Accounting for Background Sources for Risk-Based Decision Making at Vapor Intrusion Sites

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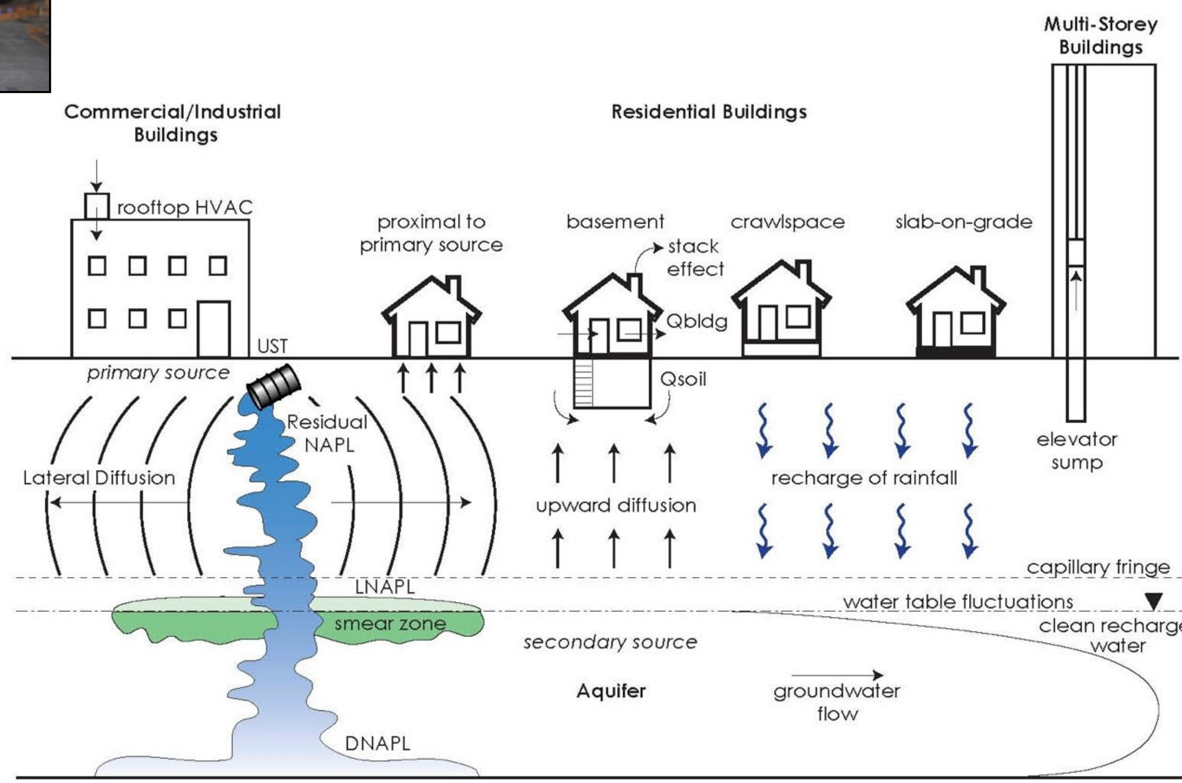
Overview

- Introduction
- Site Background
- VI Investigation
- Evaluation
- Risk Results
- Lessons Learned

