and community stakeholders of the Highway 71/72 Refinery site. Health education materials will be shared to mitigate/reduce potential exposures to site-related contaminants.

	The information produced within this health consultation will be made available to the community members and stakeholders in Bossier Parish, LA.
For More Information	If you have further concerns about the site, you can call SEET at 1-888-293-7020 and ask for information about the Highway 71/72 Refinery site.

Statement of Issue and Purpose

The Louisiana Department of Health and Hospitals, Office of Public Health, Section of Environmental Epidemiology and Toxicology (LDHH/OPH/SEET) has evaluated several types of environmental data from the Highway 71/72 site dating back to the early 1990s. The most recent data evaluation was presented in the form of a health consultation (January 2012); which included a review of groundwater monitoring data and limited indoor air data from one time-sensitive, resident-requested sampling event. In August 2012, the U.S. Environmental Protection Agency (EPA) requested that SEET generate a new evaluation to capture resident-requested indoor air sampling conducted from 2007-2012 (Appendix D). EPA also provided additional residential and commercial ambient air and soil data (2007-2012), and groundwater monitoring results (2012) collected throughout the Highway 71/72 Refinery site. As requested by the Agency for Toxic Substances and Disease Registry (ATSDR), SEET has included an evaluation of all indoor and ambient air and groundwater data in this health consultation (HC). All soil data has been evaluated in a separate HC (2013).

Background

The 215-acre Highway 71/72 Refinery site is located in Bossier City, Louisiana near the intersections of Louisiana State Highways 71 and 72 in Bossier Parish. The site is approximately 2 miles east of downtown Shreveport and 1,500 feet north of the Red River. It was operated by Arkansas Fuel Oil for the production of home heating and fuel oils from 1923 to 1946. The refinery included processing areas, bulk storage and distribution areas and a railroad tank car repair yard. Following World War II, the processing area of the refinery was dismantled, and the facility was then used as a petroleum storage and distribution center during the 1950s. Petroleum was stored at the site and included leaded gasoline. By 1955, a significant portion of the refinery process equipment had been dismantled, and most of the tanks and bulk storage were leased to third parties. Between 1955 and 1967, various refinery operations were removed and sold. By 1966, an interstate highway corridor (I-20) was under construction through the site. The interstate highway was completed by the late 1960s [1].

In November 1966, the refinery property owner, Cities Services Company (CSC) announced plans for the demolition of the remaining refinery structures and cleanup of the property. A land use plan was subsequently approved by the Bossier City Council and the Bossier City-Parish Metropolitan Planning Commission. In 1966 and 1967, CSC undertook site clearing, which is reported to have included: filling in all remaining ponds and bayous (with soil) with the exception of the two canals on the north half of the property; leveling all dikes, spoils banks, and mounds; clearing structures, foundations, and piping in planned residential areas to a depth of two feet; removing oil, product and gas lines regardless of depth, and burning or removing all asphaltic refinery waste from the site [1].

Investigations and response actions conducted at the site found evidence that the site was not thoroughly cleaned in the 1960s as had been reported. Sludge deposits were buried under thin layers of fill material or simply graded into a level surface without any attempt at removal. High concentrations of lead were found in surface soil. Numerous abandoned pipelines, foundation

remnants, concrete rubble, railroad tracks and ties, coke material, and tar material were also encountered in the surface soil during response actions conducted at the site [1].

Currently the refinery is gone, and the site is fully developed with single-family homes, apartments and businesses. The northwest corner of the site contains a single-family residential development, apartment complexes and commercial establishments. The northeastern portion of the site contains commercial establishments and a plot of undeveloped land. The southern part of the site is covered by several large apartment complexes, other residential areas and several commercial establishments including two hotels. The site has historically been divided into northern and southern halves by the present day Old Minden Road. Approximately 52 percent of the site is covered by pavement or buildings. Additionally, approximately 10 percent of the site has limited accessibility (e.g., fenced I-20 right-of-way). Land use in the area surrounding the site is similar to on-site use; residential, commercial and light industrial [2].

In July 1995, SEET conducted a voluntary blood lead screening to determine if children on site had elevated blood lead levels. All blood lead values were found to be below 10 micrograms per deciliter (ug/dL), the screening level in place at the time of testing. Because testing was voluntary, the children tested were only a portion (55 out of approximately 300 children) of all the children between ages 6 months and 6 years who lived at the site at the time of testing. They were not necessarily representative of the larger population of children who were eligible for testing. In response to recommendations made by SEET, EPA ordered the potentially responsible party (PRP) to undertake a removal action of known areas of lead-contaminated surface soil, which took place from 1996-1998.

On January 6, 1997, SEET and the Agency for Toxic Substances and Disease Registry (ATSDR) released a health consultation for the site based on results of the June 1996 screening of indoor air by the EPA using Trace Atmospheric Gas Analyzer (TAGA) technology. SEET concluded that benzene in some residences posed an unacceptable cancer risk for long-term residents. SEET further noted that some residential and motel units consistently had benzene levels above the indoor air remedial action objective (RAO) of 10 parts per billion volume (ppbv) during 4 sampling episodes, spanning 6 years. It was recommended that residents and property owners be made aware of the health risks related to indoor air exposures; mitigation of affected properties be conducted and expansion of soil gas and indoor air sampling be conducted. In response to the recommendations, EPA ordered the PRP to conduct an indoor air removal action where 8 units were remediated by sealing foundation cracks and penetrations in walls and installing or modifying the residential ventilation system. To date, regularly scheduled inspections are conducted twice yearly at these historically affected residences at the site [3]. The Post Corrective Measure Inspection (PCMI) Program provisions include unit inspections, utility sealing at wall and floor entry locations, floor sealing where required and mechanical changes to continuously vent the unit or provision of a fresh air intake to constantly exchange air within the unit [3].

In cooperation with the ATSDR, SEET released a final version of a Public Health Assessment (PHA) for the Highway 71/72 Refinery Site on June 16, 2000 [4]. The PHA contained a review of soil, soil gas, and indoor and ambient air data collected from 1988-1996. The site was classified as a public health hazard, in part because indoor air benzene concentrations detected from 1990-1994 were found to pose an unacceptable cancer risk to chronically exposed individuals; and methane concentrations measured in indoor air and soil gas presented a potential

explosion hazard. This lead to the closure of apartment #501 of building 5 in the Alexis Park Apartment complex.

In March 2001, SEET reviewed indoor air data collected from apartment #501 of the Alexis Park Apartment complex [5]. SEET concluded that benzene detected in indoor air did not present a public health or explosion hazard at that time; however, because the contamination source had not been eliminated, and because the integrity of the corrective actions may deteriorate with age, benzene levels may increase. It was recommended that apartment 501 continue to be monitored in the future as part of the semi-annual PCMI program.

EPA signed the Record of Decision (ROD) on September 26, 2000 [2]. At the time of signing, significant quantities of refinery waste remained at the Highway 71/72 Refinery site [2]. The site is currently in remedial action status. Cleanup of groundwater contamination consists of dual-phase extraction (DPE) of the light non-aqueous phase liquid (LNAPL) on the groundwater. LNAPL is a group of petroleum chemicals that tend to spread across the surface of the water table and form a layer on top. The remedial action for groundwater was separated into two installation phases. Phase I addressed groundwater contamination on a 5-acre vacant lot bounded by John Wesley Boulevard and Bobbie Street. The Phase II area encompassed Days Inn, Motel 6 and other commercial properties. Well drilling was completed in August 2009. Installation of Phase II piping started May 3, 2010 and was completed mid-June 2010. Final testing of the DPE system took place in June 2010. The system was determined to be fully operational on July 14, 2010. System optimization is ongoing; evaluation of Phase II wells is also on-going [1]. This remedy requires periodic groundwater monitoring to ensure that LNAPL is not migrating to non-contaminated areas and to evaluate that the DPE system is recovering LNAPL as planned.

SEET and ATSDR released a health consultation in January 2012, which presented an evaluation of groundwater monitoring data collected during the June and December 2010 sampling events [6]. Benzene was detected above health- based comparison values at several monitoring well locations. At press time the groundwater underneath the site was not used as a water source for residents on or offsite. However, groundwater data collected in December 2012 noted elevated levels of benzene that may be migrating offsite to industrial and residential areas not covered by the Bossier City groundwater ordinance. SEET was unable to conclude whether vapor intrusion at properties within the site borders could harm people's health.

Demographics

The Highway 71/72 Refinery site is located in Bossier City, Bossier Parish, Louisiana. Census 2012 population estimates record a city population of 64,630. The largest ethnic group in that city at that time was Caucasian (65%), followed by African American (26%). Approximately 89% of the population 25 years of age and above had earned at least a high school diploma. The median household income was $46,518 with approximately 17% of persons living below poverty level [7].

EPA estimates an onsite residential population of approximately 3,500 people, including approximately 370 children six years of age and younger [1].

Discussion

LNAPL in groundwater and areas of high soil gas concentrations are suspected to be an underlying source of potential indoor air contamination within the Highway 71/72 Refinery site boundaries. Vapor Intrusion (VI) is the process of gases, generally volatile organic compounds (VOCs), migrating from contaminated subsurface soil and groundwater into the indoor air of overlying or nearby buildings. VI is a public health concern due to the potential to cause harmful health effects in sufficiently exposed populations. In order to address community concerns, the remedial action plan for the Highway 71/72 Refinery site includes a provision where on-site residents, workers, business or property owners may request soil and/or indoor air sampling at any time. All sampling is conducted with EPA oversight at no cost to the requesting party [1]. The on-site community is notified of the availability of sampling via community meetings and bi-annual mail-outs that are sent to all addresses within the site boundaries and to known individuals owning or managing properties within the site boundaries. This Health Consultation (HC) contains an evaluation of both residential and commercial community requested indoor and ambient air data collected from 2007-2012 and the most recently available groundwater monitoring well data (2012) collected from multiple locations throughout the Highway 71/72 Refinery site.

Community Health Concerns

From 2007-2012, eighteen community requests for indoor air and/or soil sampling have been submitted to EPA through the remedial action plan provision. The majority of the requests have been submitted from residents that live on the Highway 71/72 Refinery site. A few residents have cited complaints of respiratory irritation and/or headaches along with nuisance odors in the residence. Other requests were made based on concerns about soil quality and gardening/pet safety.

Historical community health concerns from the mid-1990s were submitted to SEET and ATSDR during public meetings, door-to-door surveys and childhood blood lead screening (1995). Residents have historically been concerned about adverse health effects related to site contaminants, specifically, childhood soil lead exposures, indoor air contaminants, polycyclic aromatic hydrocarbons (PAHs)/tar-like substances identified in residential yards, and odors in and around their homes. SEET responded to all historical community health concerns and they are documented in the final version of the Public Health Assessment for the Highway 71/72 Refinery Site dated June 16, 2000 [4].

Data Used

Residential Indoor/Ambient Air Sampling Locations

At the request of EPA, SEET evaluated indoor and ambient air samples collected by Highway 71/72 Refinery site contractors and EPA oversight contractors [8-26]. Resident-requested indoor and ambient air samples were collected from 12 properties located within site boundaries from 2007-2012 (Appendix A, Figure 1). Site contractors used summa canisters to collect at least one

8-hour indoor and ambient air sample at each residence. Oversight samples were collected for purposes of regulatory supervision at seven of the 12 properties, using summa canisters to collect at least one 8-hour indoor air sample at each residence; no oversight ambient air samples were collected. Both contractor and oversight samples were analyzed for benzene using EPA Method TO-15. Benzene air sampling results by date, type and location are presented in Appendix C, Table 1.

Commercial Ambient Air Sampling Locations

In August-September 2011, ambient air sampling was conducted at 2015 Old Minden Road, as requested through the remedial action plan provision. Sampling was conducted at this commercial location as part of a proposed plan to demolish a hotel on the property, followed by construction of a new hotel with a different footprint [27]. Baseline (August 25-26, 2011) and activity-based (September 12-16, 2011 and September 19-21, 2011) perimeter air samples were collected to assess ambient air concentrations of benzene, lead, naphthalene and particulate matter near the site and to assess the potential impact of disturbing soil at the site.

