The Lodi Central Plume Area

Correlation of PCE Releases to Indoor Air

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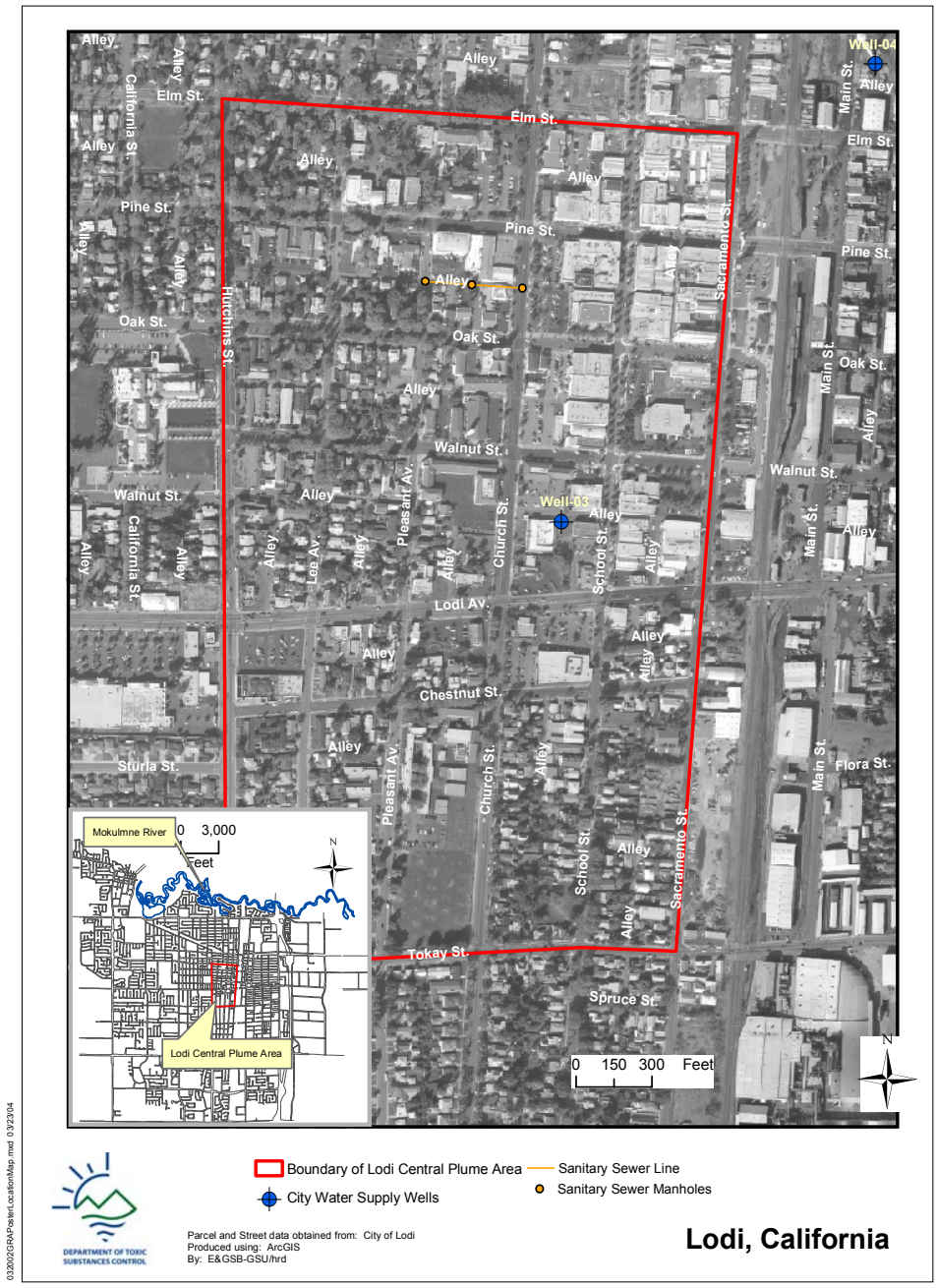
Abstract

