Health Consultation

QUARTERLY INDOOR AIR SAMPLING OF HARTFORD RESIDENCES

HARTFORD, MADISON COUNTY, ILLINOIS

SEPTEMBER 9, 2005

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

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

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HEALTH CONSULTATION

QUARTERLY INDOOR AIR SAMPLING OF HARTFORD RESIDENCES

HARTFORD, MADISON COUNTY, ILLINOIS

Prepared by:

Illinois Department of Public Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Purpose

The Illinois Department of Public Health (IDPH) developed this health consultation to evaluate quarterly air sampling data collected from June 2003 to May 2004 in Hartford, Illinois. The purpose of these samples was to evaluate the variation in levels of volatile organic compounds (VOCs) in Hartford homes throughout the year. Quarterly air sampling was recommended in the Public Health Assessment for Hartford Residential Vapor Exposures dated June 17, 2003. The health assessment concluded that the vapor intrusions of May 2002 posed a public health hazard.

Background and Statement of Issues

Hartford is in eastern Madison County, Illinois, on the flood plain of the Mississippi River known locally as the American Bottoms (Figure 1). Three petroleum refineries and associated facilities and three other communities are near Hartford (Figure 2). A levy lies between Hartford and the Mississippi River. Hartford has a population of about 1,550 persons.

Petroleum refining in this area began as early as 1908 and continues to the present. Underground pipelines link the refineries to barge docks on the Mississippi River. Several of these product lines run through the northern section of Hartford, that portion of the village north of Hawthorne Street. Subsurface releases, both reported and unreported, have occurred underneath Hartford since at least the mid-1960s. In addition to subsurface releases, there have been numerous surface and air releases.

The geology underneath Hartford is complex with several discontinuous layers of silt and sand occurring at varying depths. Depth to the main sand aquifer is approximately 30 feet below ground surface. Groundwater also may be found in sand and silt layers overlying the main aquifer during wet periods. Free petroleum hydrocarbons have been found in the main sand aquifer. In addition, trapped residual petroleum hydrocarbons have been found in the other sand formations and, in near-surface soils, petroleum hydrocarbons have been found as vapors.

Since 1966, approximately 360 petroleum odor complaints have been documented in Hartford. Air samples collected in 1966 reportedly detected the presence of petroleum hydrocarbons. In addition to the odor complaints, 22 fires from petroleum vapors have been documented in northern Hartford. Fires began in 1970 with four fires reported between 1970 and 1977. In an eight-day period in March 1978, five house fires occurred in northern Hartford. These fires led to the installation of three product recovery wells in late 1978. Five fires in three days in May 1990 prompted the installation of 12 vapor recovery wells in September 1992. Odor complaints were greatly reduced in the areas near the vapor recovery wells.

On May 13, 2002, after several weeks of heavy rain, residents of Hartford contacted IDPH staff. One caller reported that the family was awakened at 12:30 a.m. by strong odors. The family left the home and alerted other neighbors. The residents of several homes along East Watkins Street also reported odors.

Emergency response personnel from the Premcor Refinery in Hartford, the regional office of the Illinois Environmental Protection Agency (Illinois EPA), the Hartford volunteer fire department, and IDPH staff came to the scene. Two of the families found temporary housing and had concerns about returning to their homes.

The May 2002 vapor intrusion event prompted Illinois EPA, the Illinois Attorney General's Office, and the U.S. Environmental Protection Agency (USEPA) to request the petroleum hydrocarbon plume be permanently remediated. This voluntary action involving several of the refineries and associated facilities, known collectively as the Hartford Working Group, is governed by a legal agreement with USEPA called an Administrative Order on Consent and requires the group to:

- develop a site conceptual model,
- create a contingency plan,
- implement interim vapor reduction measures,
- determine vapor migration pathways, and
- design a final remedy.

A contingency plan that requires the Hartford Working Group to respond to complaints of vapors in buildings and, if necessary, temporarily relocate residents is in place. Residents who experience gasoline odors have been advised to report them to the Hartford Fire Department.