During the baseline sampling event, site contractors used summa canisters to collect one, 24-hour ambient air sample from each of four perimeter air monitoring stations (Appendix A, Figure 2). Activity based sampling was also conducted using 24-hour summa canisters to collect 92 samples from four air monitoring stations (Appendix C, Table 2). Both baseline and activity based sample analysis was conducted using EPA Method TO-15 for benzene and naphthalene. Filter cassettes were used to collect lead and particulate matter samples and analyzed using the National Institute of Occupational Safety and Health (NIOSH) Methods 7300/0500.

Real-time air monitoring was also collected (September 12-16, 19- 21, 2011) from 4 perimeter air monitoring stations and various work area locations to help characterize fluctuations in particulate matter and vapor concentrations during activity based events at the site. Each monitoring station and work area location measured concentrations of particulate matter (PM) and volatile organic compounds (VOCs). The air monitors collected approximately 550 ambient air samples at varying intervals (1 – 2 hours apart). PM samples were collected with a TSI AM510 aerosol monitor; a MultiRAE Plus photoionization detector (PID) was used to monitor VOCs.

Groundwater

The most recent bi-annual groundwater data available was collected in December 2012 from 20 monitoring wells located throughout the Highway 71/72 Refinery site [28]. Samples were analyzed for benzene, ethylbenzene, toluene and total xylene (BTEX) using EPA Method 8260B. Groundwater monitoring well data is presented in Appendix C, Table 3.

Groundwater remedial action objectives (RAOs) for the site require removal of LNAPL from groundwater until the performance standard (a threshold thickness of 0.1 foot of LNAPL) is achieved. Area A is the only area of the site that contains recoverable LNAPL in three groundwater plumes; thickness measurements are collected from 71 onsite recovery wells in Area A on a quarterly basis (Appendix A, Figure 3). The most recently available thickness measurement data was collected in June 2013 [29].

Exposure Pathways

An exposure pathway is how someone comes into contact with contaminants originating from a site. An exposure pathway consists of five elements: a source of contamination, transport through an environmental medium (air, water, or soil), a point of exposure, a route of human exposure (ingestion, dermal exposure, or inhalation), and a population. Completed pathways require that all five necessary elements exist and that exposure to a contaminant has occurred in the past, is presently occurring, or will occur in the future. Potential pathways, however, indicate that at least one of the five elements is missing, but could still exist. Potential exposures to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present.

Completed and Potential Exposure Pathways

Pathway	Exposure Pathway Elements						Time
	Source	Medium	Point of Exposure	Route of Exposure	Exposed Population	Type of Pathway	
Residential Indoor Air	Vapor intrusion via onsite subsurface soil gas or contaminated groundwater	Indoor Air	Onsite residential indoor air	Inhalation	Onsite Residents	Completed	Past Present Future
Commercial Indoor Air	Vapor intrusion via onsite subsurface soil gas or contaminated groundwater	Indoor Air	Commercial indoor air in onsite hotels and businesses	Inhalation	Onsite Hotel Occupants, Service Industry Workers	Potential	Past Present Future
Residential Ambient Air	Onsite subsurface soil gas or LNAPL-containing groundwater plumes	Ambient Air	Onsite residential ambient air	Inhalation	Onsite Residents	Potential	Past Present Future
Commercial Ambient Air	Onsite subsurface soil gas or LNAPL-containing groundwater plumes	Ambient Air	Onsite construction or demolition locations	Inhalation	Onsite Construction Workers	Potential	Past Present Future
Groundwater	Site-related contaminants migrating from onsite monitoring wells	Groundwater	Offsite groundwater wells unprotected from current ordinance	Ingestion Dermal	Offsite Residents, Industrial workers	Potential	Future

Indoor Air

The indoor air pathway is complex. It is often difficult to discriminate the contribution of site-related contaminants from other sources of air contamination. Common sources of indoor air contaminants include cigarette smoke, everyday household products such as cleaning supplies and stored fuels, as well as outdoor (ambient) air contaminants.

Residential Indoor Air Locations

According to individual site reports, pre-sampling inspections were conducted at each of the twelve residential locations to document any odors and to remove any petroleum based products from the home before sampling. All sampling locations are listed in Appendix C, Table 1. All sampling was conducted at the request of the occupant. Eight requests were based upon complaints of odors in the residence; 2 requests were triggered due to complaints of respiratory irritation and/or headaches; one request was due to concerns about grass not growing in an area of the back yard; and one request was spurred due to concerns of well installation work that was taking place near the resident's property line. With two exceptions listed below, there were no suspect odors, elevated PID readings for VOCs or household sources identified indoors during pre-sampling inspection events:

- unit 715 of the Alexis Park Apartments, where a heavy cigarette odor was noted on the summa canister field data sheet;
- 125 Carriage Square, where several petroleum containing household items were identified.

Two gasoline storage tanks were observed outside behind building 5 of the Alexis Park Apartments (unit 501) and two large above ground petroleum storage tanks were situated approximately 250 feet south of the building. A historical property access agreement is in effect with units 501, 613 and 615 of the Alexis Park Apartments, where Stage I indoor air corrective measures have been implemented to help prevent odors reported by the resident and to seal points of vapor entry into the home. Stage I indoor air corrective action measures include the sealing of plumbing fixtures and wall penetrations. A pre-sampling inspection of unit 613 (Alexis Park Apartments) conducted on June 6, 2012, revealed an odor and elevated PID reading under the bathroom sink in the unit; wall penetrations were sealed and sampling was rescheduled for July 5, 2012.

Stage I corrective measures were also conducted at 125 Carriage Square, including sealing wall penetrations in the kitchen, adjoining laundry room and downstairs bathroom. Additionally, unit S-107 at the St. Charles Place Apartments received indoor air corrective action measures and a ventilation unit was installed to help abate odors in the unit. The ventilation unit is inspected and maintained on a semi-annual basis, or as needed.

The potential for indoor air vapor intrusion increases depending on environmental conditions, such as frozen soil or soil saturated with water. Rainfall was reported during sampling events at unit S-107 of the St. Charles Place Apartments, 535 Rugby Place and 204 Napoleon Street.

SEET evaluated all indoor air results using ATSDR's minimal risk level (MRL) (3 parts per billion (ppb)) and cancer risk evaluation guide (CREG) (0.04 ppbv) for benzene in air. SEET also considered background indoor air benzene concentrations in North American residences (3.04-8.91 ppb) taken from an EPA compilation of indoor air studies from 1990-2005 [30]. An index of all benzene air standards used in this HC can be located in Appendix B.

Health based comparison values were below the laboratory detection limits for benzene at six contractor sampling locations, and at five oversight sampling locations. Laboratory analytical data reports and detection limits were unavailable for 125 Carriage Square and 202 Rampart Street (oversight reports). Summary data for these locations is included in Table 1 of Appendix C; the data was reviewed, however, due to the stated limitations, it could not be used to make any health based assessments.

Each of the remaining 6 sampling locations (units 501, 613, and 615 of Alexis Park Apartments, unit S-107 of the St. Charles Place Apartments, 535 Rugby Place and 202 Rampart Street) had indoor air concentrations above the CREG for benzene, with levels ranging from 0.13-5.5 ppb. One sampling location, 535 Rugby Place, had an indoor air benzene concentration of 5.5 ppb, above the chronic MRL (3 ppb) and slightly below the intermediate MRL (6 ppb). With the exception of one location, unit 613 of Alexis Park Apartments, all units had an indoor air benzene concentration greater than the ambient air level (Appendix C, Table 1). Exposure to benzene detected in indoor air samples may occur via the inhalation pathway. A completed indoor air exposure pathway existed in the past, and continues to exist for the present and future for residents living onsite.

Commercial Indoor Air Locations

Indoor air was not collected from any commercial locations, however, due to the LNAPL contaminated onsite groundwater and elevated levels of VOCs in soil gas, a potential indoor air exposure pathway may have existed in the past, may currently exist and may exist in the future for hotel guests occupying onsite units, and for any onsite service industry worker. It is strongly suggested that indoor air sampling be conducted at commercial locations to better assess the potential public health impacts for hotel guests and service workers at the Highway 71/72 Refinery site.

Ambient Air

Residential Ambient Air Locations

A potential ambient air exposure pathway existed in the past, and continues to exist for the present and future for residents living onsite. Benzene was detected in ten out of twelve residential ambient air samples collected from 2007-2012. Benzene levels ranged from not detected to 0.69 ppb. All sample results were within the Louisiana Toxic Air Pollutant Ambient Air Standard background level (LA TAPAAS) (3.69 ppb) [31]. Although all residential ambient air results were below background levels, it is strongly recommended that future sampling include additional residential ambient air locations as a component of the vapor intrusion pathway.

Commercial Ambient Air Locations

Baseline and activity based ambient air sampling was conducted before and during (August-September 2011) demolition activities at 2015 Old Minden Road. Benzene, naphthalene, lead and PM sampling results are presented in Appendix C, Table 2. Baseline benzene concentrations ranged from 0.72 -0.98 ppb and not detected (ND) to 0.67 ppb for naphthalene. All lead and PM baseline concentrations were non-detect.

Activity based benzene concentration ranges were slightly wider than baseline (0.23-1.0 ppb). Naphthalene ranges were also wider than baseline results (ND-2.0 ppb), with five activity based samples above baseline levels (Appendix C, Table 2). Lead was detected in two activity based samples; 12 lead samples had laboratory detection limits above ambient air comparison values. It is important that laboratory detection limits are less than health comparison values in order to allow scientists to better assess the public health implications of exposure. Particulate matter (PM) samples ranged from non-detect to 0.12 milligrams per cubic meter (mg/m^3) and 7 samples were higher than baseline concentrations. All baseline and activity based ambient air sample results were either non-detect or below the LA TAPAAS or the EPA National Ambient Air Quality Standard (NAAQS).

Daily real-time air monitoring of PM and VOCs was conducted to help characterize fluctuations of particulate and vapor concentrations in the work area and site perimeter (September 12-16, 19-21, 2011). The MultiRAE Plus photoionization detector (PID) was used to monitor vapor concentrations; a PID is a very sensitive broad-spectrum monitor that measures total vapors at low parts per million (ppm) levels. The PID is not a selective monitor, as it has very little ability to differentiate between chemicals. Real-time PID VOC sampling is not useful in evaluating exposure to specific contaminants and the health effects that may occur; however, it can be helpful as a supplemental tool. PID can identify areas with elevated vapor concentrations, affording additional occupational protection for workers and providing direction for further, selective sampling, as necessary. The maximum PM concentration (0.105 milligrams per cubic meter (mg/m^3)) was detected approximately 20 feet downwind of the work area excavation. All real-time PM sample results were below the EPA NAAQS for particulate matter (0.15 mg/m^3) for a 24 hour time period.

Occupational and perimeter ambient air exposure pathways were adequately addressed during the August-September 2011 demolition events at 2015 Old Minden Road. Occupational or perimeter residential exposures to unacceptable levels of benzene, lead, naphthalene and PM were not expected during these events. However, because the Highway 71/72 Refinery site is fully developed as mixed commercial/residential site that has current LNAPL in onsite groundwater and historical areas of high soil gas concentrations, a potential ambient air exposure pathway may have existed in the past, may currently exist or may exist in the future for perimeter occupants and construction workers. It is strongly recommended that all future demolition and construction activities include ambient air monitoring.

Groundwater

Direct ingestion and/or dermal exposures are not expected via the groundwater pathway, as there is an ordinance preventing the use of the onsite aquifer. Although June 2013 thickness measurements report a downward trend in the LNAPL plume size, onsite LNAPL continues to be present, therefore, the potential for site-related contaminants to impact indoor air still exists.

Benzene was detected above the CREG of 0.64 micrograms per liter (ug/L) at six of the 20 monitoring well locations (Appendix C, Table 3). The benzene CREG was below the laboratory method detection limit at three monitoring well locations. It should be noted that EPA has made efforts to improve groundwater laboratory detection limits; the January 2012 groundwater health consultation reported on 13 monitoring well locations with comparison values more sensitive than laboratory detection limits.

