



# Evaluation of Effects of Remediation and Background Indoor Sources on Indoor Air in a Commercial Facility

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April 2018

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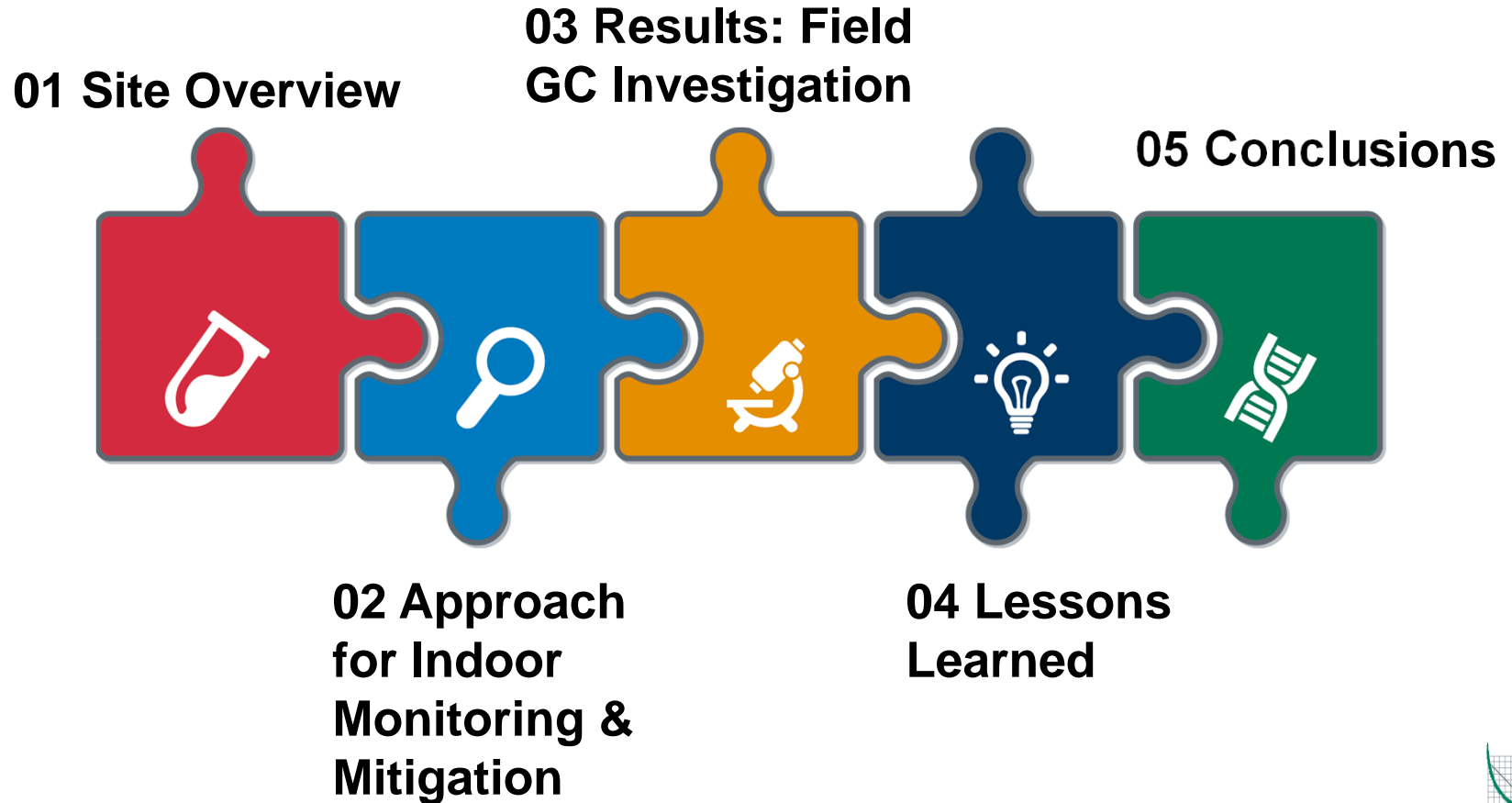
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 **PEAK**  
ENVIRONMENTAL LLC

