

Vapor Intrusion Pathway Analysis for LLNL Livermore Site and Site 300

U.S. Department of Energy – Legacy Management
2018 Long-Term Stewardship Conference

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Grand Junction, Colorado

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Track 4, Session 3: Maintaining strong partnerships with
stakeholder and regulatory communities

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- Environmental Restoration Department Personnel
 - Lawrence Livermore National Laboratory, Livermore, California
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Indoor Air Vapor Intrusion

FIGURE 2 – CONCEPTUAL MODEL FOR VAPOR INTRUSION

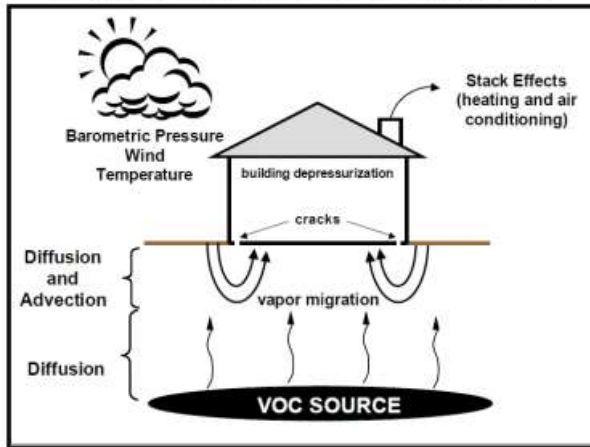
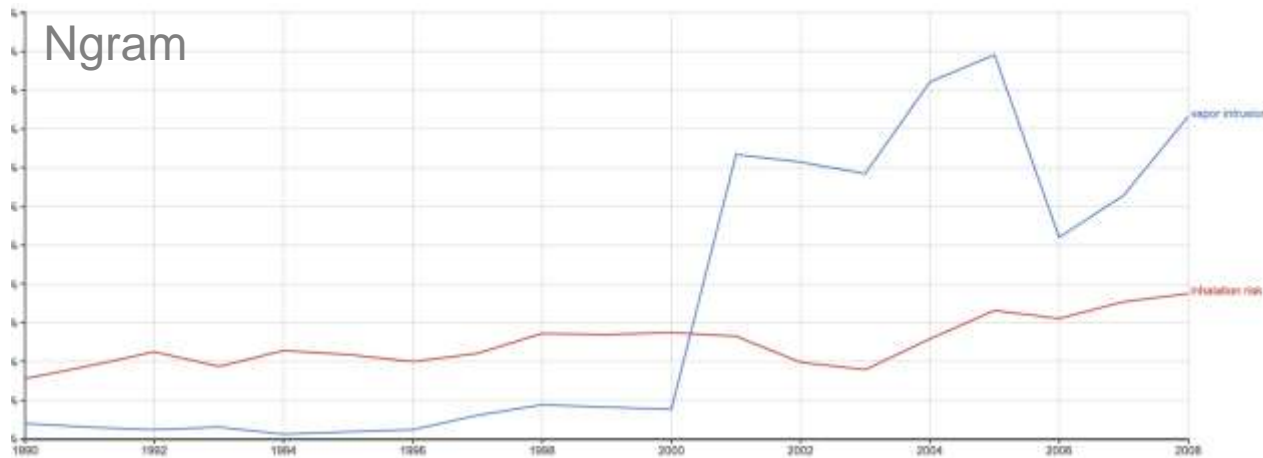
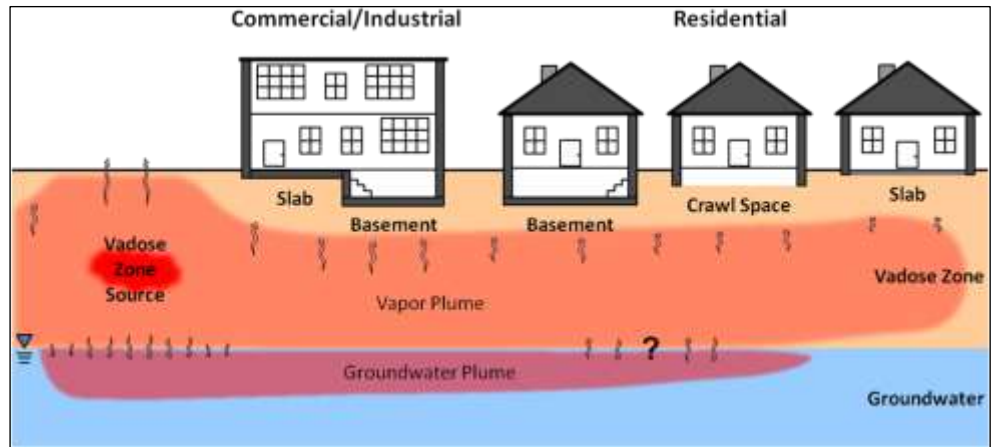
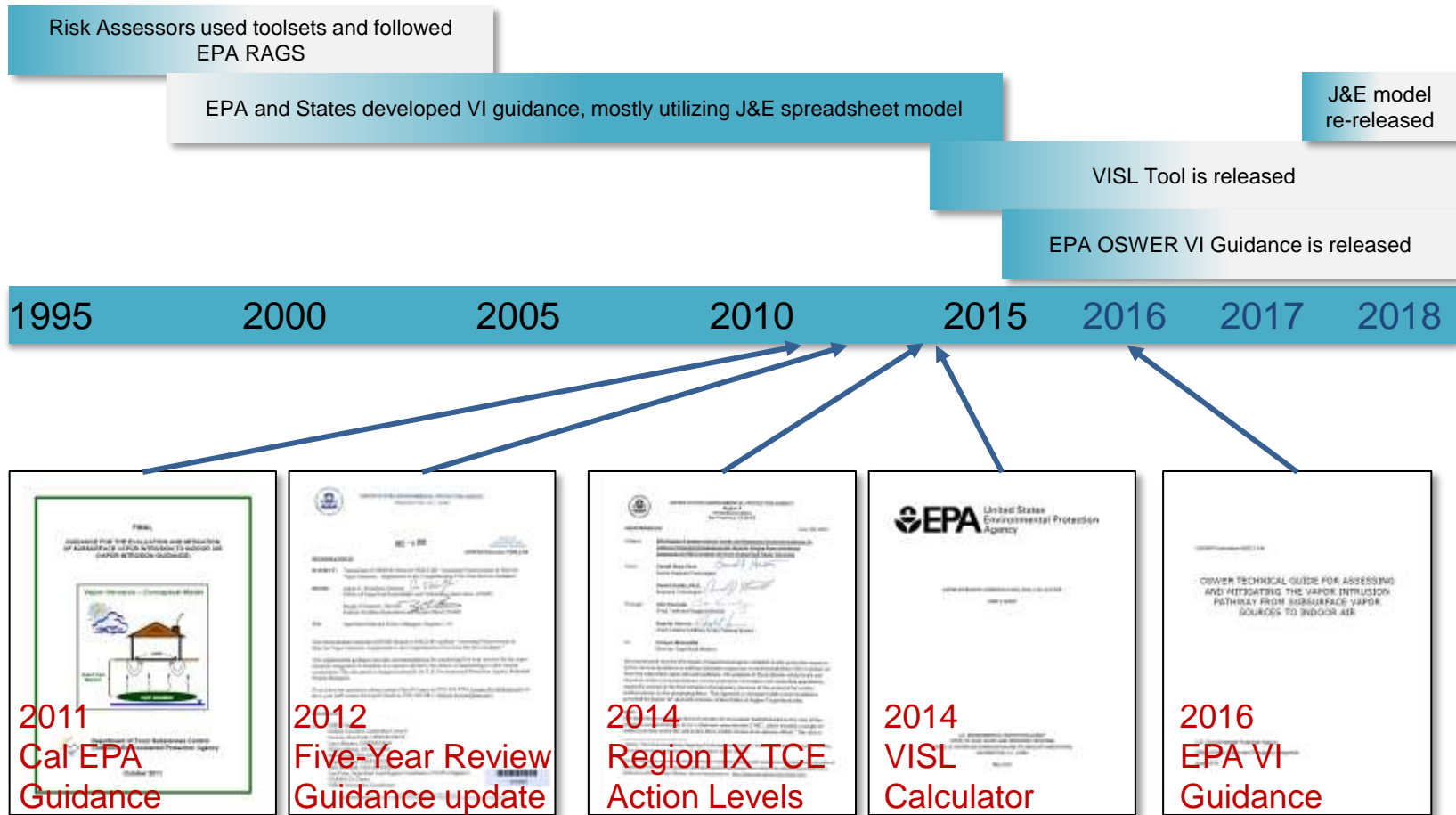