Benzene detected in monitoring wells located to the south and southeast of area D (MW-59, MW-60, MW-63, MW-114) may be migrating off-site to industrial and residential areas not covered by the groundwater ordinance restriction. Concentration trends and plume stability have not been established for these wells with the current sampling plan.

A water well search using the strategic online natural resources information system (SONRIS) did not identify any active wells (domestic, industrial, irrigational) within site boundaries or downgradient of the Highway 71/72 Refinery site. Drinking water for on-site residents comes from treated water from the Red River which provides an abundant source of water. The site aquifer is not expected to be used for drinking water or irrigation in the future because of the availability of an abundant water supply, the high total dissolved solids in the aquifer and because of a Bossier City ordinance which requires connection to the City water supply for all property owners (Appendix E) [2]. Currently, there are no completed exposure pathways with respect to groundwater ingestion or direct contact with groundwater at the site; however, it is strongly suggested that additional monitoring wells are installed and more frequent groundwater sampling be conducted in the areas south-southeast of area D in order to further delineate plumes in this area and potentially extend the geographical boundaries of the groundwater ordinance, as necessary. A potential exposure pathway could occur presently and in the future for offsite residents if a groundwater well were installed in these areas; Enforcement officials are recommended to exercise caution when reviewing well permits until further investigation is conducted.

Limitations to Evaluating the Vapor Intrusion Pathway

The primary exposure pathway related to vapor intrusion is inhalation of vapors present in indoor air that have entered a residence or commercial building via subsurface soil gas or contaminated groundwater. Three LNAPL- containing groundwater plumes overlay area A of the Highway 71/72 Refinery site; elevated levels of benzene have also been detected in groundwater monitoring wells in areas B, C and D. Recent groundwater monitoring of wells located south-southeast of area D indicate that contaminants may be migrating off-site into areas outside of the groundwater ordinance.

Historical soil gas concentrations (1992) noted that approximately 25 percent of the southern half and 10 percent of the northern half of the site had elevated soil gas concentrations which may also be an underlying source area of potential indoor air contamination at the site [4]. Current soil gas data are not available for the Highway 71/72 Refinery site, therefore, cannot be used to assist in the evaluation of the vapor intrusion pathway.

Indoor air samples collected from twelve residential locations (2007-2012) at the Highway 71/72 Refinery site provided limited data to evaluate the vapor intrusion pathway. Primary data limitations include laboratory detection limits that are above health comparison values, insufficient indoor air sampling locations and insufficient number of samples and seasonal sampling events at locations that do not already receive indoor air corrective measures.

The Highway 71/72 Refinery site has a significant history of site-related indoor air contamination, including the 1990 evacuation of 47 families from the Alexis Park Apartments due to elevated levels of methane and other hydrocarbon gases detected in the complex. Various investigations of soil, soil gas, groundwater and indoor and ambient air have been conducted over the past 20 years at the Highway 71/72 Refinery site, but the historical and limited current data inadequately characterize the vapor intrusion pathway. It is strongly recommended that a comprehensive evaluation of this pathway be conducted in order to fully evaluate the potential public health impact related to vapor intrusion exposures.

Health Effects Evaluation

The occurrences of health effects are determined by the type of contamination present, the concentration of the contaminant, the exposure pathway, the frequency and duration of a person's exposure, and the individual sensitivity of exposed persons. Exposure doses were derived for contaminants of concern from the Highway 71/72 Refinery site where completed exposure pathways are present. These doses are used to identify the potential development of noncancerous adverse health effects and/or carcinogenic health outcomes related to exposure conditions at the site. Default values used to estimate exposure risks are detailed in Appendix B.

Benzene

Benzene is a colorless liquid with a sweet odor. It evaporates quickly into air and does not readily dissolve in water. Benzene is highly flammable and is formed from both natural and anthropogenic activities. It is widely manufactured and used in the United States to make plastics, resins, nylon and other synthetic fibers. Benzene is also a component of crude oil and is found in high concentrations in cigarette smoke.

Because industrial processes are the primary source of benzene exposure, it can be found in all environmental compartments; it can volatilize into the air from soil and water. In air it reacts with other chemicals and degrades within a few days. It can also attach to rain drops or snow pellets and be carried back to the ground. Due to its volatility, there is no evidence to suggest that benzene accumulates in plants and animals [32].

Benzene exposure can come from a variety of places, including tobacco smoke, automobile exhaust and service stations, forest fires and industrial emissions. Household items that have benzene vapors include glues, paints, furniture wax and some detergents. Higher concentrations of benzene can be found in and around hazardous waste sites and near gas stations. The

threshold odor, or lowest concentration that can be detected by the human sense of smell, is 1.5 parts per million (ppm) (1500 ppb) for benzene [32].

Breathing very high levels of benzene can result in death, while chronic high level exposure can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion and unconsciousness. Eating or drinking foods that contain high levels of benzene can lead to vomiting, stomach irritation, sleepiness, convulsions, and rapid heart rate. Chronic exposures to benzene affect the blood and bone marrow, resulting in effects such as irregular menstrual bleeding in women, anemia and weakening of the immune system. EPA has classified benzene as a Group A, known human carcinogen. Increased incidence of leukemia (cancer of the tissues that form white blood cells) has been observed in humans occupationally exposed to benzene [32].

Residential Indoor Air Locations

All residential indoor air benzene concentrations were detected below the RfC (3×10^{-2} mg/m^3) and are not expected to pose any noncancer risk to onsite residents occupying sampled homes at the Highway 71/72 Refinery site.

Exposure dose concentrations were calculated for each residential indoor air sampling location that exceeded the CREG. Table 4 Appendix C lists the increases in the risk of developing cancer after a lifetime (70-year) exposure to concentrations of benzene detected in indoor air from each sampled residence in 2007-2012 at the Highway 71/72 Refinery site. Exposure to the maximum detected indoor air benzene concentration located at 535 Rugby Place presents a slight increase in cancer risk (1.37 E-04, or one to two excess cancers per 1,000 people). SEET recognizes that benzene concentrations detected at all locations fall within indoor air background concentrations, indicating that even typical background levels may pose very small potential increases in lifetime cancer risk. It is imprudent to use detected benzene concentrations from one 8-hour summa canister sample to estimate lifetime (70-year) exposures and resulting health risks. It is strongly recommended that more than one round of indoor air data be collected to account for seasonal variations.

There is limited data available to reflect the current potential impact of indoor air vapor intrusion at the Highway 71/72 Refinery site. As previously noted, only six sampling locations contained complete datasets with acceptable laboratory analytical limits. Four of the six locations already receive indoor air corrective action measures, and while even these locations presented very small increases in lifetime cancer risks, they may not fully reflect indoor air quality of other potentially impacted onsite residential locations.

Furthermore, three of the sampled residences are not located within area A, the only area of the site that contains recoverable LNAPL groundwater plumes. The highest detected indoor air benzene concentration was located at 535 Rugby Place, outside of area A (Appendix A, Figure 1). This location did not receive indoor air corrective measures; no odors or petroleum sources were identified during pre-sampling inspection events, light rainfall was reported during sampling and headaches were reported by the resident.

SEET cannot conclude that benzene levels detected in onsite residential indoor air has not or will not harm people's health.

Commercial Indoor Air Locations

Indoor air data was not available to assess the hotel occupant or service industry worker exposure pathway. Several units (guest rooms) in two onsite hotels are inspected twice yearly as part of the remedial action plan for the site. Indoor air corrective action measures are implemented as needed (sealing of wall, electrical outlet and/or plumbing penetrations); however, indoor air sampling is not conducted. Due to the lack of data, SEET cannot currently conclude whether exposures to benzene in indoor air in onsite hotel guest rooms could harm occupant or service industry worker health.

Ambient Air Locations

Residential and commercial ambient air benzene exposure pathways were eliminated for the currently sampled locations, as all benzene concentrations were detected below the LA TAPAAS. Benzene detected in these ambient air samples is not expected to harm the health of any resident or construction worker. However, it is strongly recommended that ambient air sampling be conducted during any future demolition and construction activities scheduled within the Highway 71/72 Refinery site boundaries as well as future sampling events at any residential locations. LNAPL in onsite groundwater and areas of historically high soil gas concentrations create a potential ambient air exposure pathway.

Groundwater

Benzene detected in monitoring wells located to the south and southeast of area D may be migrating off-site to industrial and residential areas not covered by the groundwater ordinance restriction. A potential ingestion and dermal exposure pathway may occur in the future if a groundwater well were installed in these areas. Due to the lack of data, SEET cannot conclude whether benzene may harm the health of offsite residents or industrial workers who may be exposed to benzene contaminated groundwater migrating from onsite monitoring wells. Enforcement officials are recommended to exercise caution when reviewing well permits until further investigation is conducted.

Vapor Intrusion

Insufficient indoor air, soil gas and groundwater data prevent SEET from concluding whether site-related benzene migration (via indoor air vapor intrusion) will harm people's health. Various investigations of soil, soil gas, groundwater and indoor and ambient air have been conducted over the past 20 years at the Highway 71/72 Refinery site, but the historical and limited current data do not support an evaluation of the vapor intrusion pathway. It is strongly recommended that a comprehensive evaluation of this pathway be conducted to include a statistically representative number of concurrently collected indoor air and soil gas (preferably subslab gas when permission can be obtained) samples from a variety of potentially impacted,

onsite structures. Conduct sampling at single family homes, hotels and businesses with variable building features (construction style, age, foundation) under varied seasonal environmental conditions, particularly in those buildings located in over or near known contaminant sources. It is recommended that further delineation of the groundwater located to the south-southeast of area D also be included to determine any potential impacts to the vapor intrusion pathway.

Child Health Considerations

The physical differences between children and adults demand special emphasis in assessing public health hazards. Children play outdoors and engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults and breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate result in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Children could be exposed to all of the media sampled at the Highway 71/72 Refinery site, including benzene in indoor and ambient air and groundwater.

Conclusions

Due to inadequate and limited data including but not limited to contaminants detected at or near comparison values and contaminants with insensitive laboratory detection limits, SEET cannot determine that benzene levels detected in onsite residential indoor air has not or will not harm people's health. Furthermore, due to a lack of commercial indoor air sampling data, SEET cannot currently determine whether exposures to benzene in indoor air in onsite hotel guest rooms could harm occupant or service industry worker health.

Direct groundwater ingestion exposures are not expected due to an ordinance preventing the use of the onsite aquifer, however benzene detected in monitoring wells located to the south and southeast of area D may be migrating offsite to industrial and residential areas not covered by the groundwater ordinance restriction. Due to the lack of data, SEET cannot determine whether benzene may harm the health of offsite residents or industrial workers who may be exposed to benzene contaminated groundwater migrating from onsite monitoring wells.

Historical soil gas concentrations (1992) noted that approximately 25 percent of the southern half and 10 percent of the northern half of the site have elevated soil gas concentrations which may also be an underlying source of indoor air vapor intrusion at the Highway 71/72 Refinery site. Insufficient soil gas data prevent SEET from evaluating the potential impact of benzene in site-related soil gas; SEET cannot determine whether benzene soil gas vapors (via indoor air vapor intrusion) will harm people's health.

Benzene concentrations in ambient air and soil at residential and commercial locations were detected below Louisiana Toxic Air Pollutant Ambient Air Standards (LA TAPAAS) and the ATSDR CREG, respectively. Benzene detected in ambient air and soil at these sampled locations is not expected to harm the health of any resident or construction worker.

Recommendations

1. SEET strongly recommends that a comprehensive evaluation of the vapor intrusion pathway at the Highway 71/72 Refinery site that includes a statistically representative number of concurrently collected indoor air and soil gas (preferably subslab gas when permission can be obtained) samples from a variety of potentially impacted, onsite structures. Conduct sampling at single family homes, hotels and businesses with variable building features (construction style, age, foundation) under varying seasonal environmental conditions, particularly located in proximity to known contaminant sources.

2. Further delineation of the groundwater located to the south-southeast of area D is needed to determine any potential impacts to the vapor intrusion and groundwater exposure pathways. It is recommended that enforcement officials exercise caution when reviewing well permits until further investigation is conducted.

3. SEET further recommends that any future demolition and construction activities conducted at the Highway 71/72 Refinery site include ambient air monitoring as a protective measure for perimeter residential occupants and construction workers. Soil sample collection during any construction or demolition activities is also suggested due to the known areas of high soil gas concentrations at the site.

