

Simulation Handout

Vapor Intrusion Site Investigation, Mitigation and/or Remediation

This experience is designed to simulate the various decisions and trade-offs typical in vapor intrusion site investigation, mitigation, and/or remediation. Performance will be evaluated on three metrics:

1. Percentage of homes that needed and received protection from VOC exposures.
2. Total cost.
3. Time elapsed in providing protection from exposures.

The simulation progress in 1-year increments, during which players **may take actions** to affect their scores. Available actions fall into these categories:

- Planning and Logistics
- Indoor Air and Subslab Soil Gas Sampling
- Groundwater Sampling (or Groundwater and External Soil Gas Nested)
- External Soil Gas Sampling (Without Collocated Groundwater)
- Mitigation
- Vadose Zone Remediation for VI Protection with SVE
- Saturated Zone Supplemental Remediation

See the cost guide on page 5 for costs associated with the available actions.

Key Simulation Principles

- Economic costs are not from the actual site but calculated from an engineer's estimate of typical costs as would apply to the anonymized site conditions in 2025 dollars.
- The live workshop audience will “play through” the simulation by audience participation. As time allows, the group will go back in time and “play through again” with different choices.
- Remediation and mitigation efforts can provide information about pollutant distributions. Investigation, mitigation, and remediation can be combined in any order and iterated. The simulation is not strictly bound by the details of the CERCLA or RCRA processes.
- The amount of investigation and remediation typically required for groundwater ingestion protection when aquifer is not currently used is a “given.”
- Each turn simulates one year.
- If you think you recognize the site, please don't tell others/use that information. The judges reserve the right to modify reality for the educational purpose of simulation.
- All risk-based screening levels are based on 2025 VISLs at TCR 10^{-5} and HQ = 1.

About the Investigation Area

- Most of the buildings are single family residences constructed in the 1950s, and the predominant construction type is basement or crawlspace.

