♨EPA   Project Summary

Background Hydrocarbon Vapor Concentration Study for Underground Fuel Storage Tanks

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This project was initiated to investigate the effectiveness of soil gas sampling in leak detection. Soil gas surveys were performed at 27 active gasoline service stations in three diverse geographic regions. Hydrocarbon vapor concentrations in the backfill surrounding the underground storage tanks were sampled and analyzed. The 27 gasoline service stations were selected as non-leaking sites and the three regions were selected for their active underground storage tank regulatory programs, as well as their differences in geology, hydrology and climate.

A comparison was made with contaminated site data obtained from Tracer Research Corporation's historical records and significant differences can be seen between the two distributions. It was determined that the best approximation of total hydrocarbon (less light aliphatics) concentrations, based on available calibration data, was achieved using an average response factor calculated from the daily response factors of benzene, toluene, ethylbenzene, and ortho-xylene.

This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Las Vegas, NV, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

A field sampling program was undertaken around underground storage tanks (USTs) to establish a baseline data set of hydrocarbon vapor concentrations. Data were collected from 27 gasoline service stations selected as non-leaking sites, in three diverse geographic regions: Central Texas (Austin, Texas); areas surrounding Long Island Sound (Suffolk County, New York; Providence, Rhode Island; Storrs, Connecticut); and Southern California (San Diego, California). The three regions were selected for their active UST regulatory programs, as well as their differences in geology, hydrology, and climate.

Procedures

A site was considered to be non-leaking if it had good inventory and maintenance records, or had recently passed a tank tightness test. The non-leaking database consists of 279 soil vapor samples from 25 service stations. At the other two stations, observed or suspected leaks prevented their data from being used in the non-leaking database.

At each location, soil was sampled at varying distances and depths from UST appurtenances (such as submersible pumps, vents, and product flow lines) to determine if a particular pattern of hydrocarbon concentration existed. Samples were collected by driving a hollow steel probe into the ground, and evacuating 5 to 10 liters of soil vapors with a vacuum pump. Volatile hydrocarbon species were

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identified and quantified at the site by utilizing gas chromatograph/flame ionization detection (GC/FID) equipment. Ten to fifteen samples were collected and analyzed at each site.

The types of compound groups that were studied were aliphatics, aromatics, and total hydrocarbons. The concentrations of volatile aliphatics that elute from the GC column before benzene were reported as a group called "light aliphatics." At 18 of the sites, the "light aliphatics" represent aliphatic compounds such as methane, ethane, propanes, butanes, and pentanes. At seven of the sites where butanes and pentanes could be quantified and reported, the concentration of "light aliphatics" represent only methane, ethane, and propanes. The aromatics reported were benzene, toluene, ethylbenzene, and the xylenes.

Hydrocarbon concentrations in soil gas are reported in micrograms per liter (mg/L). These concentrations were calculated directly from the GC/FID using calibration gas response factors and sample volumes. The concentration of total hydrocarbons (less light aliphatics) were estimated using an average response factor from the gas standards; benzene, toluene, ethylbenzene and ortho-xylene (BTEX). The concentrations in mg/L were converted to parts per million by volume (ppmv), using average molecular weights of BTEX at each site, and the ambient temperatures and pressures.

Hydrocarbon vapor concentrations from the non-leaking sites range from detection limit levels of 0.02 micrograms per liter (µg/L) to maximum values of 1,500,000 µg/L of light aliphatics, 110,000 µg/L of benzene, 160,000 µg/L of toluene, 25,000 µg/L of ethylbenzene, and 110,000 µg/L of xylenes. The maximum concentration of total hydrocarbons (less light aliphatics) 1,100,000 µg/L. Determination of total hydrocarbon concentrations exclude the light aliphatic peaks in order to elevate the compounds most representative of gaso-

line. Additionally, subtraction of the light aliphatics peaks precludes the inclusion of methane concentrations caused by naturally occurring organic decomposition.

Results and Discussion

The statistical distribution of total hydrocarbons (less light aliphatics) indicates that a majority of the concentration values are in the lower concentration ranges. The relative frequency distribution shows 53.2 percent of the samples below 1,500 µg/L (500 ppm by volume) and 93.1 percent below 100,000 µg/L (27,000 ppm by volume). The median is 800 µg/L and the mean is 23,300 µg/L.

Contamination site data were obtained from Tracer Research Corporation's historical records. The contaminated site data consists of 60 soil vapor samples taken from nine sites having known contamination from petroleum fuel leak or spill. These sites were all active gasoline service stations or fueling facilities. The contaminated site data also shows much variability. The statistical distribution of total hydrocarbons (less light aliphatics) shows a majority of sample values to be in the lower concentration ranges. The relative frequency distribution shows 35 percent of the samples below 1,500 µg/L (500 ppm by volume) and 66.7 percent below 100,000 µg/L (27,000 ppm by volume). The median is 9,000 µg/L and the mean is 160,000 µg/L.