4. Residential soil and indoor air sampling is advised to continue as requested by the community; It is recommended that residents are provided with educational materials about benzene-contaminated indoor air and groundwater including exposure reduction/prevention education to positively impact human health.

5. It is recommended that EPA continue to conduct post corrective measure inspections twice yearly to identify areas in need of maintenance or repair; and mitigation as necessary based on inspection findings. It is further recommended that the efficacy of mitigation actions be confirmed by indoor air and subslab gas (or crawlspace) monitoring. Follow-up periodic monitoring and appropriate operation and maintenance procedures are recommended to ensure that vapor intrusion is not a contributing factor to health effects.

6. It is recommended that laboratory detection limits are adjusted to ensure that they are below health-based screening criteria in order to assess the public health implications of exposure.

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APPENDIX A: Figures

Figure 1: Air sampling locations at the Highway 71/72 Refinery Site. Bossier City, Bossier Parish, LA. 2007-2012.

Map produced December 12, 2012 by the Louisiana Department of Health and Hospitals / Office of Public Health / Section of Environmental Epidemiology and Toxicology (SEET) using data provided by Agency for Toxic Substances and Disease Registry.
Disclaimer: SEET cannot guarantee the accuracy of the information contained on these maps and expressly disclaims liability for errors and omissions in their contents.

Figure 2: Ambient air sampling station locations, 2015 Old Minden Road at the Highway 71/72 Refinery Site. Bossier City, Bossier Parish, LA. August-September 2011 [27].

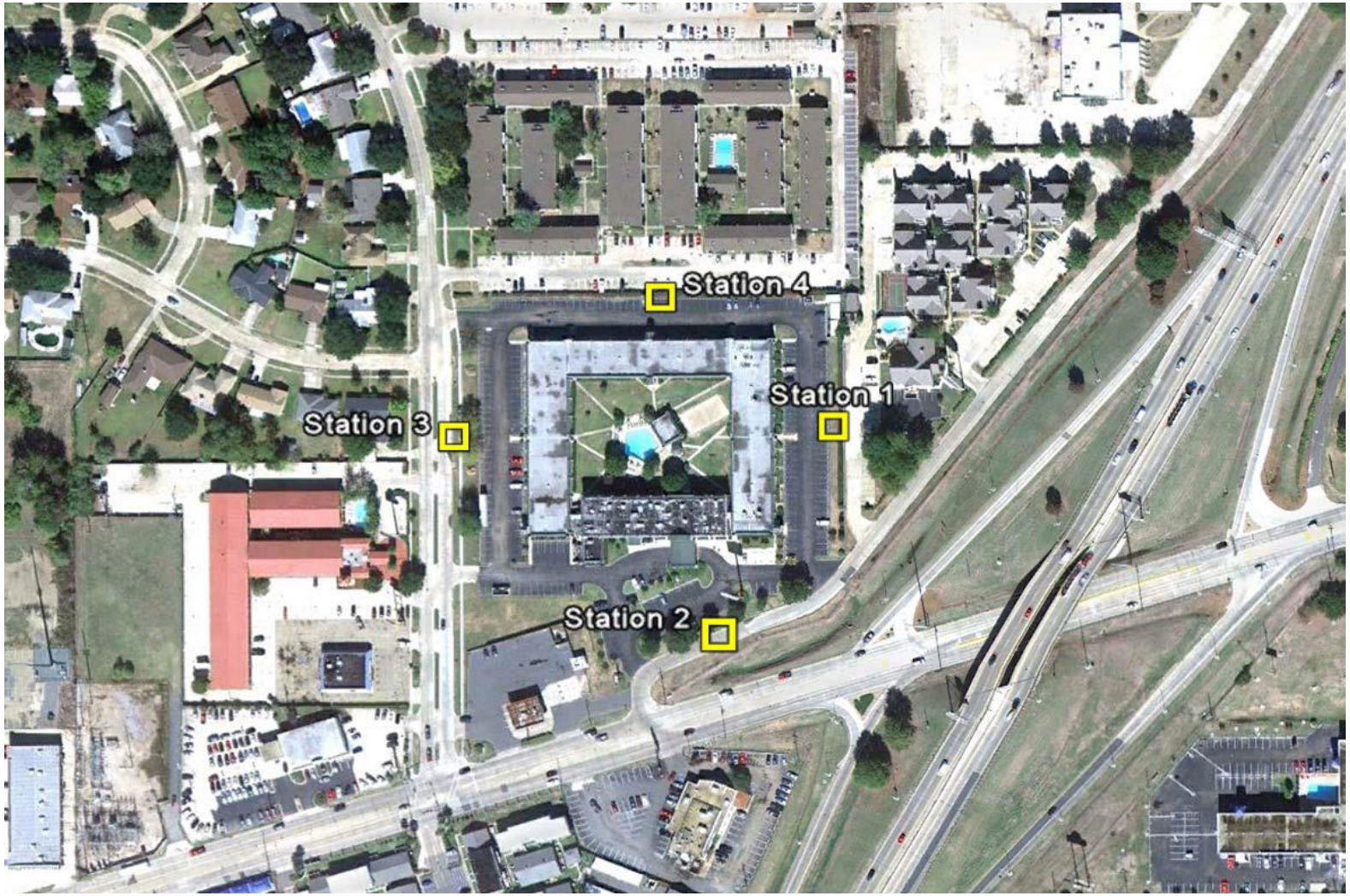
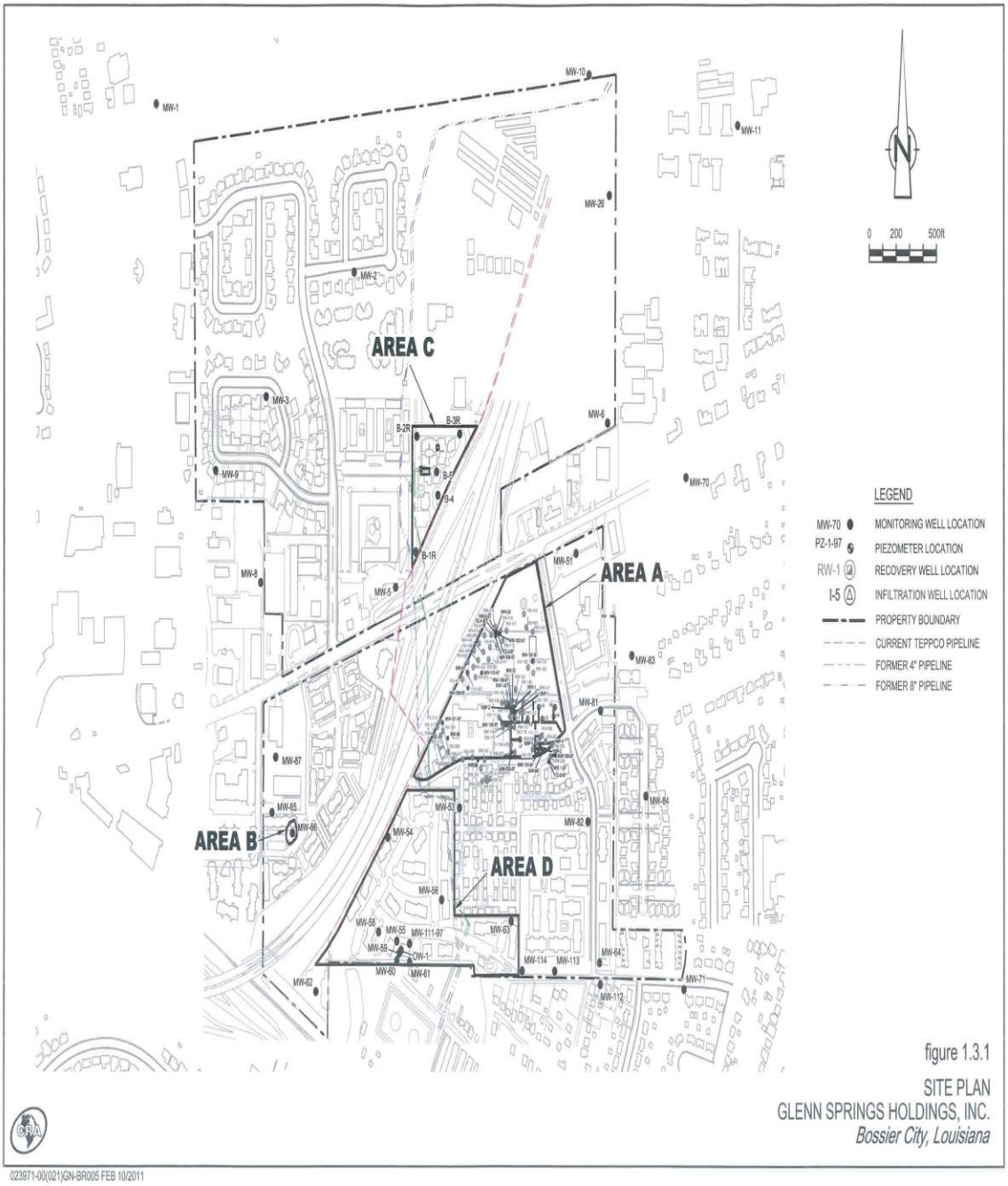


Figure 3: Groundwater monitoring and recovery well locations by area at the Highway 71/72 Refinery Site. Bossier City, Bossier Parish, LA. December 2012 [28].



APPENDIX B: Data Evaluation & Limitations

Screening Process

Comparison Values (CVs) are chemical and media-specific concentrations in air, soil, and drinking water that are used by ATSDR health assessors and others to identify environmental contaminants at hazardous waste sites that require further evaluation. CVs incorporate assumptions of daily exposure to the chemical and in the case of soil and water a standard amount that someone may likely take into their body each day. CVs are conservative and non-site specific. CVs are based on health guidelines with uncertainty or safety factors applied to ensure that they are adequately protective of public health.

The comparison of environmental data with ATSDR CVs is one of the first steps in the public health assessment process. The results of this screening step give health assessors an understanding of the priority contaminants at the site. When a contaminant is detected at a concentration less than its respective CVs, exposure is not expected to result in health effects and it is not considered further as part of the public health assessment process. It should be noted that contaminants detected at concentrations that exceed their respective CVs, do not necessarily represent a health threat. Instead, the results of the CV screening identify those contaminants that warrant a more detailed, site-specific evaluation to determine whether health effects are expected to occur. CVs are not intended to be used as environmental clean-up levels.

CVs can be based on either carcinogenic or non-carcinogenic effects. Cancer-based CVs are calculated from the U.S. Environmental Protection Agency's (EPA) oral cancer slope factor (CSF) or inhalation unit risk (IUR). CVs based on cancerous effects account for a lifetime exposure (70 years) with a theoretical excess lifetime cancer risk of 1 extra case per 1 million exposed people. Non-cancer values are calculated from ATSDR's Minimal Risk Levels (MRLs), EPA's Reference Doses (RfDs), or EPA's Reference Concentrations (RfCs). When a cancer and non-cancer CV exists for the same chemical, the lower of these values is used in the data comparison for public health protectiveness.

The ATSDR Environmental Media Evaluation Guide (EMEG), and Cancer Risk Evaluation Guide (CREG) were used as CVs in this evaluation. EMEGs are estimated contaminant concentrations that are unlikely to cause adverse non-carcinogenic health effects. EMEGs are calculated by using ATSDR's Minimal Risk Level (MRL), which is also an estimate of daily exposure to contaminants that are unlikely to cause adverse non-cancer health effects. If no MRL is available to derive an EMEG, ATSDR develops an RMEG using EPA's reference dose. Cancer risk comparison values used in this health consultation are based on ATSDR's CREG and EPA's CSF and IUR. CREGs are used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population.

Louisiana Toxic Air Pollutant Ambient Air Standards (LA TAPAAS) were used to evaluate ambient air concentrations collected during sampling at commercial locations. LA TAPASS provide contaminant specific annual average background concentrations detected in ambient air.