Interim vapor reduction or mitigation measures are available for all buildings in the area impacted by subsurface petroleum products. This area (Figure 3) is identified in the USEPA's Administrative Order on Consent (USEPA, 2004). The Hartford Working Group is offering to assess each building and develop a plan to reduce vapor intrusions specific to that building. Interim mitigation measures are then offered to the building's owner. If the owner allows, the interim measures recommended for that building are installed and an assessment of their effectiveness is performed. Interim mitigation measures may include:

- installing vent fans and fresh air intakes in basements,
- installing a vapor barrier in crawl spaces,
- pouring concrete over dirt floors in basements,
- sealing cracks in basement floors and walls, and
- installing combustible gas detectors set at 10% of the lower explosive limit (LEL).

Previous Indoor Air Sampling

Air sampling was conducted in Hartford as early as 1966. In 1990, IDPH collected air samples using sorbent tubes and Illinois EPA took combustible gas readings from the basements of several homes. The results of these samples detected elevated levels of benzene and other petroleum hydrocarbons. Combustible gas readings in the basements indicated levels from 3% to 40% of the LEL (IDPH, 2004).

Quarterly air samples were collected by IDPH from the basements of eight homes from May 1996 to May 1997. Samples were collected in SUMMA canisters and analyzed for VOCs including benzene, toluene, ethyl benzene, and xylenes. The mean benzene concentration in the basements was 10.2 micrograms per cubic meter ($\mu g/m^3$) or 3.2 parts per billion (ppb) (IDPH, 2004).

In May 2002, Premcor, Illinois EPA, and the local fire department used survey and field instruments during visits. The survey instrument readings measured by Illinois EPA emergency response staff in the basements of the affected homes on May 13 ranged from 10,000 to 11,000,000 ppb of total VOCs. During the week of May 13, 2002, IDPH staff placed stainless steel SUMMA canisters in the basements of four homes along the south side of East Watkins Street and collected 24-hour air samples. The Illinois EPA laboratory in Springfield, Illinois analyzed the contents of the SUMMA canisters (ATSDR, 2002).

In 2002, IDPH also collected basement and upstairs air samples in affected homes during the week of May 26 and June 2. While VOC levels had dropped dramatically, one home still had benzene present at 10.4 ppb in the basement on May 27 and 28, and at 12 ppb on the main floor on June 6 and 7. Another home had 11.3 ppb of benzene in the basement on June 5 and 6.

The vapor intrusion events of May 2002 led to a health consultation entitled “Vapors in Hartford Homes” dated July 1, 2002. The 2003 public health assessment for Hartford included indoor air sampling results, results from a community-wide questionnaire, community health concerns, and a review of cancer incidence data for Hartford. One of the recommendations in the health assessment was to conduct quarterly air sampling in homes in Hartford beginning in June 2003 (ATSDR, 2003).

June 2003 to May 2004 Quarterly Indoor Air Samples

Quarterly indoor air sampling, as recommended in the health assessment, began in June 2003. The sampling was conducted by IDPH and Illinois EPA. Eighteen homes were selected for the four rounds of sampling and included 16 homes north of Hawthorne Street and two homes south of Hawthorne Street. Two homeowners, north of Hawthorne Street, chose not to participate in all four rounds of sampling. Samples were collected in the months of June 2003, September 2003, January 2004, and May 2004.

VOCs, including those found in petroleum products, are commonly found in indoor air. Sources of VOCs in homes include paint and paint thinner, cigarette smoke, cleaning products, perfume, and gasoline. A walk through survey of the homes and a questionnaire was administered to the residents to determine possible sources of VOCs in the home. Residents were asked to remove these possible sources of VOCs at least 24 hours prior to sampling. This included not smoking in the home 24 hours before sampling or during the sampling event.