Historic releases of hazardous materials including tetrachloroethene (PCE) at several sites in Lodi have resulted in regional groundwater contamination of the upper aquifer and the vadose zone overlying the aquifer. The Lodi Central Plume Area (LCPA) is bounded by Elm Street to the north, Sacramento Street to the east, Tokay Street to the south, and Hutchins Street to the west. The LCPA appears to have multiple source areas, and continues to be investigated by several potentially responsible parties (PRPs) under DTSC oversight. Data reported to DTSC by the PRPs includes surveyed sewer investigation videos, lithologic information, well construction information, building construction features, sampling locations, and laboratory analytical results for environmental sampling data including: soil gas, soil, groundwater, and indoor and outdoor air samples analyzed for the volatile organic compounds related to PCE releases and its daughter compounds.

Soil gas data from the area of the highest soil vapor and groundwater concentrations observed in the LCPA indicate increasing soil gas concentrations with depth down to approximately 50 feet below ground surface where groundwater is encountered. Using a combination of a Geographic Information System (GIS) and a 3-dimensional data visualization package, surveyed sewer investigation data was modeled with available soil gas data for PCE to show concentration contours at various depth intervals from ground surface to the water table. Investigations that have been conducted to date indicate potential sources of PCE releases in the LCPA to include dry cleaners, the city sewer lines, and a former newspaper printing facility. Abandoned municipal water supply wells have been identified as potential conduits for distribution of the contaminant plume.



Several rounds of indoor air sampling in the LCPA area revealed the presence of PCE in indoor air samples analyzed from certain buildings. Engineering controls (i.e. heating and ventilation system modifications) have been implemented in one of the buildings, and have lowered measured concentrations of PCE in indoor air. Using soil gas data collected adjacent to the building, indoor air concentrations were predicted using the United States Environmental Protection Agency (USEPA) Johnson and Ettinger (J&E) Spreadsheets. The predicted indoor air concentrations approximate actual indoor air concentrations detected. In a like manner, using the groundwater analytical results from samples taken adjacent to the building, the groundwater to indoor air J & E spreadsheets also approximated actual indoor air concentrations.

DTSC will continue to utilize site investigation data in conjunction with appropriate analytical tools such as models to evaluate these types of release sites to develop remedies for cleaning up soil and groundwater that are protective of human health and the environment.