EPA's National Ambient Air Quality Standards (NAAQS) were also used to evaluate ambient air samples collected at the Highway 71/72 Refinery site. NAAQS are generated for pollutants considered harmful to public health and the environment. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics,

children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Benzene Air Standards

Agency	Citation	Standard/Comparison Value	Description
Health Based Comparison Values:			
ATSDR	http://www.atsdr.cdc.gov/mrls/index.html	0.04 ppb	Cancer Risk Evaluation Guideline (CREG)
		3 ppb	Chronic Inhalation Minimal Risk Level (MRL)
		6 ppb	Intermediate Inhalation MRL
		9 ppb	Acute Inhalation MRL
		Environmental Media Evaluation Guide (EMEG):	
		3 ppb	Chronic EMEG
		6 ppb	Intermediate EMEG
		9 ppb	Acute EMEG
EPA	http://www.epa.gov/iris/subst/0276.htm	3×10^{-2} mg/m^3	Inhalation Reference Concentration (RfC)
EPA	http://www.epa.gov/reg3hwmd/risk/human/index.htm	$7.8E^{-6}$ (ug/m^3)$^{-1}$	Inhalation Unit Risk (based on cancer)
Background Ambient Air Concentrations:			
LDEQ	LAC 33:III.5112.Table 51.2	3.69 ppb	Louisiana Toxic Air Pollutant Ambient Air Standard (annual average)
Background Indoor Air Concentrations:			
EPA	http://www.epa.gov/oswer/vaporintrusion/documents/osv-vapor-intrusion-background-Report-062411.pdf	3.04-8.91 ppb	Background indoor air concentrations in North American residences between 1990-2005 (Table ES-1)

Noncancer Health Effects

The indoor air contaminant concentrations that exceeded the benzene screening values were compared to the benzene reference concentration (RfC). An RfC is an estimated daily lifetime exposure to an airborne chemical that is unlikely to cause adverse noncancer health effects to human populations. RfCs may be found in the EPA's Integrated Risk Information System (IRIS) at http://www.epa.gov/iris and in the Risk Assessment Information System at http://rais.ornl.gov/tools/metadata.php.

Calculation of Carcinogenic Risk

To determine whether concentrations of benzene detected in indoor air sampled at residential locations throughout the Highway 71/72 Refinery site would increase an individual's risk of developing cancer, SEET estimated the lifetime excess cancer risk (LECR) for exposure to benzene. The LECR represents the increase in the probability of an individual developing cancer as a result of being exposed to a contaminant over a lifetime.

The estimated risks of developing cancer were calculated by multiplying each exposure concentration (in micrograms per cubic meter (ug/m^3)) over a 70-year (lifetime) period by an inhalation unit risk, using the following equation:

Cancer Risk= (Air Exposure Dose) X (Inhalation Unit Risk) X (Exposure Years/70)

Where Air Exposure Dose= concentration of the contaminant

Exposure Years= 70 (a lifetime exposure)

For example, the theoretical cancer risk for the highest concentration detected in indoor air located at 535 Rugby Place on the Highway 71/72 Refinery site would be calculated as follows for a 70-year (lifetime) exposure duration:

The highest indoor air benzene concentration detected at 535 Rugby Place was 5.5 parts per billion (ppb), also equal to $1.75 \times 10^{+1}$ ug/m^3.

Cancer Risk= ($1.75 \times 10^{+1}$ ug/m^3) X (7.80×10^{-6} $(ug/m^3)^{-1}$) X (70/70)

$= 1.37 \times 10^{-4}$

The results of a carcinogenic risk calculation estimate the worst-case maximum increase in the risk of developing cancer after exposure to the contaminant. This estimation is accurate within one order of magnitude greater or less than calculated. Therefore, a calculated cancer risk of 2 excess cancers per 10,000 people might actually be 2 excess cancers per 1,000 people or 2 excess cancers per 100,000 people. The lifetime excess cancer risk of 10^{-4} (or 1.0×10^{-4}), which is 1 excess cancer per 10,000 people, is the upper bound of the range used by EPA to make decisions about the need to take action at contaminated sites. Estimates of theoretical cancer risks that fall below 1.0×10^{-6} are considered to pose no significant increase in cancer risk.

Data Limitations

Several laboratory detection limits were greater than their respective comparison values at varied sample locations and therefore could not be used to make health based assessments in this HC. SEET recognizes that all regulatory agencies do not use the same comparison values for evaluation purposes; however, it is critical that laboratory detection limits are more than or as sensitive as health based comparison values in order to allow scientists to better assess the public health implications of exposure. The following contaminants of potential concern that were fully or partially affected include:

Indoor Air: benzene

Ambient Air: benzene, lead

Groundwater: benzene

Summary data only (no qualified laboratory data) was available for the following sampling locations:

- 125 Carriage Square: oversight indoor air samples
- 202 Rampart Street: oversight indoor air samples and corresponding laboratory detection limits

There are not a statistically significant number of indoor air sampling locations to characterize the indoor air vapor intrusion pathway and the potential for human health risks. Health based comparison values were below the laboratory detection limits for benzene at six contractor sampling locations, and at three oversight sampling locations. This further limited the number of residential sampling locations that could be used to make health based assessments.

Four of the six indoor air datasets were collected from residential locations that already receive indoor air corrective action measures. SEET recognizes that sampling was community requested and not intentionally biased; however, this may not fully reflect indoor air quality of other potentially impacted onsite residential locations.

Indoor air samples were collected from residential locations spread throughout the Highway71/72 Refinery site. Assumptions that the highest detected indoor air benzene concentrations would likely be found within area A, the only remaining area containing recoverable LNAPL in groundwater, were unfounded. It is suggested that future indoor air sampling also be conducted in areas outside of area A.

One 8-hour summa canister indoor and ambient air sample was collected at each of the twelve residential sampling locations (2007-2012). It is recommended that samples be obtained over a longer exposure time (24 hours) during multiple seasons, including at least one sample in the winter to characterize seasonal variability.

Oversight ambient air samples were not collected at any of the twelve indoor air residential locations sampled from 2007-2012.

Indoor air samples were not collected from any commercial locations. As a result we were unable to assess contaminant levels and exposures for hotel guests and service workers at the Highway 71/72 Refinery site. It is suggested that future sampling include hotels and businesses located in proximity to known onsite contaminant sources.

Personal breathing zone air samples were collected for workers during excavation and foamer operation remedial activities (September 12-16, 19- 21, 2011) at 2015 Old Minden Road. Samples were collected to assess occupational exposure to benzene, lead, naphthalene and PM. Benzene and naphthalene concentrations were measured with a 3M 3520 OVM Passive Dosimeter badge via NIOSH Methods 1500/1501; lead and PM were collected with a filter cassette and SKC air sampling pump and analyzed using NIOSH Methods 7300/0500. All personal breathing zone air samples were either non-detect or below chemical-specific occupational exposure standards and guidelines. SEET did not conduct a separate analysis of this data since non-occupational comparison values are not suitable for such an evaluation.

Groundwater concentrations and plume stability have not been established for the monitoring wells located south-southeast of area D, limiting the evaluation of potential health risks to residential and industrial populations' downgradient of the wells outside of the groundwater ordinance protections.

APPENDIX C: Data Tables

Table 1: Benzene air sampling results collected in 2007-2012 from residential properties within the Highway 71/72 site.
(Contaminant concentrations exceeding their screening values are listed in **bold red**)

Sample Location	Collection Date	Detected PID[1] Reading? Yes/No	Contractor Sample (ppbv)[2] (Detection Limit)[Ω]		Oversight Sample (ppbv) (Detection Limit)		Benzene CREG[3] (0.04 ppbv) Exceeded? Yes/No				Soil Collected? Yes/No
			Indoor	Ambient	Indoor	Ambient	Contractor Sample		Oversight Sample		
							I[4]	A[5]	I	A	
2201 Loreco Street, Alexis Park Apartments, Unit 615	7/5/2012	No	**0.52** (0.046)	**0.32** (0.046)	NS[6]	NS	Yes	Yes	NS	NS	No
2201 Loreco Street, Alexis Park Apartments, Unit 613	7/5/2012	No	**0.13** (0.046) **0.13*** (0.046)	**0.44** (0.046) **035*** (0.046)	NS	NS	Yes Yes	Yes Yes	NS	NS	No
2201 Loreco Street, Alexis Park Apartments, Unit 501	11/4/2011	No	**0.51** (0.049)	**0.19** (0.049)	NS	NS	Yes	Yes	NS	NS	No
2000 Old Minden Road, St. Charles Place Apartments, Unit S-107	6/3/2010	No	**0.65** (0.021) **0.89*** (0.021)	Faulty Summa canister	**0.463** (0.2)	NS	Yes Yes	NS	Yes[ff]	NS	No
535 Rugby Place	6/3/2010	No	**5.5** (0.021) **3.9*** (0.021)	**0.69** (0.021) **0.60*** (0.021)	**4.27** (0.2)	NS	Yes Yes	Yes Yes	Yes[ff]	NS	No
202 Rampart Street	8/25/2009	No	**0.98** (0.021) **0.95*** (0.021)	**0.43** (0.021)	**0.851**	NS	Yes Yes	Yes	Yes[f]	NS	Yes
2201 Loreco Street, Alexis Park Apartments, Unit 715	10/8/2008	No**	**4.5** (0.86)	**0.29** (0.90)	NS	NS	Yes[ff]	Yes[ff]	NS	NS	No
400 John Wesley Boulevard, Mission Village Unit 85	10/8/2008	No	**0.49** (0.90)	**0.24** (0.90)	NS	NS	Yes[ff]	Yes[ff]	NS	NS	No
403 Preston Boulevard	2/1/2008	No	**0.70** (0.88) **0.69*** (0.92)	**0.52** (0.82)	**0.74** (0.70)	NS	Yes[ff] Yes[ff]	Yes[ff]	Yes[ff]	NS	Yes
204 Napoleon Street	8/17/2007	No	**1.2** (0.86)	**0.34** (0.90)	**1.8** (0.70)	NS	Yes[ff]	Yes[ff]	Yes[ff]	NS	Yes
201 John Wesley Boulevard, 1st Methodist Church	6/12/2007	No	**1.2** (0.86) **0.58*** (0.88)	**0.57** (0.90)	0.86 ND[7] **0.90*** (0.88)	NS	Yes[ff] Yes[ff]	Yes[ff]	Yes[ff] Yes[ff]	NS	No
125 Carriage Square	1/25/2007	Not Available	**1.00 ND**	**0.96 ND**	**0.82**	NS	Yes[ff]	Yes[ff]	Yes[f]	NS	No

Highlighted cells represent sampling points where summary data only was available (laboratory data missing) and/or laboratory detection limits were missing; data was reviewed, but not used to make health based assessments

[Ω] Laboratory method detection limit/reporting limit; * Replicate sample; ** Heavy cigarette odor noted on canister field data sheet; [f]Laboratory detection limits not available; [ff]Detection limit above comparison value

[1]PID- photoionization detector; [2]ppbv- parts per billion volume; [3]CREG- Cancer Risk Evaluation Guide; [4]I- indoor; [5]A- ambient; [6]NS- not sampled; [7]ND- not detected

Table 2: Ambient air sampling results collected from a commercial location at 2015 Old Minden Road within the Highway 71/72 Refinery site boundaries. August and September 2011.