Image from Pacific Northwest National Laboratory – VIETUS tool



Timeline



EPA RAGS = U.S. Environmental Protection Agency Risk Assessment Guidelines for Superfund

VI = Vapor Intrusion (from subsurface to indoor air)

J&E = Johnson and Ettinger one-dimensional transport model

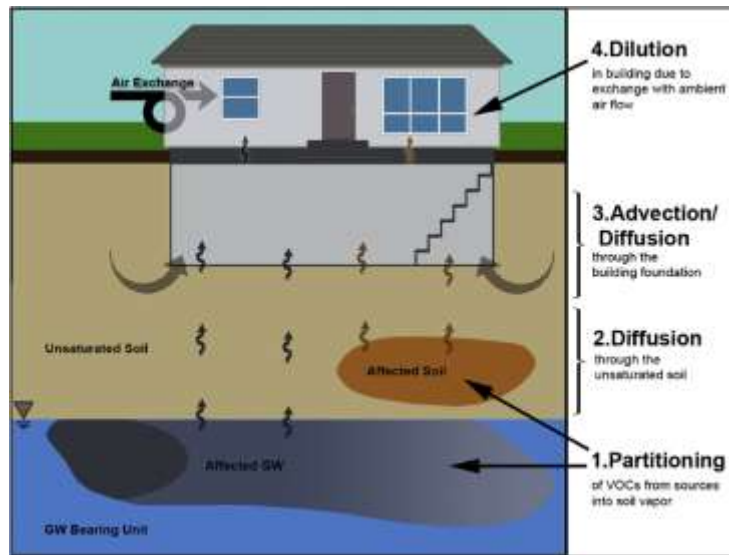
VISL = Vapor Intrusion Screening Level

OSWER = EPA Office of Solid Waste and Emergency Response

Determining Screening Levels

Model-based approach (Johnson & Ettinger)

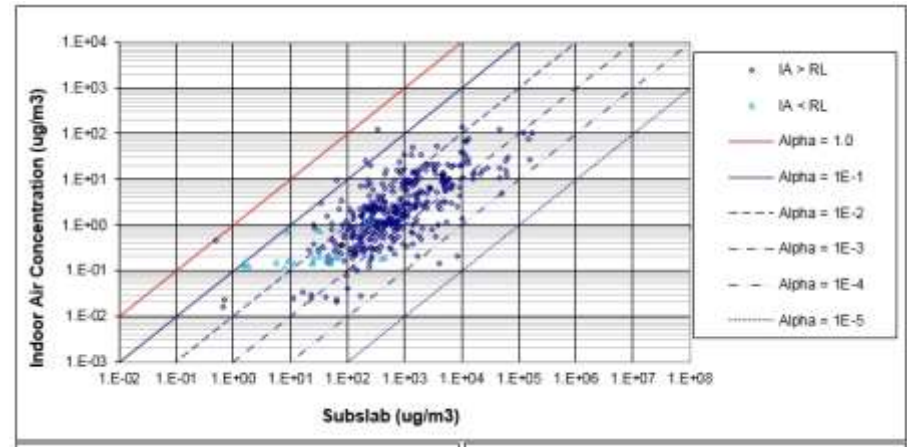
- One-dimensional model to calculate indoor air concentrations starting with concentrations in groundwater or soil vapor



T. McHugh et al. / Journal of Environmental Management (2017)

Statistical approach (VISL)

- Attenuation Factor (AF) Based Screening Level Tool
- AFs are determined from a peer-reviewed database
 - 41 sites, ~2400 analyses