Sampling consisted of placing one SUMMA canister on the first floor and one in the basement of each home for 24 hours. An outdoor (ambient) air sample was collected for each day that indoor samples were collected. The SUMMA canisters were analyzed for 68 petroleum hydrocarbons

and methyl tertiary butyl ether. Illinois EPA used a toxic vapor analyzer (TVA) to collect photo ionization detector/flame ionization detector data at each home. The TVA measures total VOCs in the air. In a limited number of homes a combustible gas indicator was used to determine if combustible gases were present. Air samples also were collected on sorbent tubes in basements during the May 2004 sample round. The sorbent tubes were analyzed for tetraethyl lead and tetramethyl lead.

The mean benzene levels were 6.3 $\mu g/m^3$ upstairs, 7.1 $\mu g/m^3$ in the basements, and 2.6 $\mu g/m^3$ in outdoor air. The mean 1,3-butadiene levels were 2.2 $\mu g/m^3$ upstairs, 0.83 $\mu g/m^3$ in the basement, and 0.09 $\mu g/m^3$ in outdoor air. Neither tetraethyl lead nor tetramethyl lead were detected in any of the samples.

IDPH sent letters to participating residents after each round of sampling. These letters provided a health-based interpretation of each round of sampling data for their individual home. After all four rounds of samples were completed and the results reviewed, IDPH sent a letter to each participating resident that summarized and provided a health-based interpretation of all the quarterly results for their home.

Discussion

Chemicals of Interest

IDPH compared the results of each air sample with the appropriate screening comparison value used to select chemicals for further evaluation for carcinogenic and non-carcinogenic health effects. Chemicals found at levels greater than comparison values or those for which no comparison value exists were selected for further evaluation. A discussion of each comparison value is found in Attachment 1. The chemicals of interest are benzene, 1,3-butadiene, and trimethylbenzenes (Table 1).

Exposure Analysis

The residents are exposed to VOCs by breathing them in their indoor air during periods when conditions exist that lead to vapors entering their homes. The actual exposure depends on many factors including the amount of VOCs entering the home, other VOC sources in the home, the mixing of basement air with air elsewhere in the home, and the time spent in the basement and the home. IDPH assumed that adults (70 kilogram body weight) and children (36 kilogram body weight) living in the homes would be exposed to the average level of VOCs detected for 16 hours per day, 50 weeks per year.

Benzene

The estimated dose for a child exposed to the average level of benzene in indoor air, 0.0017 milligrams per kilogram-day (mg/kg-day) is less than the chronic reference dose (RfD) of 0.004 mg/kg-day established by USEPA. The estimated adult dose, 0.001 mg/kg-day, is also less than the RfD. The increased theoretical risk of cancer from exposure to benzene ranged from no

apparent increased risk of cancer in 15 homes to a low increased risk of cancer in one home (Table 2).

1,3-Butadiene

ATSDR has not established an MRL for 1,3-butadiene; however, USEPA has established a noncancer reference concentration of 2 µg/m^3 and a cancer unit risk of 0.00003 per µg/m^3. Only four homes exceeded the reference concentration for 1,3-butadiene (2.4 to 6.7 µg/m^3). The average level detected on the first floor of sampled homes exceeded the average level found in basements. Since 1,3-butadiene is heavier than air, the higher levels on the first floor suggest that the source of this chemical is not vapor intrusion. The estimated increased cancer risk for exposure to the average level of 1,3-butadiene in homes over a person's lifetime ranged from no apparent increased risk of cancer in 13 homes to a low increased risk of cancer in three homes (Table 2). No noncancer health effects would be expected from exposure to 1,3-butadiene.

Combined Cancer Risk

Because benzene and 1,3-butadiene can both cause leukemia, their risks were added together to determine an overall cancer risk. Table 2 shows the overall estimated increased cancer risk for each house in the last column. When combined, 6 homes had a low increased risk of cancer, while 10 had no apparent increased risk of cancer.

Trimethylbenzenes

ATSDR has not established an MRL for trimethylbenzenes; however, USEPA has established a provisional reference dose of 0.0017 mg/kg-day for trimethylbenzenes (Oak Ridge, 2004). All child doses and three of the adult doses exceeded the provisional reference dose (Table 3).