Analyte	Station 1	Station 2	Station 3	Station 4	Comparison Value (CV)
Baseline Perimeter Sampling Event: August 25-26, 2011					
Benzene (ppb)[1]	0.72	0.98	0.80	0.76	3.69 ppb LA TAPAAS[2]
Naphthalene (ppb)	0.67	ND[3]	0.29	0.39	2.23 ppb LA TAPAAS
Lead (mg/m^3)[4]	ND	ND	ND	ND	0.00015 mg/m^3 EPA NAAQS[5]
PM (mg/m^3)	ND	ND	ND	ND	0.15 mg/m^3 EPA NAAQS
	Station 1	**Station 2**	**Station 3**	**Station 4**	
Perimeter Sampling Event: September 12-13, 2011					
Benzene	0.79	0.86	0.81	0.57	
Naphthalene	0.41	1.5	1.7	0.031 ND	
Lead	0.00030 ND	0.00030 ND	0.00029 ND	0.00030 ND	
PM	0.11	0.081 ND	0.077 ND	0.094	
Perimeter Sampling Event: September 13-14, 2011					
Benzene	0.38	0.36	0.30	0.35	
Naphthalene	0.031 ND	0.031 ND	2.0	0.45	
Lead	0.000047	0.000046 ND	0.000046 ND	0.000046 ND	
PM	0.1	0.061 ND	0.062 ND	0.11	
Perimeter Sampling Event: September 14-15, 2011					
Benzene	0.23	0.46	0.25	0.28	
Naphthalene	0.031 ND	0.031 ND	0.22	0.20	
Lead	0.00025 ND	0.00025 ND	0.00024 ND	0.00025 ND	
PM	0.1	0.067 ND	0.065 ND	0.07	
Perimeter Sampling Event: September 15-16, 2011					
Benzene	0.33	0.31	0.30	0.31	
Naphthalene	0.19	0.87	0.40	0.59	
Lead	0.000051 ND	0.000050 ND	0.000049 ND	0.000052 ND	
PM	0.067 ND	0.067 ND	0.065 ND	0.070 ND	
Perimeter Sampling Event: September 16-17, 2011					
Benzene	0.51	0.61	0.49	0.44	
Naphthalene	0.031 ND	0.031 ND	0.031 ND	0.031 ND	
Lead	0.000044 ND	0.000044 ND	0.000043 ND	0.000044	
PM	ND	ND	ND	0.12	
Perimeter Sampling Event: September 19-20, 2011					
Benzene	0.39	0.33	0.31	0.33	
Naphthalene	0.031 ND	0.031 ND	0.031 ND	1.1	
Lead	0.000053 ND	0.000050 ND	0.000049 ND	0.000050 ND	
PM	0.14 ND	0.13 ND	0.13 ND	0.13 ND	
Perimeter Sampling Event: September 20-21, 2011					
Benzene	0.74	1.0	0.70	0.74	
Naphthalene	0.19	0.32	0.25	0.031 ND	
Lead	0.000037 ND	0.000041 ND	0.000040 ND	0.000038 ND	
PM	0.098 ND	0.11 ND	0.11 ND	0.10 ND	
Perimeter Sampling Event: September 21, 2011					
Lead	0.00023 ND	0.00022 ND	0.00023 ND	0.00025 ND	
PM	0.12 ND	0.12 ND	0.12 ND	0.13 ND	

[1]ppb- parts per billion; [2]LA TAPAAS- Louisiana Toxic Air Pollutant Ambient Air Quality Standard; [3]ND- not detected;
[4]mg/m^3- milligrams per cubic meter; [5]EPA NAAQS- Environmental Protection Agency National Ambient Air Quality Standard

Table 3: Groundwater monitoring results collected during routine bi-annual sampling throughout the Highway 71/72 Refinery site. December 2012.

(Contaminant concentrations exceeding their screening values are listed in **bold red**)

Sample location	Benzene	Ethylbenzene	Toluene	Xylene (total)
Health Based CV[1]:	**0.64 ug/L[2] CREG[3]**	**4,000 ug/L Ch. EMEG[4]**	**200 ug/L Ch. EMEG**	**2,000 ug/L Ch. EMEG**
Area A:				
MW-51	0.34 ND[5]	0.32 ND	0.63	0.87 ND
MW-81	0.34 ND	0.32 ND	0.89	0.87 ND
MW-82	0.34 ND	0.32 ND	0.33	0.87 ND
MW-83	0.34 ND	0.32 ND	0.33 ND	0.87 ND
Area B:				
MW-62	0.34 ND	0.32 ND	0.33 ND	0.87 ND
MW-66	**1,600[±]**	17	64.1	48.5
Area C:				
B-2R	**38.6**	21	39.3	129
B-3	ND	ND	0.41	ND
B-4	0.48	0.36	0.45	ND
MW-6	0.34 ND	0.32 ND	0.33 ND	0.87 ND
MW-8	0.34 ND	0.32 ND	0.44	0.87 ND
Area D:				
MW-53	0.34 ND	0.32 ND	0.33 ND	0.87 ND
MW-59	**501[±]**	39.2	69.4	307
MW-60	**143**	0.43	6.4	11.7
WR-1 (MW-60duplicate)	39.3	21	40.6	133
MW-63	**8,710[±]**	178	109	94.8
MW-64	0.34 ND	0.32 ND	0.33 ND	0.87 ND
MW-71	0.34 ND	0.32 ND	0.33 ND	0.87 ND
MW-112	0.34 ND	0.32ND	0.33 ND	0.87 ND
MW-113	0.34 ND	0.32 ND	0.33 ND	0.87 ND
MW-114	**3.8**	0.32 ND	0.75	0.87 ND

[1]CV- comparison value; [2]ug/L- micrograms per liter (parts per billion); [3]CREG- Cancer Risk Evaluation Guide; [4]Ch. EMEG- Child Environmental Media Evaluation Guide; [5]ND- not detected above the laboratory method detection limit
[±]comparison value below detection limit

Table 4: Estimated cancer risks for benzene in indoor air samples collected in 2007-2012 from residential properties within the Highway 71/72 Refinery site boundaries.

(Estimated cancer risks exceeding acceptable risk levels listed in **bold red**)

Sample Location	Inhalation Unit Risk ((ug/m^{3*})$^{-1}$)	Cancer Risk Level	
		Contractor Sample	Oversight Sample
2201 Loreco Street, Alexis Park Apartments, Unit 615	7.8E^{-6} (ug/m^3)$^{-1}$	1.30 x 10^{-5}	NS$^{\pm}$
2201 Loreco Street, Alexis Park Apartments, Unit 613		3.24 x 10^{-6}	NS
2201 Loreco Street, Alexis Park Apartments, Unit 501		1.27 x 10^{-5}	NS
2000 Old Minden Road, St. Charles Place Apartments, Unit S-107		2.22 x 10^{-5**}	1.15 x 10^{-5}
535 Rugby Place		**1.37 x 10^{-4}**	**1.06 x 10^{-4}**
202 Rampart Street		2.44 x 10^{-5}	2.12 x 10^{-5}
2201 Loreco Street, Alexis Park Apartments, Unit 715		**1.12 x 10^{-4}**	NS
400 John Wesley Boulevard, Mission Village Unit 85		1.22 x 10^{-5}	NS
403 Preston Boulevard		1.74 x 10^{-5}	1.84 x 10^{-5}
204 Napoleon Street		2.99 x 10^{-5}	4.49 x 10^{-5}
201 John Wesley Boulevard, 1st Methodist Church		2.99 x 10^{-5}	2.24 x 10^{-5**}
125 Carriage Square		2.49 X 10$^{-5\Omega}$	2.04 x 10^{-5}

Highlighted cells represent sampling points where summary data only was available (laboratory data missing) and/or laboratory detection limits were missing or lacked sensitivity; data was reviewed and theoretical cancer risk estimates were generated, but not used to make health based recommendations

*ug/m^3- micrograms per cubic meter; **based on replicate sample; $^{\pm}$NS-not sampled; $^{\Omega}$ based on a non-detect sample

Appendix D: EPA Request and LDHH Response

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS TEXAS 75202-2733

October 15, 2012

Ms. Kathleen Aubin
1450 Poydras Street, Suite 1640
New Orleans, Louisiana 70112

Re: Highway 71/72 Refinery Site, City of Bossier City, LA: Health Consultation

Dear Ms. Aubin:

This letter is a follow-up to the August 21, 2012, conference that the U.S. Environmental Protection Agency (EPA) held with the Louisiana Department of Health and Hospitals/Office of Public Health/Section of Environmental Epidemiology and Toxicology (LDHH/OPH/SEET) to discuss SEET's January 13, 2012, Health Consultation for the Highway 71/72 Refinery Site (the "Site"). The EPA received this document on May 10, 2012.

1. **EPA's historic indoor air sampling data and analysis, which included hundreds of Site-wide samples, was not utilized in the Health Consultation and inappropriately discounted during the conference call. To efficiently focus future actions to protect human health from vapor intrusion and to cleanup ground water, EPA's data should have been considered.**

Indoor air sampling is currently conducted at the Site as part the Remedial Action (RA) required by EPA's September 2000 Record of Decision (ROD). Glenn Springs Holdings Inc. (GSHI) conducts sampling for benzene in indoor air at the request of Site residents. (GSHI is acting on behalf of the responsible party (PRP), CanadianOxy Offshore Production Company (COPCO)). The ROD remediation goal for benzene in indoor air is 10 parts per billion per volume. If benzene contamination exceeding the ROD remediation goal is discovered after requested sampling, mitigation measures to prevent vapor intrusion are implemented. Sampling and any needed mitigation measures are available at no cost to site residents.

From 2007 to 2012, indoor air samples were collected at twelve locations at the request of Site residents. The samples were collected as part of the RA under the ROD. The twelve locations included indoor air samples collected and analyzed at eleven Site residences and at the 1st United Methodist Church located on the Site.

In addition to the twelve samples collected at the request of Site residents, Site-wide indoor air sampling was conducted from 1994 through 2000 as part of the Remedial Investigation (RI) conducted by EPA, OXY USA Inc. (through contractors Law Environmental and Conestoga Rovers & Associates), and GSHI. This sampling was undertaken to address indoor air contamination found through RI sampling. This effort included more than 500 indoor air samples taken on the Site from more than 190 residential units and businesses.

The RI indoor air samples were collected using summa canister sampling, carbon sorbent tube sampling, and real-time Trace Atmospheric Gas Analyzer (TAGA) sampling. Please see the enclosed document entitled "Indoor Air Locations on 2010 Aerial." This figure in the enclosure shows the locations where indoor air sampling from the RI and RA has already occurred on the Site. Results from the numerous sampling events that occurred from 1994 through 2000, plus results from the indoor air sampling conducted from 2007 through 2011 as part of the RA for the Site were supplied to SEET on compact disk in October 2011. Our hope was that SEET would use these data and analysis in preparation of the Health Consultation.

The reason we have described the extensive indoor air sampling activities undertaken at the Site is that it remains unclear to EPA why SEET chose to disregard that extensive sampling when it prepared its Health Consultation report. We are confused because, rather than use the extensive sampling data and analysis provided; SEET decided to base conclusions and recommendations regarding indoor air in its Health Consultation report on the result from a single sample—an indoor air sample taken on November 4, 2010.

Based on this single sample, SEET recommended in its Health Consultation report, that all properties within the Highway 71/72 site borders should be sampled for benzene in indoor and outdoor air. As described above in this letter, site-wide sampling has already been conducted. As we explained in our August 12, 2012, conference call with SEET, it is inappropriate to ignore these historic data if we are to efficiently focus our future efforts to protect human health from vapor intrusion and to cleanup ground water.

2. **EPA also collected soil gas samples from 898 locations in a Site-wide sampling effort.**

In our August 21, 2012, conference call EPA and SEET also talked about sampling and analysis of soil gas. As was discussed, soil gas sampling is a non-intrusive method of sampling for vapor intrusion potential. A Site-wide soil gas analysis was conducted in 1992 to investigate the nature and extent of soil gases and their potential sources. Soil gas samples from 898 locations were collected from depths of approximately 2.5 to 7.0 feet below ground surface at locations throughout the Site. Each sample was analyzed for light hydrocarbon gases including methane, ethane, propane, butanes, and the C5 plus (gasoline range) compounds. The results of the soil gas survey indicate that the highest hydrocarbon gas concentrations were generally found in the southern half of the Site. The highest soil gas readings tended to be concentrated in the area where ground water monitoring results indicate the presence of LNAPL, and along the old impounded bayous. These readings indicated the potential presence of organic material remaining from past refinery waste activities. Similar readings were found in the former railroad tank car repair yard where hydrocarbon-saturated soil was detected in boreholes.

Residences and businesses in the areas with the highest soil gas readings from the 1992 Site-wide soil gas survey were extensively sampled during the RI and residences in these areas have been sampled as part of the RA for the Site. EPA does not believe that additional Site soil gas sampling is warranted or that additional soil gas sampling will yield results different to those from the extensive sampling conducted in 1992. If SEET wishes to have a copy of the 1992 Site-wide soil gas analysis results, EPA will be happy to provide it.