Although much variability exists in both the non-leaking and contaminated site data, significant differences could be seen between the two distributions. A 10-fold difference exists between the numbers of samples with concentrations above 100,000 µg/L (3,000 ppmv) for the two data sets. For example, 29.6 percent of the non-leaking samples occurred in the range of 10,000 µg/L to 100,000 µg/L while 33.3 percent of the contaminated samples concentrations occurred in the range of 100,00 µg/L to 1,000,000 µg/L.
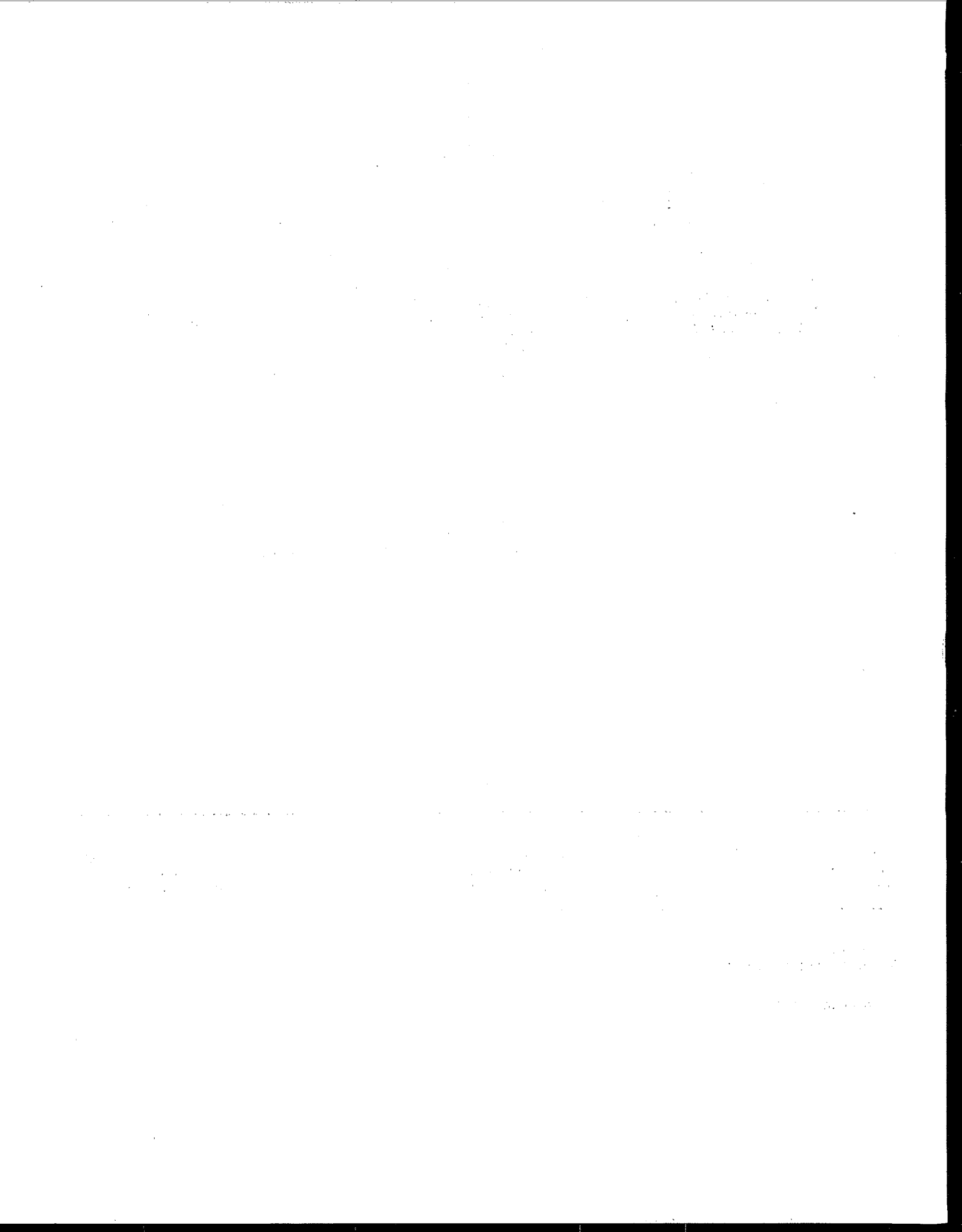
Statistical data patterns associated with site location and sample depth were de-

lineated using non-parametric statistical methods. Statistically significant differences were found to exist between the total hydrocarbon (less light aliphatics) vapor concentrations among the five locations studied for steel tank systems, whereas these differences were not significant for fiberglass tank systems. Statistically significant differences also occurred between the total hydrocarbon (less light aliphatics) vapor concentrations among the sample depths of 2,6, and 10 feet for both steel and fiberglass tank systems. Higher concentrations were found at the lower depths.

A fresh spill at one station in Austin provided an opportunity to add butane to the list of analytes under study. The butane concentration in 15 soil gas samples taken during the first four days after the spill occurred ranged from 530 µg/L to 300,000 µg/L. Butane was also sampled at sites in Storrs, Connecticut, and Providence, Rhode Island, both of which had no evidence of recent leaks or spills. At these two sites, butane concentrations in 65 soil gas samples ranged from the mimimum detection limit of 0.02 µg/L to 930 µg/L. The large difference between the butane concentrations at the fresh spill site in Austin and the non-leaking sites in Connecticut and Rhode Island suggest that butane may be a good indicator of a fresh spill or leak.

Conclusion

Because there are no standard procedures for estimating and reporting total hydrocarbon concentration data, Geoscience Consultants, Ltd. evaluated different estimation methods. It was determined that the best approximation of total hydrocarbon (less light aliphatics) concentrations, based on available calibration data, was achieved using an average response factor calculated from the daily response factors of benzene, toluene, ethylbenzene, and ortho-xylene.

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EPA/600/S4-91/009