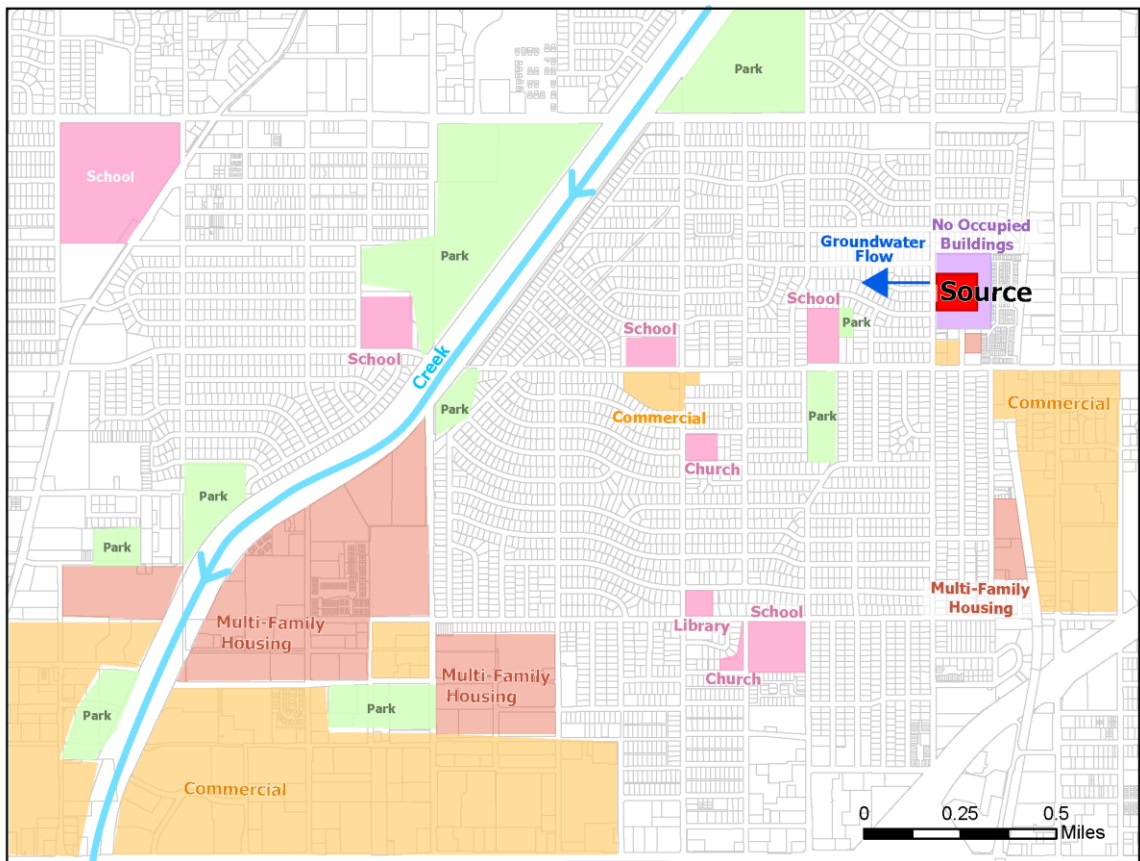
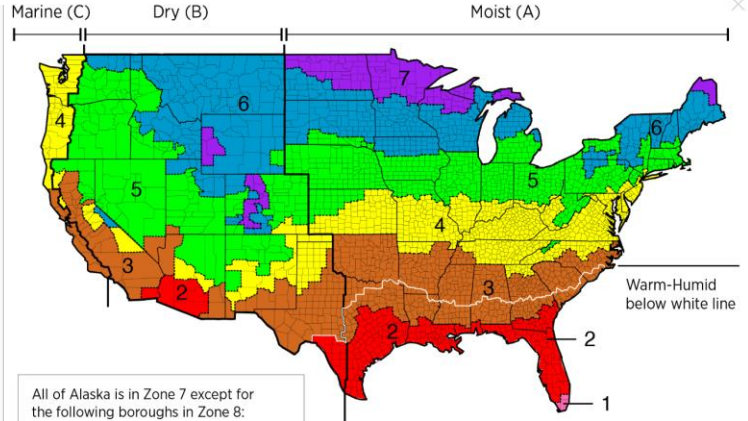
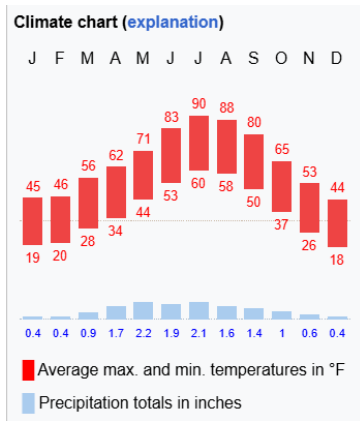


Figure 1: House resembling many in neighborhood reprinted from <https://www.housebeautiful.com/design-inspiration/real-estate/news/a7087/midcentury-home-tour-texas/>



Figure 2: Other homes in the neighborhood look like this one reprinted from <https://www.atomic-ranch.com/architecture-design/peggy-blue/>

- Typical lot size is 75x125', about a quarter acre.
- Depth to groundwater ranges from 10 to 35 feet below ground surface.
- The predominant soil type is silty sand and clay with some coarse materials.
- The climate zone is continental semiarid; 14 inches annual precipitation. IECC (energy) climate zone is 5 (dry) – see map to visualize the type of weather to expect.



Project Screening and Action Levels

Chemical	CAS Number	Target Indoor Air Concentration (TCR=1E-05 or THQ=1) MIN($C_{ia,c}$, $C_{ia,nc}$) ($\mu\text{g}/\text{m}^3$)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-05 or THQ=1) $C_{sg,Target}$ ($\mu\text{g}/\text{m}^3$)	Target Groundwater Concentration (TCR=1E-05 or THQ=1) $C_{gw,Target}$ ($\mu\text{g}/\text{L}$)	Is Target Groundwater Concentration < MCL? ($C_{gw} < \text{MCL}$?)
Dichloroethylene, 1,1-	75-35-4	4.1	NC	138	3.9	Yes (7)
Tetrachloroethylene	127-18-4	42	NC	1390	57.6	No (5)
Trichloroethane, 1,1,1-	71-55-6	5210	NC	174,000	7420.0	No (200)
Trichloroethylene	79-01-6	2.1	NC	70	5.2	No (5)

Source: USEPA Vapor Intrusion Screening Level Calculator

(<https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-level-calculator>)