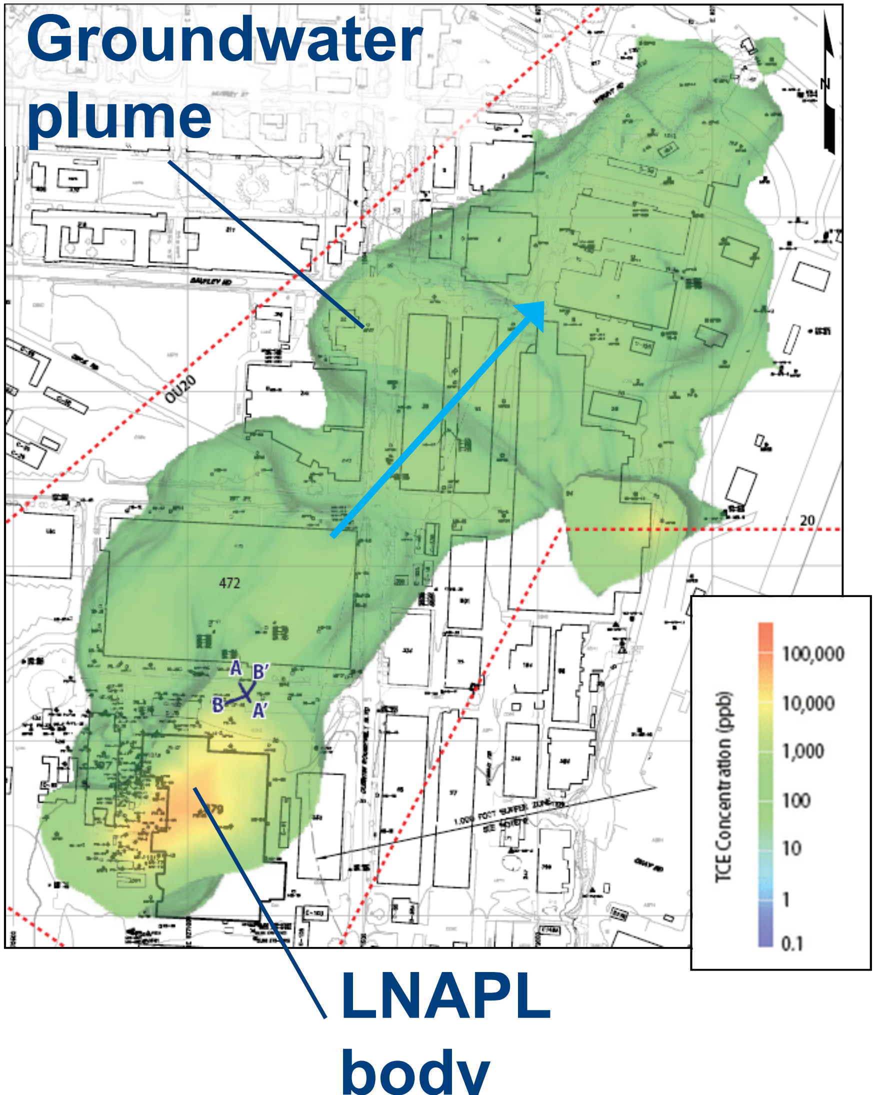
Introduction

Distinguishing compounds that are VI-related from those that are due to background is important

Identification and removal of potential background sources is challenging



Site Background –
Naval Air Station North Island OU 19/20



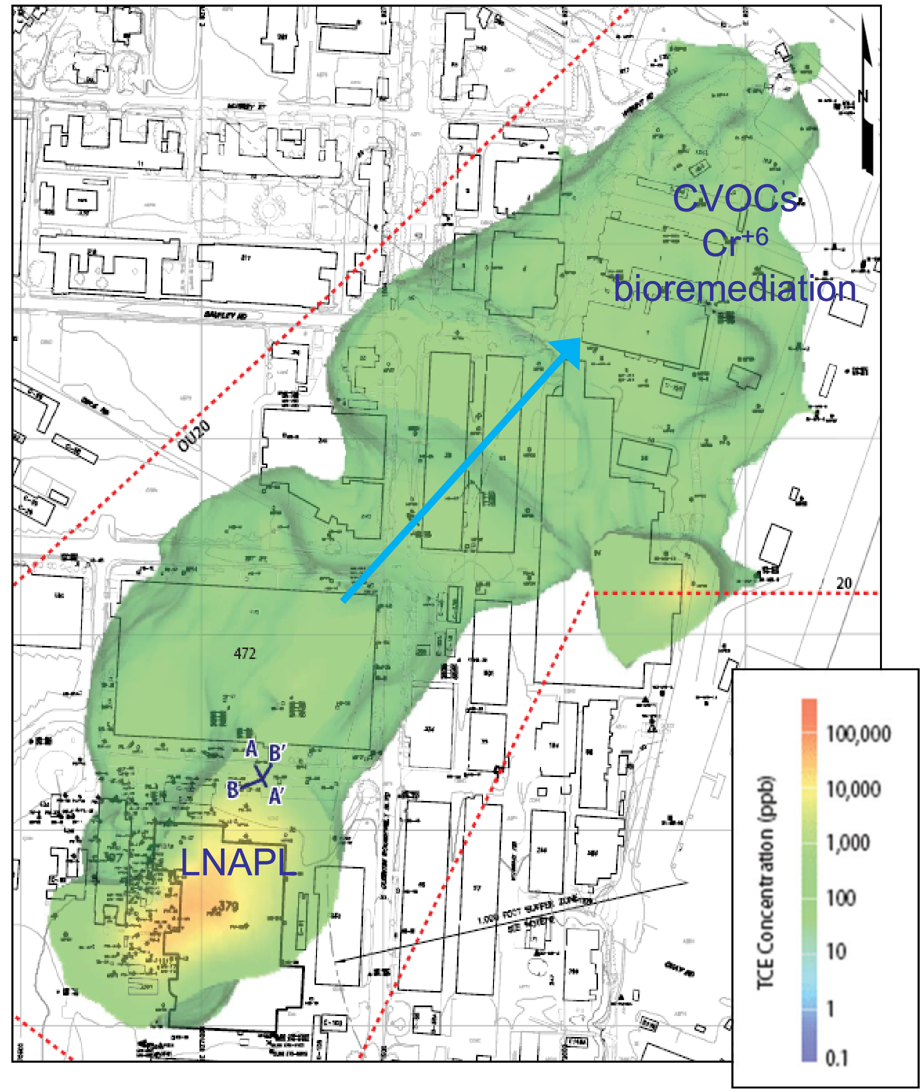
Highly industrialized Area:
- –Testing and maintenance shops
- –Storage
- –Offices