U.S. EPA OSWER Guidance

Vapor Intrusion vs. Long-Term Stewardship

- U.S. EPA Five-Year Review Guidance update in 2012 requires all Superfund sites to re-evaluate the vapor intrusion pathway
 - Sites that had previously declared this pathway to be a non-issue may be required to expand their cleanup efforts
 - Five-year Review reports are required to declare 'deferred protectiveness' due to VI pathway evaluations
- The new screening levels may require sites to re-evaluate portions of the subsurface contamination that was previously declared clean.
 - California VI screening level for PCE in groundwater is now below the drinking water standard:
 - MCL: 5.0 $\mu\text{g/L}$
 - VISL_{CA} : 3.9 $\mu\text{g/L}$



2012
Five-Year Review
Guidance update

Example VI Screening Levels: Trichloroethylene

Exposure scenario	U.S. EPA OSWER Vapor Intrusion Screening Level	U.S. EPA Region IX Accelerated Response Action Level (HQ=1)	U.S. EPA Region IX Urgent Response Action Level (HQ=3)
Residential	0.48 $\mu\text{g}/\text{m}^3$ (0.00009 ppmv)	2 $\mu\text{g}/\text{m}^3$ (0.0004 ppmv)	6 $\mu\text{g}/\text{m}^3$ (0.0011 ppmv)
Commercial/Industrial (8 hr/day)	3 $\mu\text{g}/\text{m}^3$ (0.00055 ppmv)	8 $\mu\text{g}/\text{m}^3$ (0.0015 ppmv)	24 $\mu\text{g}/\text{m}^3$ (0.0045 ppmv)
Commercial/Industrial (10 hr/day)	2.4 $\mu\text{g}/\text{m}^3$ (0.00045 ppmv)	7 $\mu\text{g}/\text{m}^3$ (0.0013 ppmv)	21 $\mu\text{g}/\text{m}^3$ (0.0039 ppmv)

*TCE Indoor Air Concentration > Accelerated Response Action Level (HQ=1): In the event indoor air TCE concentrations are observed to be greater than the accelerated response action level, we recommend early or interim mitigation measures be evaluated and implemented quickly, and their effectiveness (defined as a reduction of the TCE indoor air concentration to below HQ=1 level) confirmed promptly (e.g., all actions completed and confirmed **within a few weeks**).*

*TCE Indoor Air Concentration > the Urgent Response Action Level (HQ=3): In the event indoor air TCE concentrations are observed to be greater than the urgent response action level, we recommend mitigation measures be initiated immediately and their effectiveness (defined as a reduction of the indoor air TCE concentration to below HQ=1 level) confirmed before any additional exposure is allowed to occur (e.g., all actions completed and confirmed **within a few days**). Note that temporary relocation may be indicated under these circumstances because of the need to prevent additional exposure.*

Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs):

537,423. $\mu\text{g}/\text{m}^3$ (100 ppmv)

California Division of Occupational Safety and Health (Cal/OSHA) Permissible Exposure Limits (PELs):

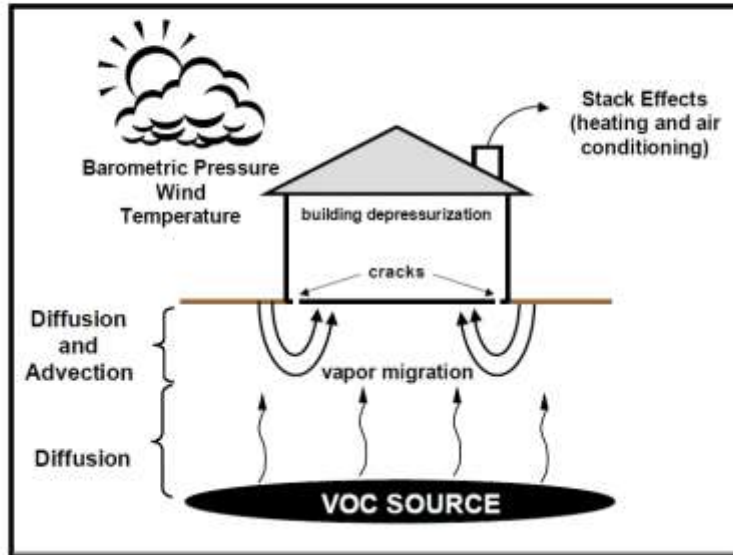
134,356. $\mu\text{g}/\text{m}^3$ (25 ppmv)