Figure 1

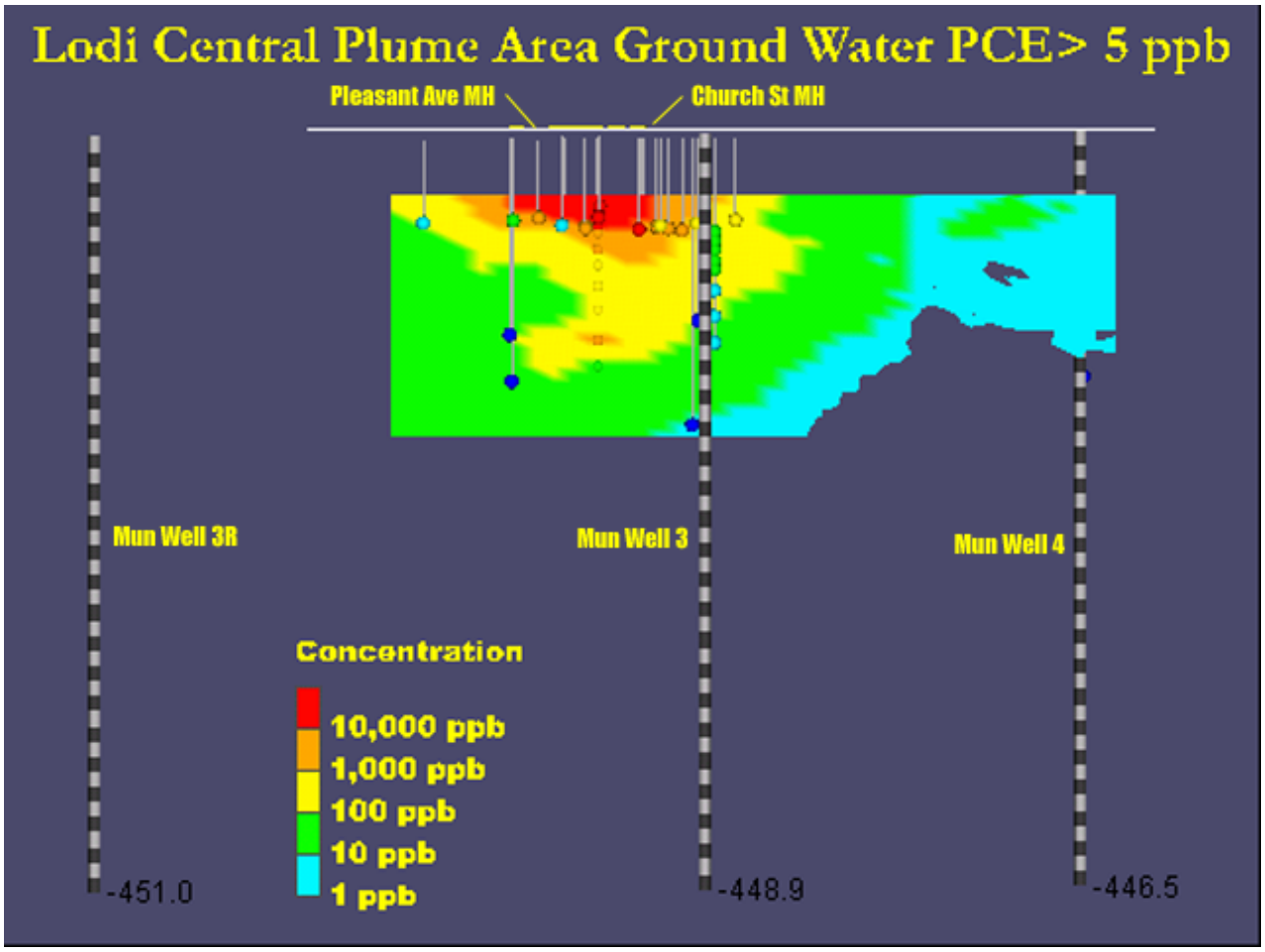


Figure 1 is a vertical slice through the upper saturated zone along the plane of the sewer line in the alley adjacent to the City Hall annex. Sampling locations and approximate concentrations are shown along with the relative sampling intervals. Note that the MCL for PCE [5 ppb] is exceeded throughout most of the upper saturated area.