Toxicological Evaluation

Benzene

Benzene is found in gasoline as well as cigarette smoke, and is a known human carcinogen. It has been associated with leukemia in humans exposed to benzene in the workplace (ATSDR, 1997). Based on the estimated lifetime dose described above, exposure to benzene in Hartford homes could pose a low increased cancer risk. This calculation is based on the assumption that there is no safe level of exposure to be a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. While benzene is linked to causing leukemia, no detectable excess leukemia has been observed in workers exposed to benzene at levels of 1000 ppb or less for 40 years.

1,3-Butadiene

1,3-butadiene is found in gasoline as well as cigarette smoke, and is listed as a known human

carcinogen by the National Toxicology Program and as a probable human carcinogen by the International Agency for Research on Cancer (ATSDR, 1992). It has been associated with lymphocytic lymphoma (a type of leukemia). Based on the estimated lifetime dose described above, exposure to 1,3-butadiene in Hartford homes would pose a low increased risk of cancer in some homes.

Trimethylbenzenes

Breathing trimethylbenzenes at the levels detected in a few homes may cause adverse health effects including headache, fatigue, and drowsiness as well as nose and throat irritation (Oak Ridge, 2004). In some homes the primary source of trimethylbenzenes was painting or other homeowner activity.

Community Health Concerns

Residents are concerned about long-term adverse health outcomes because of VOC exposures. Concerns were shared about leukemia and chronic blood disorders. They also are concerned about future vapor intrusion events.

Residents have additional concerns including economic issues such as property values, increased costs of homeowners insurance, disclosure to future buyers, and potential loss of property.

Child Health Considerations

ATSDR and IDPH recognize that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of their environment. Children were the most sensitive population considered when evaluating exposure to VOCs in Hartford.

Conclusions

IDPH concludes that long-term exposure to benzene and 1,3-butadiene in some homes in Hartford poses a public health hazard to persons in affected homes. This conclusion is based on an estimated increased cancer risk from long-term exposures to benzene and 1,3-butadiene.

Conditions still exist in Hartford where acute, high-level vapor intrusions may occur again, as they did in May 2002, and pose an urgent public health hazard. Due to the variability of weather conditions and changes in groundwater elevation, it is difficult to accurately predict when and where these intrusions will occur.

Recommendations

IDPH recommends that interim mitigation measures should be performed in homes that are impacted by vapor intrusion in Hartford. Mitigation measures are available for all buildings located in the area impacted by subsurface petroleum products. This area is outlined in the USEPA Administrative Order on Consent.

IDPH also recommends that the regulatory agencies and the Hartford Working Group work to evaluate and correct deficiencies in the existing area vapor recovery system. This work began in the summer of 2004.

Public Health Action Plan

From June 2003 to August 2004, IDPH sent letters to participating residents after each round of indoor air sampling. These letters provided a health-based interpretation of the VOCs found in each round of sample data. After all four rounds of samples were completed and the results reviewed, IDPH sent a letter to each participating resident that summarized and provided a health-based interpretation of all the results for their individual home or building.

USEPA and Illinois EPA have hosted several public meetings over the past two years, and IDPH staff have provided health-based information to Hartford residents at these meetings. In addition, IDPH staff have developed the health messages that have been included in USEPA, Illinois EPA, and ATSDR fact sheets for the Hartford site.

IDPH staff will continue to work with regulatory agencies to assist with progress toward exposure mitigation and will review any future environmental data.

Preparer of Report

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Certification

This Health Consultation on Vapors in Homes on East Watkins Street, Hartford, Madison County, Illinois Hartford Health Consultation was prepared by the Illinois Department of Public Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

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

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Table 1 – Chemicals of Interest in Hartford Quarterly Air Samples Collected June 2003 to May 2004 (concentrations in micrograms per cubic meter, µg/m^3)

Compound	Ambient	1st Floor	Basement	Comparison Value	
	Range	Range	Range	Non-cancer	Cancer
benzene	0.95-5.0	0.99-20.29	0.12-29.08	4*	0.1
1,3-butadiene	ND-0.28	ND-23.9	ND-20.4	2	0.03
trimethylbenzenes	0.42-6.1	0.53-260.7	0.34-288.9	6	NV

* Intermediate Minimal Risk Level
ND – Not Detected
NV – No Value

Table 2. Estimated Cancer Risk for Each Home Sampled.