Water table
- –4-25 ft bgs

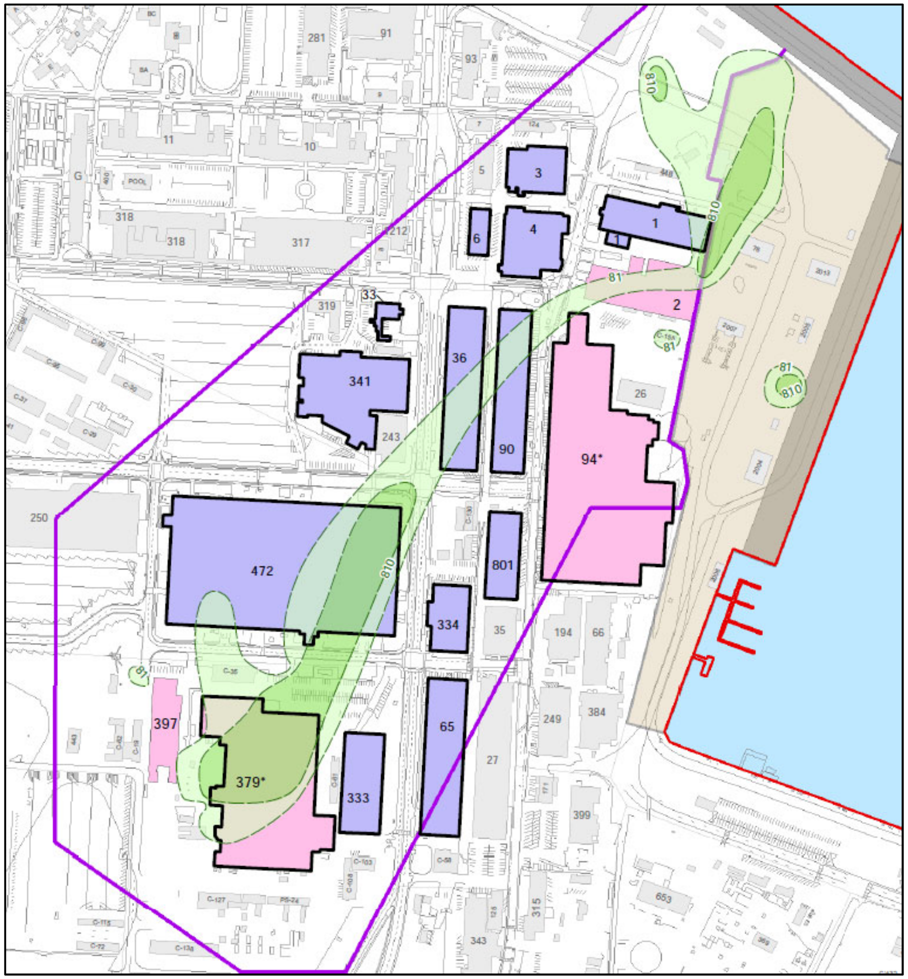
Sand & silty sand
- –to 40 ft bgs

Site Background – Naval Air Station North Island OU 19/20

- **LNAPL body**
  - Jet fuel (JP-5)
  - Stoddard solvent
  - TCE
- **Additional source areas**
- **Groundwater plume**
  - 2,400-ft long
  - TCE and other CVOCs
  - Cr^{+6} in downgradient area
- **Bioremediation TCRA**
- **RI/FS in progress**



Vapor Intrusion Investigation



- **Building prioritization**
  - Proximity to source areas and shallow subsurface contamination
  - Building, foundation, ventilation type
  - Building occupancy and use
    - Phase 1: 4 buildings
    - Phase 2: 13 buildings
- **Building inspection & Portable GC/MS screening** (HAPSITE)
- **Summa canister sampling**
  - Sub-slab
  - Indoor/outdoor air (8 hr)
  - VOCs (full TO-15 list)

Risk/Hazard Evaluation

Cumulative Incremental Risk

$$\text{Risk} = \sum_{i} \frac{\text{Maximum Concentration}_i}{\text{Cancer Screening Level}_i} \times 10^{-6}$$

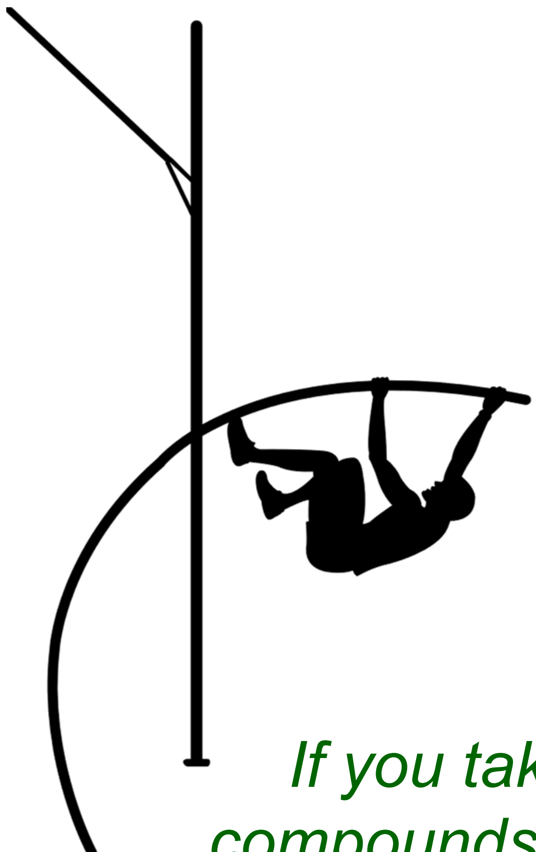
Cumulative Incremental Hazard

$$\text{Hazard} = \sum_{i} \frac{\text{Maximum Concentration}_i}{\text{Noncancer Screening Level}_i}$$

$$\text{where } i = \text{detected compounds}$$

Incremental risk and hazard are summed for each medium, building, and sampling event.

Cumulative Incremental Risk/Hazard



- **Sub-slab** – default generic attenuation factor
- **Sub-slab** – building-specific attenuation factors
- **Indoor air**
- **Outdoor air**
- ***Potentially VI-related Indoor Air***

If you take the time to examine your data and exclude compounds that are not related to VI, you can be protective without jumping higher over the bar than necessary.

http://www.supercoloring.com/silhouettes/pole-vault

Building-Specific Attenuation Factors

- Collocated or proximal indoor air and sub-slab summa canister sample results for TCE (primary VI COC)

$$AF_{bldg} = \text{Maximum} \frac{\text{Indoor Air TCE Concentration}}{\text{Subslab TCE Concentration}}$$

AF_{bldg} results ranged from 0.00004 to <0.01

< CA DTSC generic default of 0.05

< USEPA generic default of 0.03

$$SL_{subslab} = \frac{SL_{indoor\ air}}{AF}$$

$$\text{Risk} = \frac{\text{Maximum Concentration}}{SL} \times 10^{-6}$$

Identifying Background

Examine Summa canister results for each compound detected:

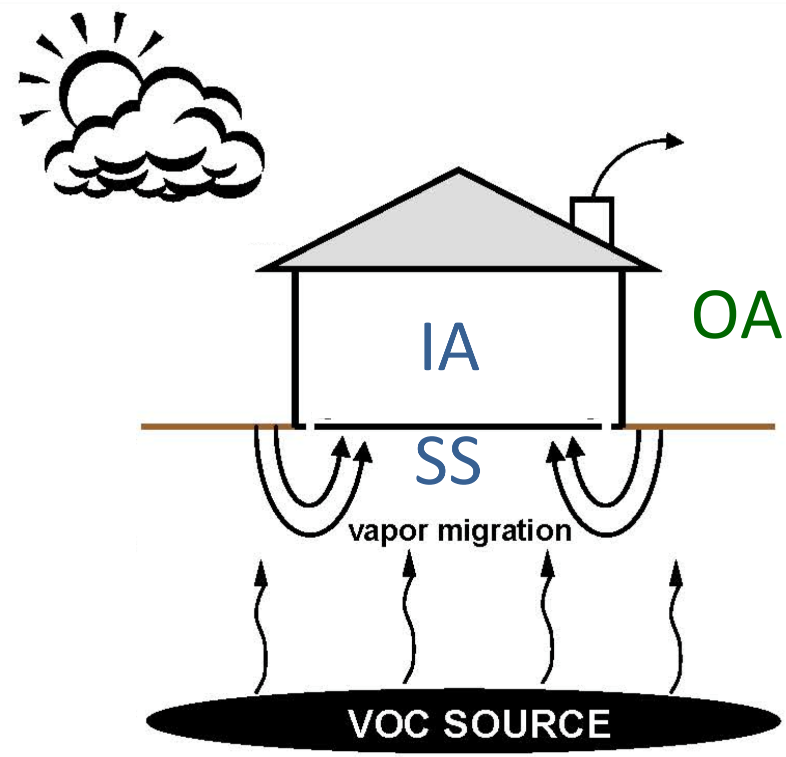
Maximum Outdoor Air

≥

Maximum Indoor Air

↓

Outdoor air source



DTSC. 2011. Final VI Guidance

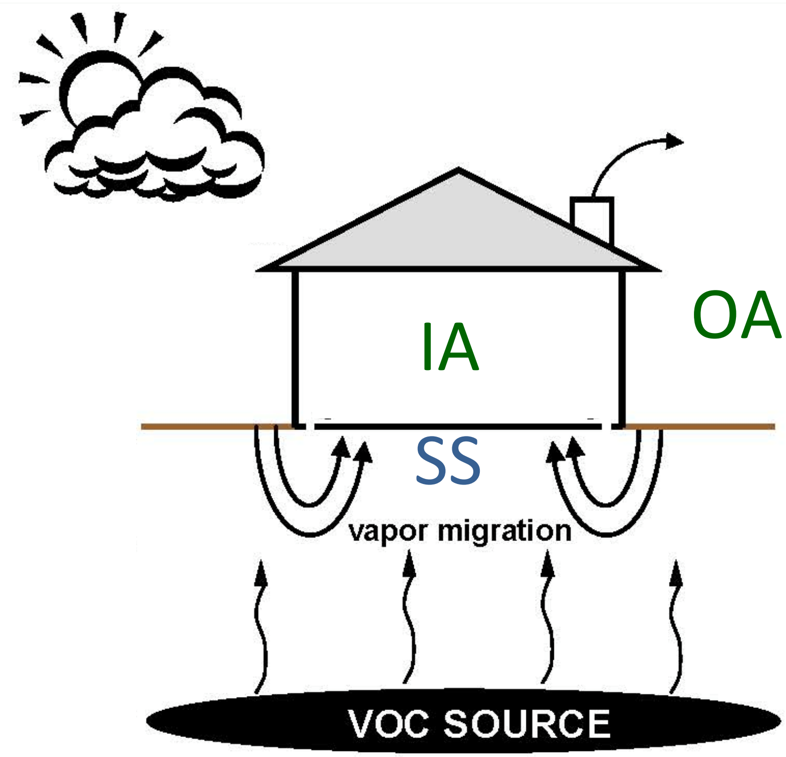
Identifying Background

Examine Summa canister results for each compound detected:

Not detected in Sub-slab

⬇

No subsurface source



DTSC. 2011. Final VI Guidance

Identifying Background

Examine Summa canister results for each compound detected:

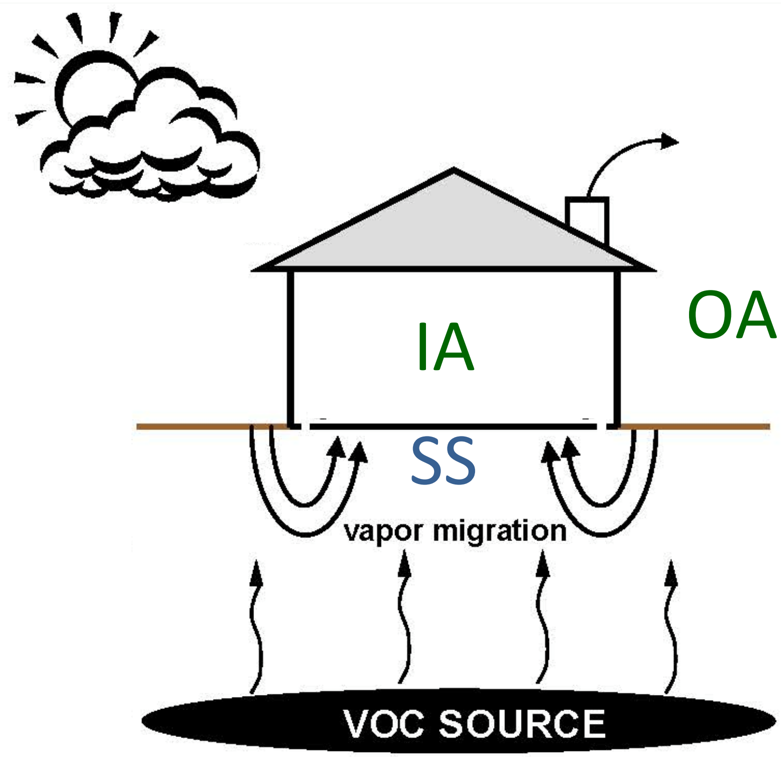
Maximum Indoor Air

>

Maximum Sub-slab

(& Sub-Slab is not elevated)