Notional Cost Guide

(includes all anticipated labor, materials, equipment, subcontractors and laboratory costs)

Category	Detailed Task Description	Cost (\$K)
Planning and Logistics	Prepare initial Indoor air and Subslab Soil Gas Sampling Plan	10
	Approach 30 properties to gain access to 10	6
	Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) for external soil gas and/or groundwater sampling	11
	Site Access agreement and traffic control plan for Municipal Right of Way for 25 soil gas points or wells	6
Indoor air and Subslab Soil Gas Sampling	Conduct Initial Indoor Air Survey and Install Average of 2 subslab ports per structure in 10 structures, with utility clearance and leak check	15
	Per Round of Indoor Air Sampling and Subslab Sampling, Convenience Timed, 10 structures, 2 indoor and 2 subslab locations per structure plus QC and reporting	29
	Set of 4 Rounds of Indoor Air Sampling and Subslab Sampling, TO-15, Seasonal Timed, 10 structures, 2 indoor and 2 subslab locations per structure plus QC and reporting	112
	Set of 4 Rounds of Indoor Air Sampling, TO-15 and 2 Rounds Subslab Sampling, ITS Timed Indoors (one year of two Airthings units per structure), 10 structures, 2 indoor and 2 subslab locations per structure plus QC and reporting	109
	Set of 4 Rounds of Indoor Air Sampling and Subslab Sampling, Month-long Radiello Indoor Air, TO-15 Subslab, Seasonal Timed, 10 structures, 2 indoor and 2 subslab locations per structure plus QC and reporting	103
Groundwater Sampling (or Groundwater and External Soil Gas Nested)	Install and Develop 25 groundwater monitoring wells, hollow stem auger, 4" at the water table with 5' wide screens typical depth of well 35'; collect first VOC sample and report	166
	Include multidepth soil gas monitoring points with the 25 groundwater wells	41
	Twice per year groundwater sampling in 25 shallow wells for 5 years for VOCs and field parameters with annual report	215
	Twice per year VMP sampling for VOCs at 25 GW wells (3 VMPs/well) for 5 years with annual report	263
External Soil Gas Sampling (without collocated groundwater)	Install, sample for the first time and report 25, semipermanent external soil gas probes at 10' bls with direct push	98
	Twice per year external soil gas probe sampling, at 25 locations, with report every year, for a total of 5 years	161
	Install, sample 50 temporary passive external soil gas samplers at 2' bls with man portable tools	42
Mitigation	Mitigation: consent forms, regulatory plans and permits for first 30 single family residence sized structures	9
	Mitigation Design, Install and Testing for first year, modification as needed, reporting and homeowner communication 30 structures	419

Category	Detailed Task Description	Cost (\$K)
	Mitigation years 2-5, Monitoring and Maintenance for 30 structures (inspection plus one round sampling in yrs 2 and 3, annual inspection only with differential pressure check in yrs 4 and 5); small number of system revisions;	122
	Mitigation years 6 to 15, Monitor and Maintenance for 30 structures (inspection plus one round of sampling every 5 years, inspection with differential pressure only in other years), Fan replacements of 70% of installed fans, reporting	269
Vadose Zone Remediation for VI Protection with SVE	Install and sample for the first time 10 triple-probe, soil vapor monitoring points	68
	Twice per year VMP sampling for VOCs at 10 VMP wells (3 VMPs/well) for 5 years with annual report	132
	Develop Design Basis for Soil Gas Management (SGM) under 30 homes	17
	Install & operate a single well pilot test of SGM; and pilot test report	40
	Install SGM system under 30 homes (radius of effective management =ROEM = 85 ft, 2 SGM Systems)	312
	Operate & monitor the 1st Year (ROEM = 85 ft)	108
	Operate & monitor Years 2 & 3 cost (ROEM = 85 ft)	145
	Operate & monitor 5-year increments (ROEM = 85 ft)	174
Saturated Zone Supplemental Remediation	Remediation of area of 30 houses – 8.5 acres. Treated with lime activated permanganate injected across a 10 ft vertical interval. With 30 ft injection radius 131 injection locations. One round of injection across full area, with 50% coverage in second injection for hot spots.	6,159