3. **SEET's direct comparison of a single sampling result to the ATSDR MRL and to the CREG is overly conservative. In addition, SEET did not take into account other non-Site-related sources of indoor benzene in its Health Consultation.**

SEET compared the one, November 4, 2010, indoor air sample result with the Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk level (MRL) and with the ATSDR cancer risk evaluation guide level (CREG). A direct comparison of the single indoor air sample taken with the MRL and the CREG is overly conservative because not all benzene in indoor air can be attributed to potential vapor intrusion. Evaluations of indoor benzene contamination must take into account non-Site-related ambient benzene levels that may be present in indoor air; otherwise, conclusions will be drawn without a clear baseline for comparison. Health evaluations conducted during the RI compared indoor benzene contamination to EPA's May 1988 National Ambient Volatile Organic Compounds (VOCs) Database Update, EPA/600/S3-88/010 and the EPA's June 1987 Total Exposure Assessment Methodology (TEAM) Study, EPA/600/6-87/002a. Comparison with these ambient indoor air data provides a more realistic basis for evaluation of indoor air contamination. On the call, SEET indicated that it would have to consult with the ATSDR before it could include evaluation of ambient benzene levels from non-Site-related sources as part of future Health Consultations. EPA requests that SEET work with ATSDR so that ambient benzene levels may be included in its future Health Consultations. As explained above, without measuring the concentrations of non-Site-related benzene in indoor air it is impossible to tell if benzene hits collected during sampling are due to Site-related contamination.

4. **It is important to note that LNAPL thickness at the site is trending downward due to extraction efforts taken as part of EPA's remedy. Consequently, it is anticipated that the potential for benzene to intrude into indoor air has also decreased.**

Dual-phase extraction of LNAPL from ground water and site-wide ground water monitoring are also components of EPA's ROD. Results from the operation of the dual-phase extraction system indicate that LNAPL has decreased significantly. Please see attachments to this letter, entitled, "Average LNAPL Thickness Trend – Phase I Recovery Wells" and "Average LNAPL Thickness Trend – Phase II Recovery Wells." These attachments are from the April 2012 RA Annual Report. These RA Annual Reports have been routinely shared with SEET. The decrease in LNAPL contamination and with the general decreasing trend for ground water contamination indicate that over time the potential for vapor intrusion of benzene into indoor air should also decrease.

5. **Conclusion**

The Health Consultations report's recommendation that Site-wide indoor and outdoor air sampling is warranted is ill-founded. Specifically, it is based on one sampling event that did not account for non-Site-related benzene contamination in the indoor air measured. Moreover, the Health Consultation did not address indoor air sampling data and analysis gathered from hundreds of data points. In addition, the Health Consultation used overly conservative comparisons to the MRL and CREG. Finally, the Health Consultation did not acknowledge the downward trend in LNAPL thickness, which indicates that the potential for vapor intrusion of benzene into indoor air is likely decreasing.

Nonetheless, GSHI has agreed to conduct additional limited indoor air sampling at Site properties. This additional indoor air sampling will serve to supplement citizen-requested sampling conducted as part of the RA. Indoor air sampling will be targeted to the areas of greatest concern based on the 1992 Site-wide soil gas survey. It is our understanding from our August 12, 2012, conference call that SEET agrees that

the additional limited indoor air sampling would address the concerns it voiced in the Health Consultation report. It is also our understanding that SEET agrees that the sampling should focus on only those properties that overlay contaminated ground water or LNAPL contamination. Finally, it is our understanding that SEET agrees that an additional site-wide sampling effort is not necessary.

The Louisiana Department of Environmental Quality has reviewed this letter and concurs with its conclusions. Should you have any questions or need any additional information please do not hesitate to contact me at (214) 665-7525.

Sincerely yours,

Laura Stankosky
Remedial Project Manager

enclosures

cc: Mr. John Halk, LDEQ - Project Manager (AI-5347)
Mr. Steve Clary, Project Coordinator, GSHI
Mr. Raymond (Trace) Chadwick, CRA
Ms. Darcie Olexia, MSPH
Mr. George Pettigrew, ATSDR/ R6 Liaison
Mr. Jeff Kellam, ATSDR/DHAC
Mr. Rick Gillig, ATSDR/DHAC

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The Louisiana Department of Health and Hospitals, Office of Public Health, Section of Environmental Epidemiology and Toxicology (LDHH/OPH/SEET) received comments from the U.S. Environmental Protection Agency (EPA) regarding the Highway 71/72 Refinery Site Groundwater Health Consultation (January 2012). Each comment and supporting statements have been extracted from the attached EPA letter dated October 15, 2012. SEET's italicized responses are noted within each comment.

1. EPA's historic indoor air sampling data and analysis, which included hundreds of site-wide samples, was not utilized in the Health Consultation and inappropriately discounted during the conference call. To efficiently focus future actions to protect human health from vapor intrusion and to cleanup ground water, EPA's data should have been considered.

   Indoor air sampling is currently conducted at the site as part of the Remedial Action (RA) required by EPA's September 2000 Record of Decision (ROD). Glenn Springs Holdings Inc. (GSHI) conducts sampling for benzene in indoor air at the request of site residents. (GSHI is acting on behalf of the responsible party (PRP), CanadianOxy Offshore Production Company (COPCO)). The ROD remediation goal for benzene in indoor air is 10 parts per billion per volume. If benzene contamination exceeding the ROD remediation goal is discovered after requested sampling, mitigation measures to prevent vapor intrusion are implemented. Sampling and any needed mitigation measures are available at no cost to site residents.

   This comment has been noted. In the Highway 71/72 Refinery Site Groundwater Health Consultation (January 2012), SEET cited available sampling and mitigation measures available to site residents as required by the ROD.

   From 2007 to 2012, indoor air samples were collected at twelve locations at the request of site residents. The samples were collected as part of the RA under the ROD. The twelve locations included indoor air samples collected and analyzed at eleven site residences and at the 1st United Methodist Church located on the site.

   At the request of EPA, SEET has included within this document an evaluation of indoor and ambient air samples collected from 2007 through 2012 at the aforementioned residential and commercial locations.

   In addition to the twelve samples collected at the request of site residents, site-wide indoor air sampling was conducted from 1994 through 2000 as part of the Remedial Investigation (RI) conducted by EPA, OXY USA Inc. (through contractors Law Environmental and Conestoga Rovers & Associates), and GSHI. This sampling was undertaken to address indoor air contamination found through RI sampling. This effort included more than 500 indoor air samples taken on the site from more than 190 residential units and businesses.

   The RI indoor air samples were collected using summa canister sampling, carbon sorbent tube sampling and real-time Trace Atmospheric Gas Analyzer (TAGA) sampling. Please

see the enclosed document entitled "indoor Air Locations on 2010 Aerial." This figure in the enclosure shows the locations where indoor air sampling from the RI and RA has already occurred on the site. Results from the numerous sampling events that occurred from 1994 through 2000, plus results from the indoor air sampling conducted from 2007 through 2011 as part of the RA for the site were supplied to SEET on compact disk in October 2011. Our hope was that SEET would use these data and analysis in preparation of the Health Consultation.

In cooperation with the ATSDR, SEET released a final version of a Public Health Assessment (PHA) for the Highway 71/72 Refinery Site on June 16, 2000. The PHA included an exhaustive review of the data that was provided to SEET on compact disk in October 2011, and also contained additional datasets that were not included on the disc. SEET has a significant history of involvement at the site, having reviewed all but one (1997 indoor air) dataset included in the 1999 Remedial Investigation (RI) and all indoor air data from the 1997 Baseline Risk Assessment (BRA). Please note that the 1997 indoor air data that was not reviewed by SEET contained monitoring using technology unsuitable for preparing risk calculations. SEET further reviewed indoor air and soil gas monitoring data collected from the Highway 71/72 Refinery site in a Health Consultation released on January 6, 1997 as well as indoor air data collected from the Alexis Park Apartments (Health Consultation March 21, 2001).
It should be noted that SEET carefully considered historical data in preparation of the January 2012 Health Consultation, even if such data was not expressly the focus of the evaluation. SEET respectfully notes the historical sitewide indoor air sampling; however, much of the data is more than 10 years old and was limited for use in assessing human health risks at the site. SEET provides an explanation of the data limitations in each of its documents and Volume I of the 1999 Remedial Investigation for the Highway 71/72 Refinery Site concurs that most of the historical indoor air data collected from the site is not suitable to determine health risks. Of the more than 500 indoor air samples collected from more than 190 residential units and businesses, only 31summa canister samples were suitable for inclusion in the 1997 BRA. Sampling conducted with flame ionization detector (FID) and Trace Atmospheric Gas Analyzer (TAGA) technologies are considered to be screening tests to help determine sources of indoor air contamination. FID does not allow for separating out individual compounds, rather it groups contaminants together as total hydrocarbons; it is not useful in evaluating exposure to specific contaminants and the health effects that may occur. TAGA data does not represent a time weighted average and is therefore not usable for risk calculations; it is helpful however, in directing further detailed sampling, which led to the June 1996 collection of the 31 summa canister samples used in the BRA. Unacceptable cancer risks associated with benzene contaminated indoor air were reported in both the 1997 BRA and the 2000 PHA. Further data quality concerns were raised in the PHA and RI related to February 1994 indoor air data collected to assess the inhalation pathway for a human health risk assessment; data quality prohibited its use in any health evaluations. SEET has consistently recommended the most protective measures for public health at the Highway 71/72 Refinery site due to the uncertainty surrounding exposures to site-related contaminants. Given the stated limitations, age of historical site-related data, excess estimated cancer risks associated with the most recent 1997 site-wide indoor air dataset,

and the continued presence of LNAPL in onsite ground water as well as areas with high soil gas concentrations, SEET considers its request for further sampling to be a reasonable recommendation.

The reason we have described the extensive indoor air sampling activities undertaken at the site is that it remains unclear to EPA why SEET chose to disregard that extensive sampling data and analysis provided; SEET decided to base conclusions and recommendations regarding indoor air in its Health Consultation report on the result from a single sample- an indoor air sample taken on November 4, 2010.

The January 2012 Health Consultation was an evaluation of the most recent groundwater data available at the time of publication. Due to the historical evidence of the potential for indoor air contamination related to onsite LNAPL groundwater plumes and areas containing high soil gas concentrations, our Federal health partner, ATSDR strongly advised including the most recent indoor and ambient air data available for the Highway 71/72 Refinery site. Since much of the indoor and ambient air data for the site is at least more than 10 years old, SEET chose to highlight the most recent results from one citizen-requested air sampling event conducted on November 4, 2010. The sample provided time-sensitive data as an example of one of the Remedial Action (RA) provisions instituted at the site; the ability for onsite residents and businesses to request air and/or soil sampling at no cost. It was not intended to exhibit an exhaustive characterization of sitewide indoor air contaminant concentrations; however, it was among a very small sampling of available data that may reflect current indoor air conditions at the site. SEET further stated in its evaluation that one sample is not sufficient to characterize environmental conditions throughout the site, and used this as a basis to recommend further indoor air sampling.

Based on this single sample, SEET recommended in its Health Consultation report, that all properties within the Highway 71/72 site borders should be sampled for benzene in indoor and outdoor air. As described above in this letter, site-wide sampling has already been conducted. As we explained in our August 12, 2012 conference call with SEET, it is inappropriate to ignore these historic data if we are to efficiently focus our future efforts to protect human health from vapor intrusion and to cleanup ground water.

As previously outlined, SEET is aware of the level and quality of the historical indoor data available for the Highway 71/72 Refinery site. The data was not inappropriately ignored; rather its deficiencies were highlighted as support for future sampling efforts to protect human health from potential vapor intrusion at the site. SEET and ATSDR (via draft comment) believe that sampling conducted at the request of residents, workers and property owners does not adequately characterize current indoor air environments or identify the potential exposure risk to all occupants.