Figure 2

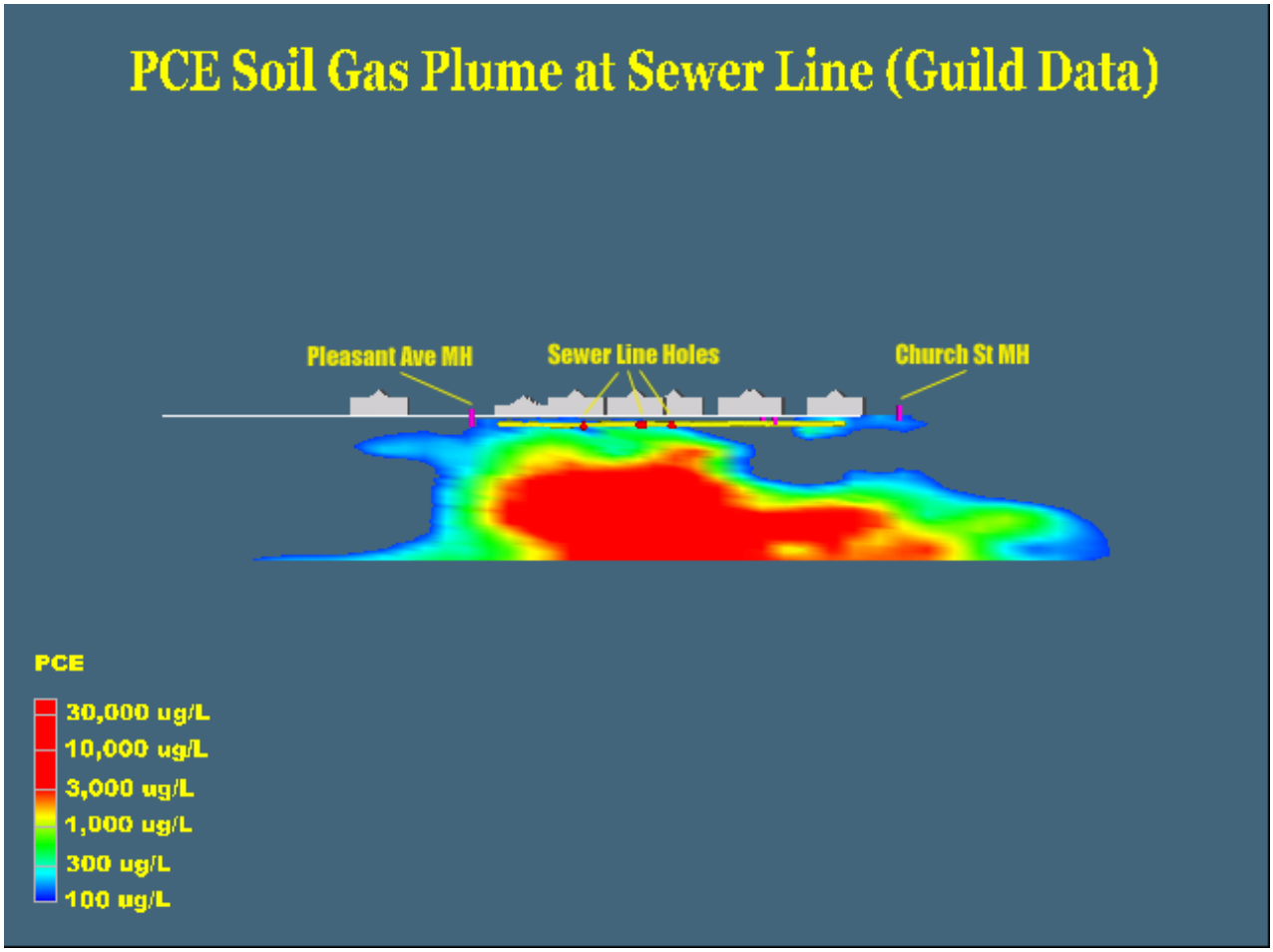


Figure 2 is a vertical slice through the vadose zone along the plane of the sewer line in the alley adjacent to the City Hall annex. The slice reflects soil gas concentrations down to 40 feet bgs. This illustrates the concentrations of PCE [soil gas] along with the vertical and horizontal extent of the soil gas plume.