Indoor or Outdoor air source



DTSC. 2011. Final VI Guidance

Identifying Background – Literature Values

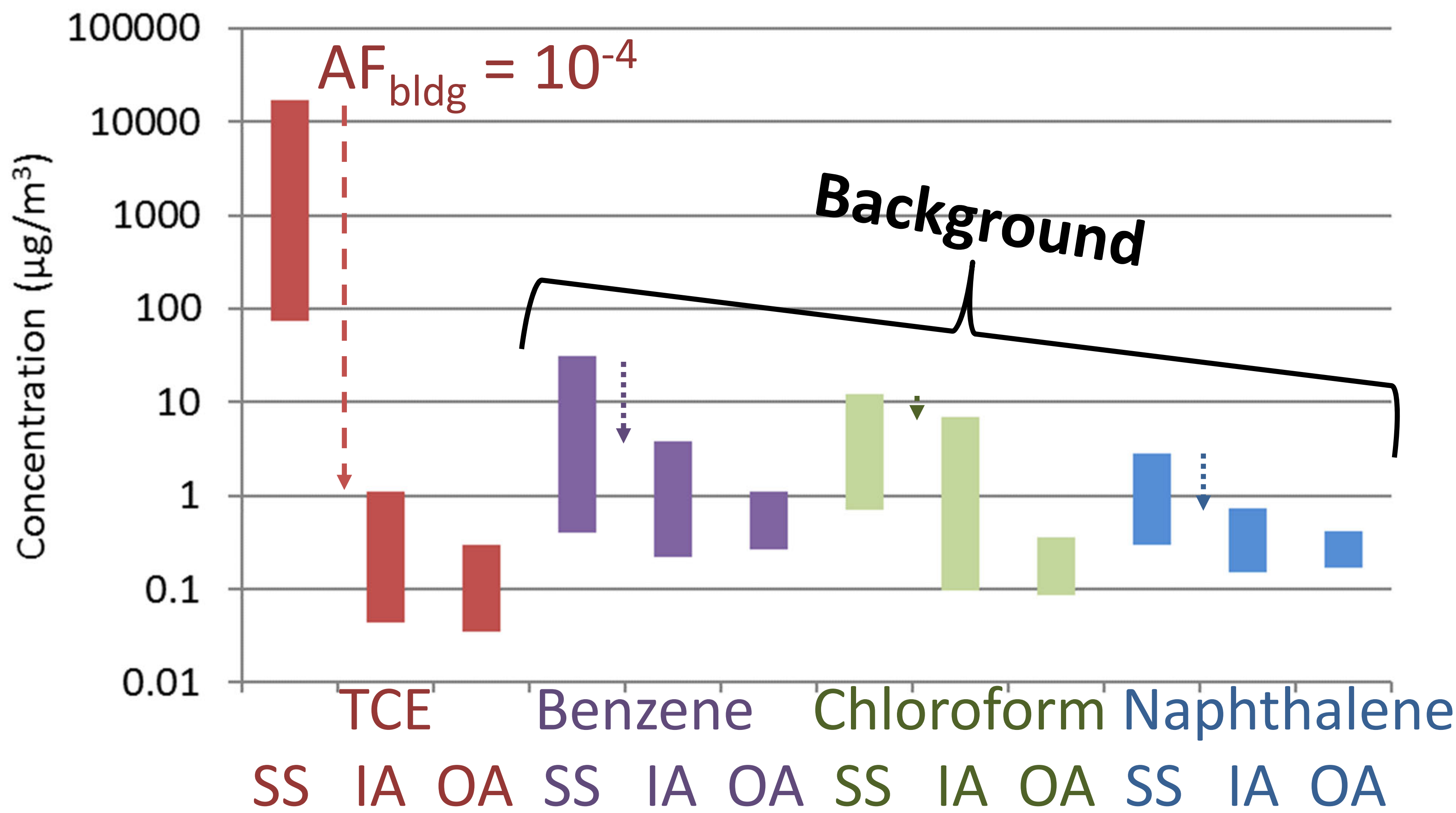
Compounds commonly found in indoor air in office buildings (Hodgson and Levin, 2003)

Compound	Literature (µg/m³)	Common Source
Benzene	3.2 central tendency	Tobacco smoke, gasoline, motor vehicles, glue, paint, furniture wax, detergent, industrial uses
Chloroform	9.8 max	Chlorine-disinfected water
Naphthalene	10 max	Industrial uses, open burning, motor vehicles, tobacco smoke, mothballs

Literature > Max Indoor Air ➡ Indoor/outdoor source

Hodgson, A.T. and H. Levin. 2003. *Volatile Organic Compounds in Indoor Air.* LBNL report number 51715. April 21.

Compound Ratio Analysis



IA – indoor air SS – sub-slab OA – outdoor air AF_{bldg} – building specific attenuation factor

Background Compounds Detected in Indoor Air Samples

Compound	Reason Not Considered a Potential VI Compound
1,1,2-Trichlorotrifluoroethane	OA ≥ IA
2-Butanone	OA ≥ IA
4-Methyl-2-pentanone	IA > SS
Acetone	OA ≥ IA
Benzene	IA ≤ typical background, compound ratio analysis
Carbon disulfide	OA ≥ IA
Carbon tetrachloride	IA > SS
Chloroethane	OA ≥ IA
Chloroform	IA ≤ typical background, compound ratio analysis
Chloromethane	OA ≥ IA, IA > SS
Dichlorodifluoromethane	OA ≥ IA, IA > SS
Naphthalene	IA ≤ typical background, compound ratio analysis
Styrene	OA ≥ IA
Trichlorofluoromethane	OA ≥ IA