Cancer risk was calculated by multiplying the average concentration of the respective chemicals by the unit risk factor for that chemical. Risks in bold italics are those that represent a low increased risk of cancer.

Average Benzene Concentration in µg/m^3	Benzene Cancer Risk	Average 1,3-Butadiene Concentration in µg/m^3	1,3-Butadiene Cancer Risk	Total Cancer Risk
8.4	6.6 x 10^{-5}	6.7	***2.0 x 10-4***	***2.7 x 10-4***
6.8	5.3 x 10^{-5}	4.0	***1.2 x 10-4***	***1.7 x 10-4***
4.3	3.4 x 10^{-5}	2.8	***8.4 x 10-5***	***1.2 x 10-4***
12.0	***9.4 x 10^{-5}***	0.65	2.0 x 10-5	***1.1 x 10-4***
2.6	2.0 x 10^{-5}	2.4	7.2 x 10-5	***9.2 x 10-5***
5.3	4.1 x 10^{-5}	1.6	4.8 x 10-5	***8.9 x 10-5***
5.2	4.1 x 10^{-5}	0.84	2.5 x 10-5	6.6 x 10-5
4.7	3.7 x 10^{-5}	0.66	2.0 x 10-5	5.7 x 10-5
4.9	3.8 x 10^{-5}	0.46	1.4 x 10-5	5.2 x 10-5
4.8	3.7 x 10^{-5}	0.05	1.5 x 10-6	3.9 x 10-5
4.3	3.4 x 10^{-5}	0.16	4.8 x 10-6	3.9 x 10-5
3.6	2.8 x 10^{-5}	0.26	7.8 x 10-6	3.6 x 10-5
3.0	2.3 x 10^{-5}	0.27	8.1 x 10-6	3.1 x 10-5
3.5	2.7 x 10^{-5}	0.09	2.7 x 10-6	3.0 x 10-5
2.5	2.0 x 10^{-5}	0.07	2.1 x 10-6	2.2 x 10-5
1.7	1.3 x 10^{-5}	0.09	2.7 x 10-6	1.6 x 10-5

Table 3. Estimated Non-Cancer Risk.

The doses in the following table were calculated using the following exposure factors:

Adult: Breathing Rate 15 m^3/day, 70 kg, 16 hours/day, 50 weeks/year
Child: Breathing Rate 13.5 m^3/day, 36.3 kg, 16 hours/day, 50 weeks/year

Average Trimethylbenzene Concentration* (in mg/m^3)	Trimethylbenzene Child Dose in mg/kg-day	Trimethylbenzene Adult Dose in mg/kg-day	Trimethylbenzene Reference Dose in mg/kg-day (Provisional)
0.037	0.009	0.005	0.0017
0.021	0.005	0.003	0.0017
0.011	0.003	0.002	0.0017
0.0078	0.002	0.001	0.0017

*Only those homes exceeding the reference concentration of 0.006 mg/m^3 are listed.