Figure 3

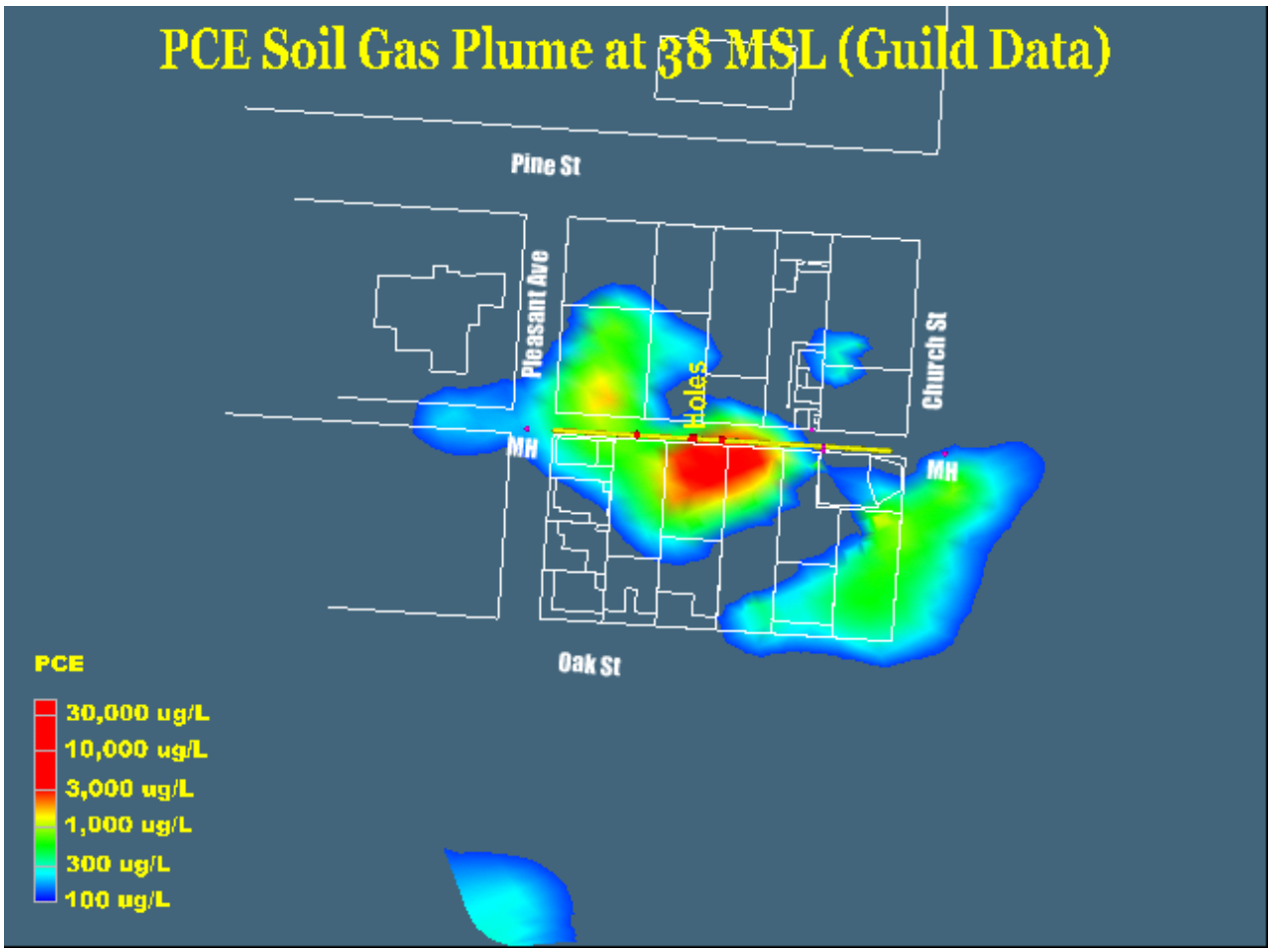


Figure 3 shows a planar view of the PCE soil gas concentrations at approximately 10 feet bgs. Note that there are at least three potential source areas for the PCE (concentrations greater than 1000 ug/L). The sanitary sewer line is depicted by the yellow line along the alley, and sewer line breaks are identified by red spheres along the line.