2. <u>EPA also collected soil gas samples from 898 locations in a site-wide sampling effort.</u>

In our August 21, 2012 conference call, EPA and SEET also talked about sampling and analysis of soil gas. As was discussed, soil gas sampling is a non-intrusive method of sampling for vapor intrusion potential. A site-wide soil gas analysis was conducted in

1992 to investigate the nature and extent of soil gases and their potential sources. Soil gas samples from 898 locations were collected from depths of approximately 2.5 to 7.0 feet below ground surface at locations throughout the site. Each sample was analyzed for light hydrocarbon gases including methane, ethane, propane, butanes and the C5 plus (gasoline range) compounds. The results of the soil gas survey indicate that the highest hydrocarbon gas concentrations were generally found in the southern half of the site. The highest soil gas readings tended to be concentrated in the area where ground water monitoring results indicate the presence of LNAPL, and along the old impounded bayous. These readings indicated the potential presence of organic material remaining from past refinery waste activities. Similar readings were found in the former railroad tank car repair yard where hydrocarbon-saturated soil was detected in boreholes.

Residences and businesses in the areas with the highest soil gas readings from the 1992 Site-wide soil gas survey were extensively sampled during the RI and residences in these areas have been sampled as part of the RA for the site. EPA does not believe that additional site soil gas sampling is warranted or that additional soil gas sampling will yield results different to those from the extensive sampling conducted in 1992. If SEET wishes to have a copy of the 1992 site-wide soil gas analysis results, EPA will be happy to provide it.

In cooperation with the ATSDR, SEET released a final version of a Public Health Assessment (PHA) for the Highway 71/72 Refinery Site on June 16, 2000. In addition to air and groundwater data, the PHA included an evaluation of the 1992 Site-wide soil gas survey, and an evaluation of surface and subsurface soil and tar samples. SEET further evaluated additional soil gas data presented in a Health Consultation released on January 6, 1997. In response to recommendations made in those documents, EPA ordered the potentially responsible party (PRP) to conduct soil and indoor air removal actions on portions of the Highway 71/72 site. SEET has consistently recommended that indoor air screening and time-weighted sampling, along with soil gas screening and sampling be expanded throughout the impacted areas of the Highway 71/72 site. Historical indoor air and soil gas datasets are unable to capture current site conditions that may affect the vapor intrusion pathway and ultimately human health. During the aforementioned call on August 21, 2012, EPA suggested that a request for the collection of additional soil gas samples could be made to the PRP; SEET was agreeable to the suggestion.

3. <u>SEET's direct comparison of a single sampling result to the ATSDR MRL and to the CREG is overly conservative. In addition, SEET did not take into account other non-site-related sources of indoor benzene in its Health Consultation.</u>

SEET compared the one, November 4, 2010, indoor air sample result with the Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk level (MRL) and with the ATSDR cancer risk evaluation guide level (CREG). A direct comparison of the single indoor air sample taken with the MRL and CREG is overly conservative because not all benzene in indoor air can be attributed to potential vapor intrusion. Evaluations of indoor benzene contamination must take into account non-site-related ambient benzene levels that may be present in indoor air; otherwise, conclusions will be drawn without a clear

baseline for comparison. Health evaluations conducted during the RI compared indoor benzene contamination to EPA's May 1988 National Ambient Volatile Organic Compounds (VOCs) Database Update, EPA/600/S3-88/010 and the EPA's June 1987 Total Exposure Assessment Methodology (TEAM) Study, EPA/600/6-87/002a. Comparison with these ambient indoor air data provides a more realistic basis for evaluation of indoor air contamination. On the call, SEET indicated that it would have to consult with the ATSDR before it could include evaluation of ambient benzene levels from non-site-related sources as part of future Health Consultations. EPA requests that SEET work with ATSDR so that ambient benzene levels may be included in its future Health Consultations. As explained above, without measuring the concentrations of non-site-related benzene in indoor air it is impossible to tell if benzene hits collected during sampling are due to site-related contamination.

Various government agencies establish screening or comparison values to assist in the interpretation of chemical concentrations in the environment and those values can differ significantly among agencies. Comparison value differences are related to each agency's mission, its objectives in interpreting the chemical values, and the nature of the resource or endpoint it is charged with protecting. In some cases, the development of comparison values includes a risk/benefit component, or consideration of factors other than risk, such as logistics and cost. In the case of the Highway 71/72 Refinery site, where vapor intrusion of carcinogenic volatiles such as benzene is of concern, the differences among screening criteria are substantial. The soil, indoor air, and ground water Remedial Action Objectives (RAOs) currently outlined in the ROD are substantially higher than the ATSDR minimal risk level (MRL) and the cancer risk evaluation guide (CREG). SEET recognizes that these comparison values may be viewed as overly conservative measures of comparison to estimate health effects; however, ATSDR provides clear guidance that CREGs and MRLs are considered Hierarchy I comparison values and must be utilized when chemical specific values are available. Standards meant to protect the lay public must consider not only healthy individuals, but also the most vulnerable of the population including children, pregnant women and their growing fetuses, the elderly and/or the disabled.

SEET clearly stated in the January 2012 Health Consultation that it would be imprudent to compare a singular 8-hour summa canister sample to the CREG, which assumes a 70-year exposure period; although it could not be concluded that detected benzene levels in indoor air would not harm people's health. The Highway 71/72 Refinery site has a significant history of site-related indoor air contamination, including the 1990 evacuation of 47 families from the Alexis Park Apartments due to elevated levels of methane and other hydrocarbon gases detected in the complex. While known site-related hazards have triggered response action and mitigation, the potential for future exposure exists with the continued, albeit decreasing, presence of LNAPL ground water plumes and soil gas sources. The current contaminant levels and mechanisms by which these sources may lead to future indoor air contamination are difficult to quantify and predict with the aged data that is available.

SEET has consulted with ATSDR for permissions to include national and state-based background ambient and indoor air concentrations in the evaluation of air data contained within this document. The background levels have been used in conjunction

with standard ATSDR health assessment methodology and guidance. It should be noted that much of the extensive historical indoor air sampling conducted at the Highway 71/72 Refinery site already provides valuable onsite contaminant background levels detected with FID and TAGA technologies; this historical background data can support and guide future source sampling efforts.

4. It is important to note that LNAPL thickness at the site is trending downward due to extraction efforts taken as part of EPA's remedy. Consequently, it is anticipated that the potential for benzene to intrude into indoor air has also decreased.

   Dual-phase extraction of LNAPL from ground water and site-wide ground water monitoring are also components of EPA's ROD. Results from the operation of the dual-phase extraction system indicate that LNAPL has decreased significantly. Please see attachments to this letter, entitled, "Average LNAPL Thickness Trend- Phase I Recovery Wells" and "Average LNAPL Thickness Trend- Phase II Recovery Wells." These attachments are from the April 2012 RA Annual Report. These RA Annual Reports have been routinely shared with SEET. The decrease in LNAPL contamination and with the general decreasing trend for ground water contamination indicate that over time the potential for vapor intrusion of benzene into indoor air should also decrease.

   SEET routinely received the RA Annual Reports; ground water data extracted from the those reports were analyzed in the January 2012 ground water Health Consultation and within this document. SEET has referenced LNAPL thickness in these documents, specifically thickness measurements showing that a continued reduction in the LNAPL plume size is being achieved. SEET recognizes the reduction of LNAPL groundwater plumes in the southern portion of the site; however, because LNAPL is still present, the potential for site-related contaminants to impact indoor air still exists. Furthermore, because site conditions change over time, including but not limited to shifts in building foundations and variable environmental conditions, new vapor migration pathways are likely to emerge. While it may be anticipated that the potential for benzene to intrude into indoor air has decreased along with LNAPL thickness, it is not possible to quantify those statements with the aged data that is currently available. In agreeing to conduct further sampling at the Highway 71/72 Refinery site, the PRP has an opportunity to substantiate their assumptions with environmental data reflective of current site conditions.

5. Conclusion

   The Health Consultations report's recommendation that site-wide indoor and outdoor air sampling is warranted is ill-founded. Specifically, it is based on one sampling event that did not account for non-site-related benzene contamination in the indoor air measured. Moreover, the Health Consultation did not address indoor air sampling data and analysis gathered from hundreds of data points. In addition, the Health Consultation used overly conservative comparisons to the MRL and CREG. Finally, the Health Consultation did not acknowledge the downward trend in LNAPL thickness, which indicates that the potential for vapor intrusion of benzene into indoor air is likely decreasing.

This comment has been noted and extensively addressed in previous responses. SEET remains supportive of the ATSDR health assessment methodology used in the completion of the January 2012 Health Consultation and of the sampling recommendations put forth in the document. Moving forward, SEET proposed and agreed to conduct an evaluation of all resident-requested indoor air sampling collected from 2007-2012 at the Highway 71/72 Refinery site. This evaluation is included within this document. SEET has generated a zip code level Cancer Statistics Review (CSR) for the site relative to site-related carcinogenic contaminants (benzene, toluene, ethylbenzene, and xylene) [January 28, 2013]. SEET supports the creation of a unified Public Health Action Plan in collaboration with all state and federal partners based upon a review of recommendations from historical Highway 71/72 documents including PHAs and HCs. Separate from resident-requested sampling, it is recommended that EPA conduct oversight of sampling in residences located within the LNAPL footprint of the site; especially where known ground water contamination exists. These actions will provide timely data to reflect any changes to site conditions and identify potential exposure risks to occupants.

Nonetheless, GSHI has agreed to conduct additional limited indoor air sampling at site properties. This additional indoor air sampling will serve to supplement citizen-requested sampling conducted as part of the RA. Indoor air sampling will be targeted to the areas of greatest concern based on the 1992 site-wide soil gas survey. It is our understanding from our August 12, 2012, conference call that SEET agrees that the additional limited indoor air sampling would address the concerns it voiced in the Health Consultation report. It is also our understanding that SEET agrees that the sampling should focus on only those properties that overlay contaminated ground water or LNAPL contamination. Finally, it is our understanding that SEET agrees that an additional site-side sampling effort is not necessary.

SEET agrees that soils located in the southern portion of the Highway 71/72 Refinery site have historically been the most impacted by site-related contaminants. This statement is based on 1992 soil data collected from sampled areas only, and is qualified with the knowledge that as stated in the 1999 Remedial Investigation Report, a comprehensive site characterization study has never been conducted at the Highway 71/72 Refinery site. However, it is reasonable to investigate properties located within the LNAPL ground water plume footprints to generate time-sensitive data for exposure and health risk assessments. SEET respectfully requests that sampling plans be generated with input from State and Federal health agencies in order to include the necessary variables for conducting a health risk assessment.

Appendix E: Bossier City Groundwater Ordinance

The following Ordinance offered and adopted:

ORDINANCE 109 OF 2000

AN ORDINANCE PROHIBITING THE INSTALLATION OF GROUNDWATER WELLS WITHIN THE HIGHWAY 71/72 REFINERY SITE IN BOSSIER CITY

WHEREAS, the City has no feasible process to determine the contents, quality, or safety of underground sources of water; and

WHEREAS, the City has sufficient water to meet current residential and commercial water needs of the city from existing water treatment plant resources.

NOW, THEREFORE, BE IT ORDAINED, that the City Council of Bossier City, Louisiana, in regular session convened, hereby prohibits the installation of any new groundwater wells on the Highway 71/72 Refinery Site.

BE IT FURTHER ORDAINED, water from the existing well on that site, or any other that may be discovered on that site, shall not be used for any purpose.

The above and foregoing Ordinance, was read in full at open and legal session convened, on motion of MR. DARBY, seconded by MRS. RAWLS, and adopted on the 17 day of OCTOBER, 2000, by the following vote:

AYES: MRS. COOPER, MR. DEPRANG, MRS. RAWLS, MR. DARBY, MR. WILLIAMS, DR. ROGERS
NAYS: NONE
ABSENT: MR. JONES
ABSTAIN: NONE

Coy Cooper

COY COOPER
VICE PRESIDENT

Helen Thornton

HELEN THORNTON, CITY CLERK
NOVEMBER 2, 2000
BOSSIER PRESS TRIBUNE

I, Helen Thornton, City Clerk of the City Council of Bossier City, Louisiana, do hereby certify that the above is a true and correct copy of Ordinance #109 of 2000 as adopted at the City Council REGULAR meeting held on the 17 day of OCTOBER, 2000

Helen Thornton

Helen Thornton, City Clerk