Exclude these compounds from summation of incremental risk/hazard for indoor air

Incremental Risk/Hazard Results

$< 1 \times 10^{-6}$ cancer risk
or
< 1 non-cancer hazard

cancer risk management range
$1 \times 10^{-6} – 1 \times 10^{-4}$

$> 1 \times 10^{-4}$ cancer risk
or
> 1 non-cancer hazard

Cumulative Incremental Risk Results

Building 1, Season 1	Carcinogenic Risk	Non-Cancer Hazard
Sub-slab (default generic)	***4E-04***	***1E+02***
Sub-slab (building-specific)	3E-06	8E-01
Indoor Air	5E-06	1E-01
Outdoor Air	4E-06	1E-01
Potentially VI-related Indoor Air	5E-07	4E-02

All Indoor Air – Raw Risk Analysis

Building	Carcinogenic Risk				Non-Cancer Hazard			
	2015 Winter	2015 Summer	2016 Summer	2017 Winter	2015 Winter	2015 Summer	2016 Summer	2017 Winter
2	2E-05	8E-06	--	--	5E-01	2E-01	--	--
94	6E-05	2E-05	8E-06	4E-05	***2E+00***	4E-01	4E-01	1E+00
379	3E-05	6E-05	3E-05	--	***6E+00***	***9E+00***	***4E+00***	--
397	2E-05	7E-06	--	--	6E-01	2E-01	--	--
1	--	--	5E-06	3E-05	--	--	1E-01	6E-01
3	--	--	3E-06	6E-06	--	--	7E-02	1E-01
4	--	--	9E-06	9E-06	--	--	3E-01	2E-01
6	--	--	2E-06	2E-06	--	--	5E-02	2E-02
33	--	--	5E-06	6E-06	--	--	7E-02	1E-01
36	--	--	2E-05	7E-06	--	--	7E-01	2E-01
65	--	--	8E-06	7E-06	--	--	3E-01	2E-01
90	--	--	5E-06	7E-06	--	--	2E-01	4E-01
333	--	--	3E-05	7E-06	--	--	1E+00	2E-01
334	--	--	2E-06	5E-06	--	--	2E-02	1E-01
341	--	--	2E-05	--	--	--	7E-01	--
472	--	--	2E-05	1E-05	--	--	7E-01	3E-01
801	--	--	9E-06	7E-06	--	--	3E-01	3E-01

-- – not sampled

Potentially VI-Related Indoor Air – Refined Risk Analysis

Building	Carcinogenic Risk				Non-Cancer Hazard			
	2015 Winter	2015 Summer	2016 Summer	2017 Winter	2015 Winter	2015 Summer	2016 Summer	2017 Winter
2	6E-07	8E-07	--	--	1E-01	9E-02	--	--
94	5E-06	2E-06	1E-06	3E-06	9E-01	3E-01	3E-01	5E-01
379 ★	2E-05	3E-05	9E-06	--	***5E+00***	***9E+00***	***3E+00***	--
397	2E-07	8E-08	--	--	1E-01	4E-02	--	--
1	--	--	5E-07	9E-07	--	--	4E-02	2E-01
3		--	NCD	2E-08	--	--	3E-03	1E-02
4		--	2E-07	9E-09	--	--	1E-01	4E-02
6		--	5E-07	4E-07	--	--	4E-02	9E-03
33		--	NCD	1E-07	--	--	7E-03	1E-03
36	--	--	6E-07	5E-07	--	--	1E-01	1E-01
65	--	--	8E-07	7E-07	--	--	1E-01	4E-02
90	--	--	7E-07	2E-06	--	--	7E-02	4E-01
333	--	--	5E-07	3E-07	--	--	7E-02	4E-02
334	--	--	NCD	NCD	--	--	7E-03	7E-03
341	--	--	8E-08	--	--	--	6E-02	--
472	--	--	4E-06	3E-06	--	--	3E-01	2E-01
801	--	--	3E-07	3E-07	--	--	7E-02	1E-01

Mitigation performed (vapor entry point sealing and horizontal SVE)

-- – not sampled   NCD – no VI-related carcinogens were detected

Lessons Learned

- **Accounting for the contribution of background sources:**
  - Improved VI risk and hazard estimates and
  - Allowed for better risk management decision making
- **Use Multiple Lines of Evidence!**
  - Building-specific attenuation factors
  - Compare indoor air to outdoor air
  - Compare indoor air to sub-slab and/or soil gas
  - Consider common indoor air background concentrations reported in literature
  - Perform compound ratio analysis

Questions ?