Figure 4

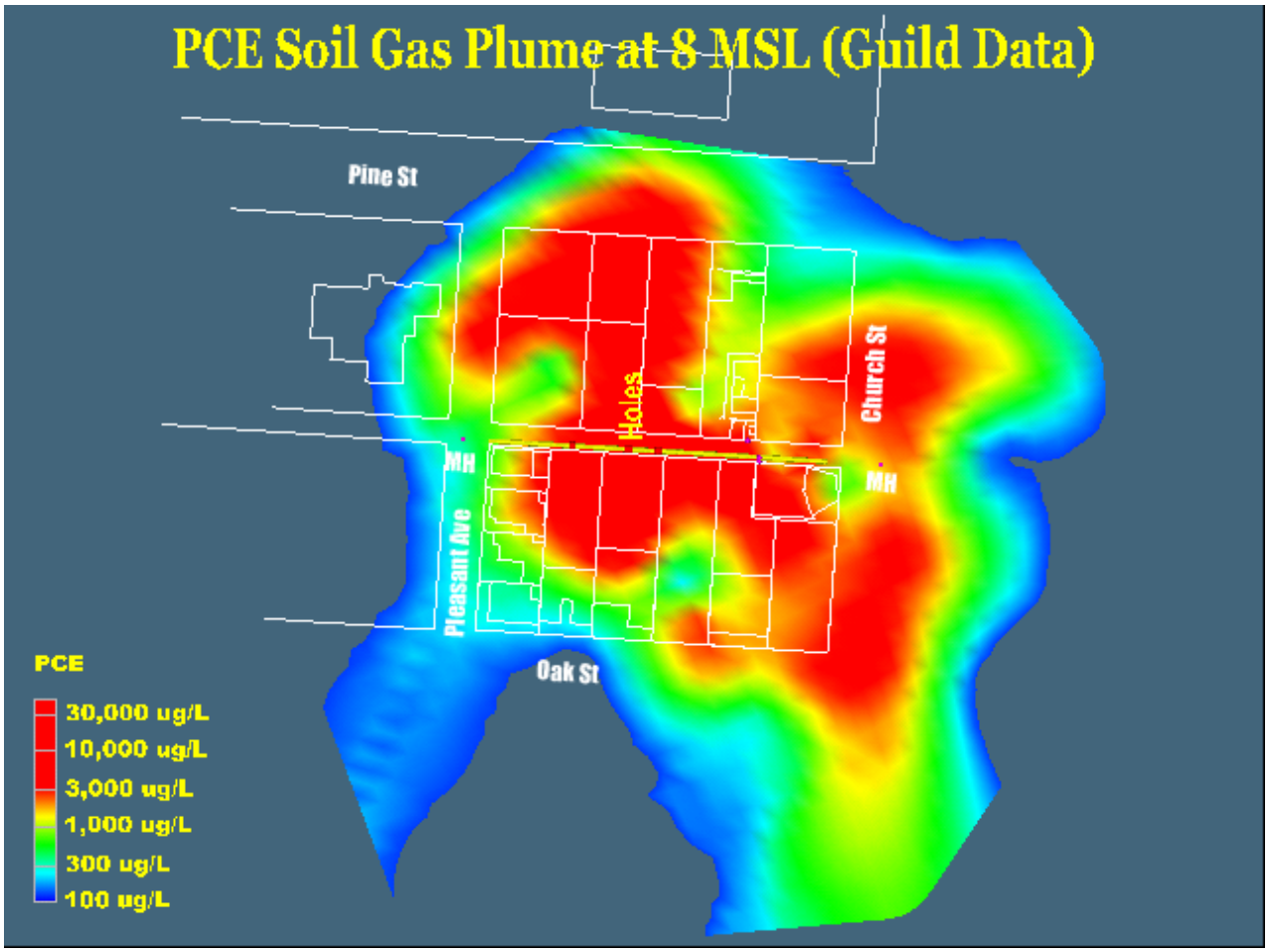


Figure 4 shows a planar view of the PCE soil gas concentrations at approximately 40 feet bgs. Note that high concentrations of soil gas [>20,000 ug/L] are distributed throughout the mapped area. The lateral distribution of soil gas concentrations relative to the source areas are illustrated.

Note:

Lodi Data Management Issues

- LFR 8/19/03 CPT data did not include surface elevations. In order to use the data, the average of elevations of monitoring wells in the chemistry results file was used.
- Two monitoring well elevations were listed as 8 to 14 feet higher than surrounding well elevations, although the area is relatively flat. Surface elevations for those points were assumed to be the same as their nearest neighbors.
- The values assigned to sample non-detect results was ½ of the detection limit.
- EVS calculations represent all sample data, however mapped data excludes data below the mapping threshold.
- Soil gas plume drawn to 125 ug/L minimum, and the ground water plume is drawn to 5 ppb.