American Conference of Governmental Industrial Hygienists, Threshold Limit Values (TLVs):

53,742.3 $\mu\text{g}/\text{m}^3$ (10 ppmv)

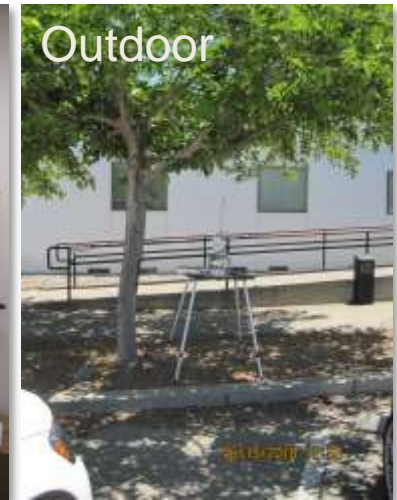
Multiple lines of evidence

FIGURE 2 – CONCEPTUAL MODEL FOR VAPOR INTRUSION



Different ventilation (HVAC) conditions

Different atmospheric conditions,
- summer and winter



Evaluation Costs

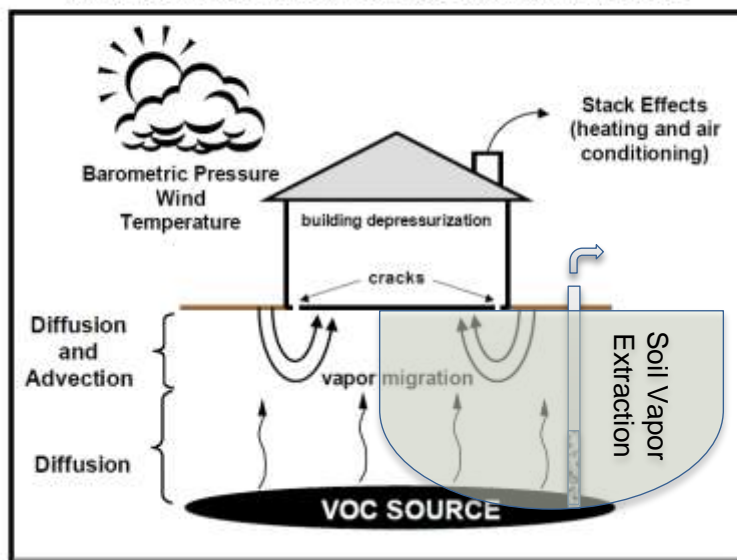
- EPA TO-15SIM analysis is \$300/sample
- Portable GCMS System
 - \$600/day rental
 - \$150K to purchase
 - Will need an experienced operator
- Sub-slab sampling
 - \$3K to \$5K for the probe installation
- Deep soil gas sampling with direct push technologies
 - \$5K to \$10K
- Other costs: Work plans, work controls/access to buildings, field technician, analysis & reporting, regulatory interactions, etc.

Mitigation

State of California
Vapor Intrusion Guidance Document – Final

October 2011
DTSC – Cal/EPA

FIGURE 2 – CONCEPTUAL MODEL FOR VAPOR INTRUSION



- Ventilation
 - HVAC adjustments
- Passive Measures
 - Sealing
 - Vapor barriers
 - Sub-slab ventilation
- Active Measures
 - Soil Vapor Extraction

What is the impact to LLNL sites?

- All Five-Year Review documents will have to address the vapor intrusion pathway under the new guidance
 - EPA Region 9 Action Levels for near-term inhalation exposure will be part of the evaluation
 - Vapor sampling in or beneath operational buildings presents new access challenges
 - Any volatile exceeding the VISL numbers will be evaluated using the new guidance (= multiple lines of evidence)
- All future building constructions will have to incorporate an evaluation, and possibly a risk mitigation element in the design
- Frequent changes in guidance, screening levels, and updates to regulatory tools present new challenges when completing VI evaluations
 - Budget planning
 - Meeting data quality objectives
- Mitigation costs and disruption to operations