Figure 1. Hartford Location Map

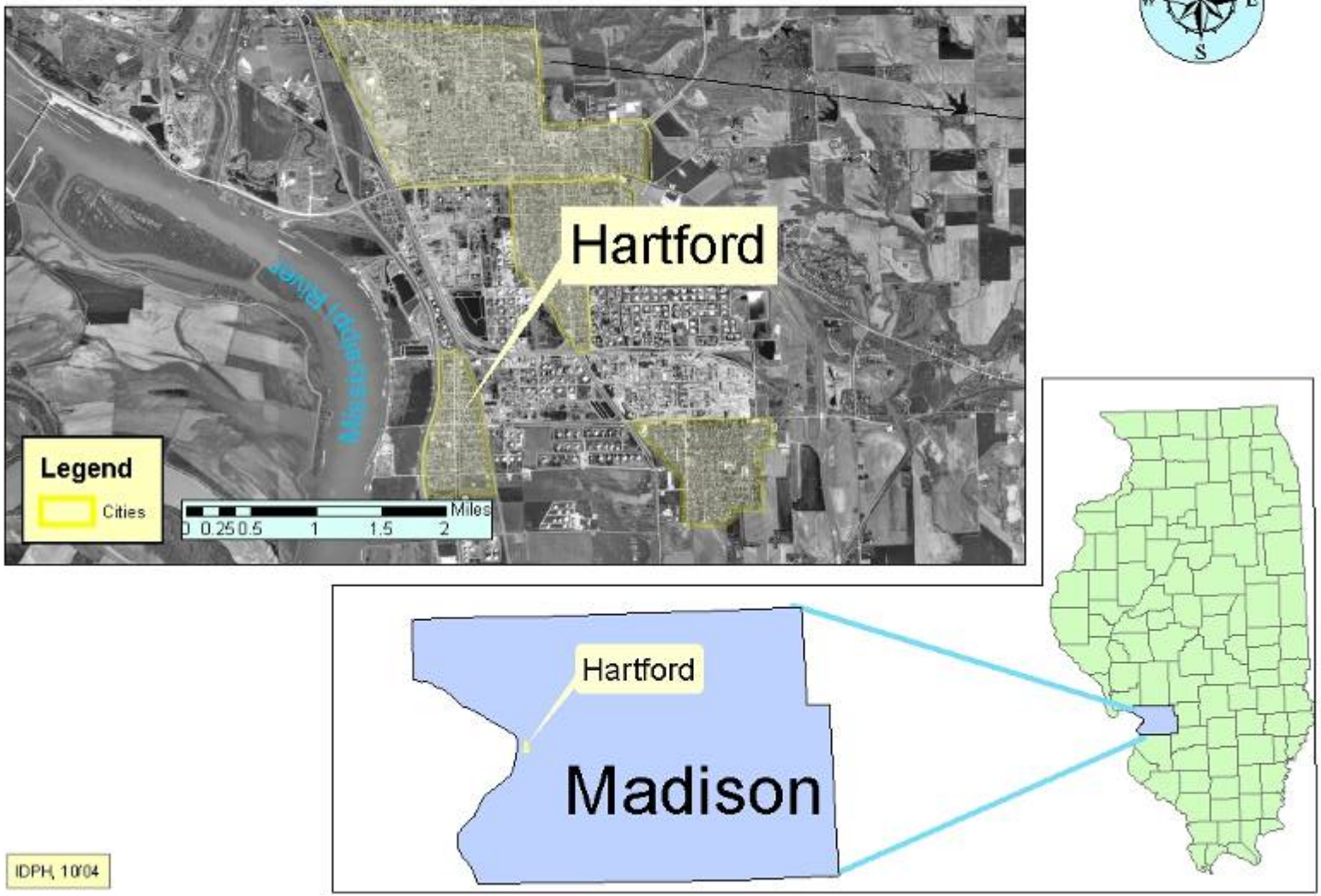

Figure 2. Hartford Site Map

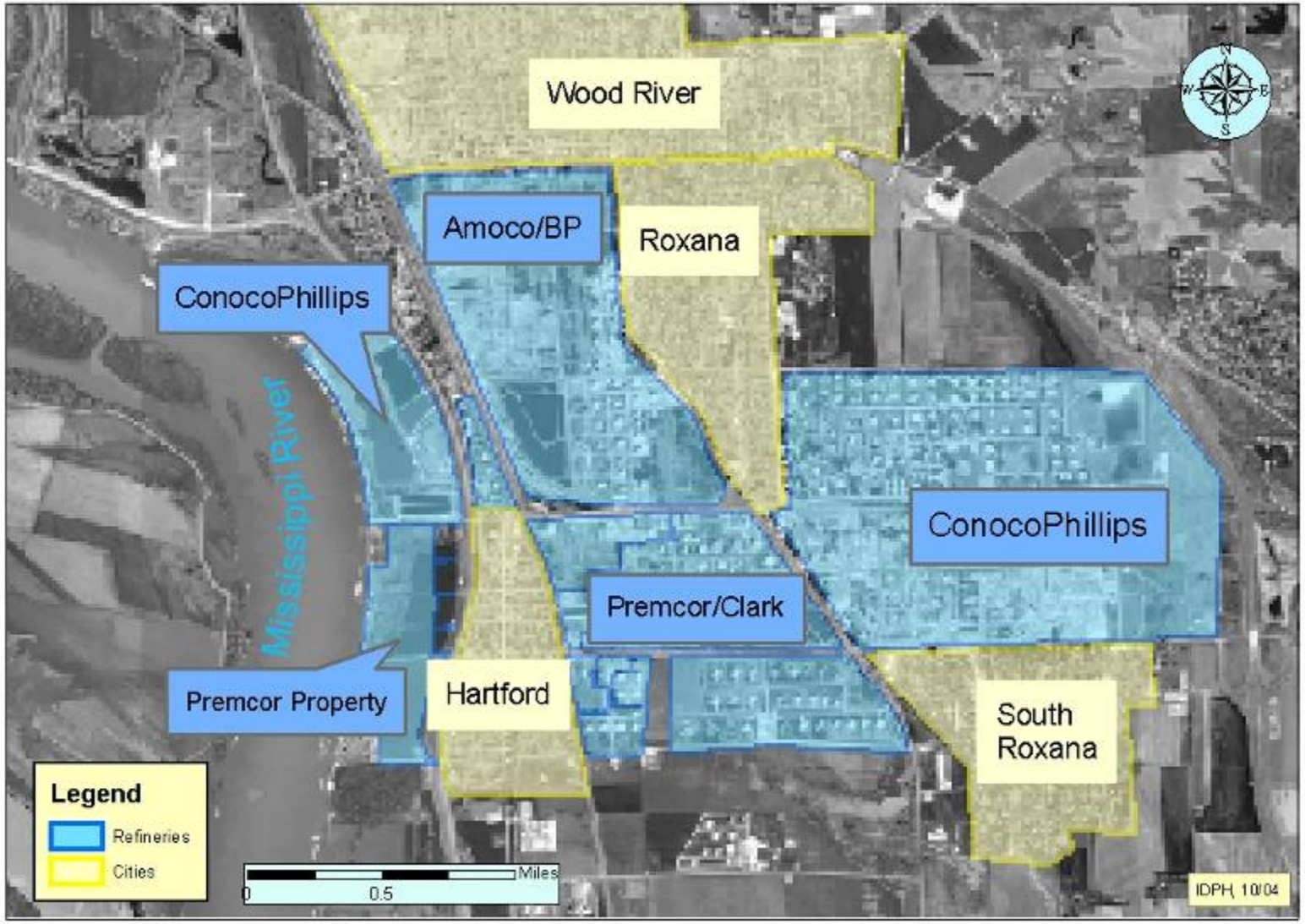

Figure 3. Hartford Mitigation Measures Offer Area

ATTACHMENT 1

Comparison Values Used In Screening Contaminants for Further Evaluation

Environmental Media Evaluation Guides (EMEGs) are developed for chemicals based on their toxicity, frequency of occurrence at National Priorities List (NPL) sites, and potential for human exposure. They are not action levels but are comparison values. They are developed without consideration for carcinogenic effects, chemical interactions, multiple route exposure, or exposure through other environmental media. They are very conservative concentration values designed to protect sensitive members of the population.

Reference Dose Media Evaluation Guides (RMEGs) are another type of comparison value. They are developed without consideration for carcinogenic effects, chemical interactions, multiple route exposure, or exposure through other environmental media. They are very conservative concentration values designed to protect sensitive members of the population.

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations based on a probability of one excess cancer in a million persons exposed to a chemical over a lifetime.