Johnson and Ettinger (J&E) Indoor Air Model

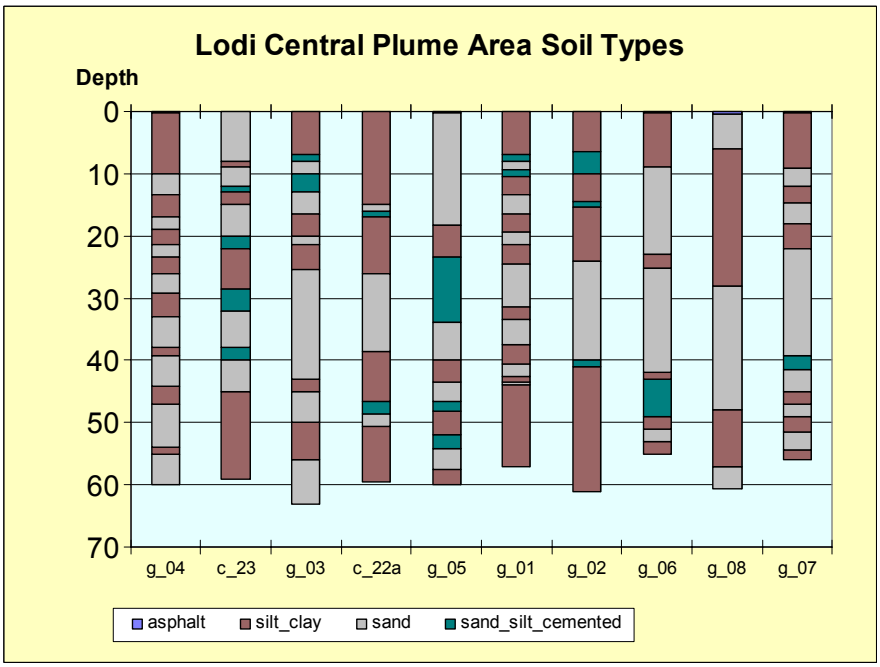
The combination of fate and transport modeling and computer visualization of the soil gas and groundwater data indicate that soil gas and groundwater can contribute to indoor air concentrations of PCE that are of potential human health concern.

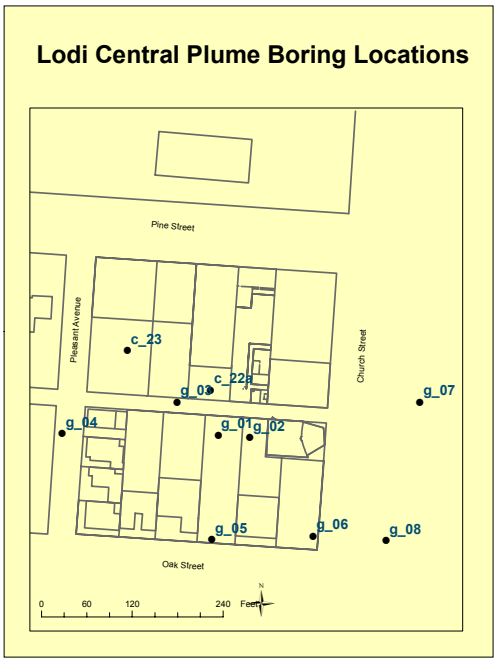
The tables below provide information concerning the data sources and modeling assumptions used for the J & E predictive models.

J & E Advanced Model Parameters [GW & SG]	
Soil Type	Sandy Loam [A]; Clay [B]; Loamy sand [C]
Depth to soil gas sample	305 cm [10 ft]; 1220 cm [40 feet]
Depth to groundwater	1524 cm [50 feet]
Slab thickness	20 cm [6 inches]
Bulk density	1.43 gm/cm^3 to 1.62 g/cm^3 [default]
Total soil porosity	0.387 to 0.459 [default]
Water-filled porosity	0.076 cm^3/cm^3 to 0.215 cm^3/cm^3 [default]
Building width	1676 cm [55 feet]
Building length	3810 cm [125 feet]
Ceiling height	366 cm [12 feet]
Air exchange rate	0.50 [default]
Q_{soil} value	Calculated

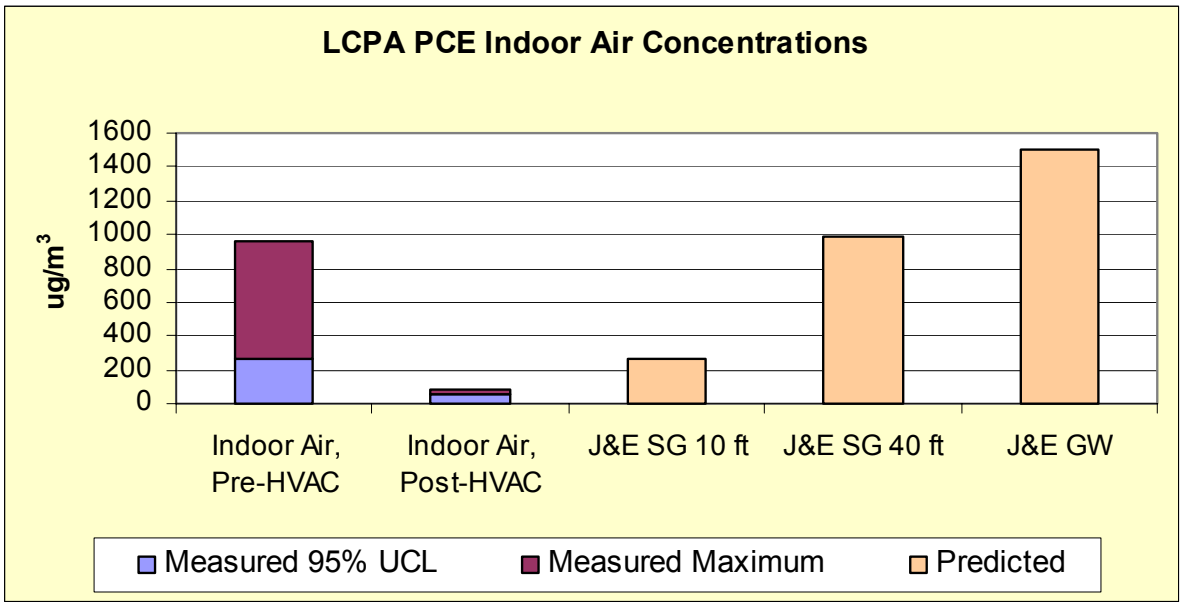
Media Type and Concentrations	
Groundwater	MW-9
Depth to Groundwater	50 feet
Concentration	101,080 µg/l [95th UCL on arithmetic mean]
Soil Gas	SV-28, SV-34, SV-35, SV-36, SV-37, SV-38, SV-41
Depth below ground surface	40 feet
Concentration	30,638 µg/l [95th UCL on arithmetic mean]
Indoor Air, Pre-HVAC adjustment	264 µg/m^3 [95th UCL; range 40 to 960]
Indoor Air, Post HVAC adjustment	55 µg/m^3 [95th UCL; range 9.8 to 87]

The bar graph and boring location map below present the soil borings and associated lithology which was considered when developing the modeling assumptions.





The bar graph below illustrates the indoor air PCE sampling data for the City Hall Annex building (Magellan, 2001, 2003) and the predicted indoor air concentrations using the DTSC modified USEPA J & E Vapor Intrusion Spreadsheets. The groundwater and the soil gas models predicted indoor air PCE concentrations within an order of magnitude of the actual measured concentrations.



Conclusions

1. Data visualization and modeling tools provide a mechanism to evaluate data and provide technical insight into project status.
2. Data modeling enables identification of potential sources and release mechanisms.
3. Indoor air concentrations can be reliably predicted using Johnson and Ettinger (J&E) spreadsheets.
4. Models provide graphic illustration of data required for adequate site characterization.

***Note:**

Opinions represented here are those of the authors and do not necessarily reflect any policy or finding of the State, the Administration, Cal/EPA or DTSC.