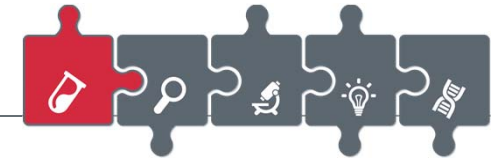
  
**ERM**

# Agenda

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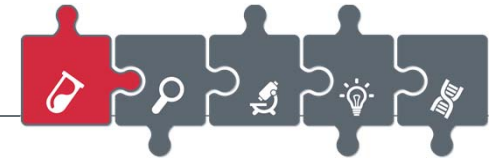


# Site Overview



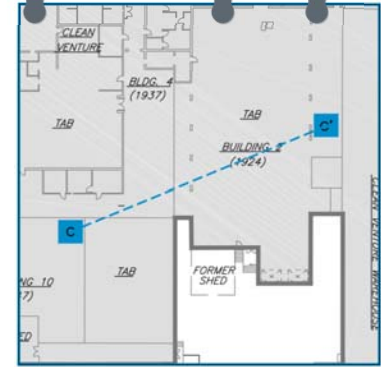
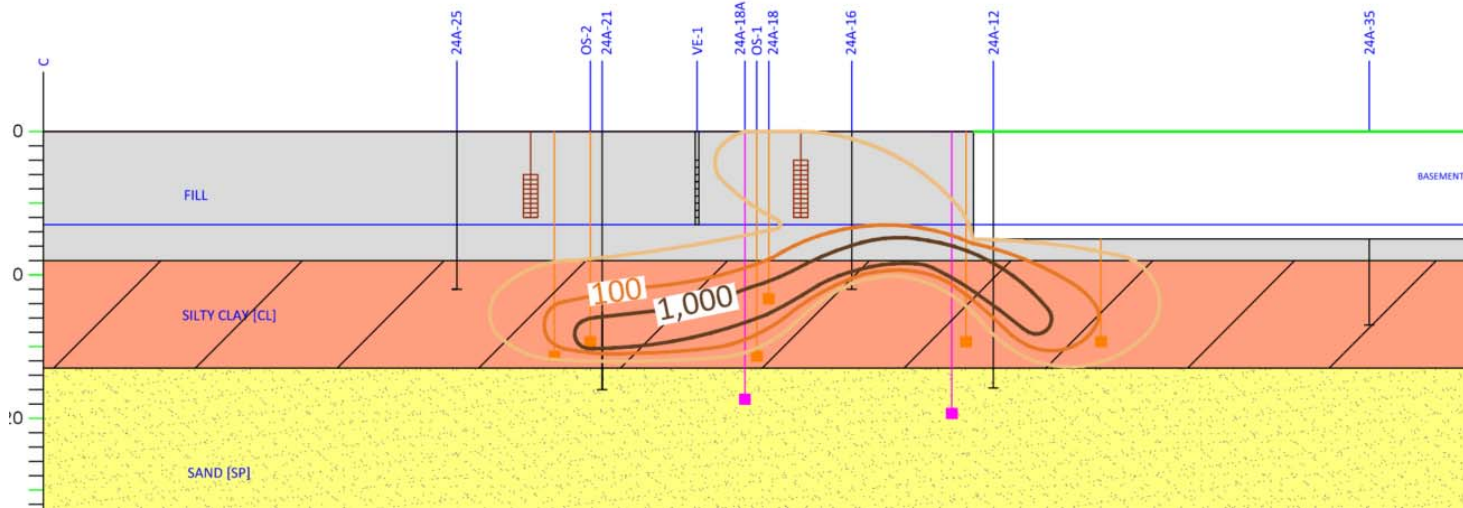
- Building 100 years old
- Historically used for manufacture of electrical components
- Degreasing operations, cadmium & zinc plating
- Located in an urban industrial area
- Listed under state program & investigated since 1995
- Dual Phase Extraction (DPE): 2002 to 2004
- Vapor intrusion investigations started in 2003
- Building currently occupied by various commercial & industrial occupants

# Project Goals and Objectives



- Current remediation goals
  - Reduce soil concentration to less than regulatory level
  - Reduce contaminant mass in soil to allow groundwater to naturally attenuate
- Eliminate VI pathway and not create additional concerns
- Monitor indoor air in an occupied commercial building

# Site Hydrogeology



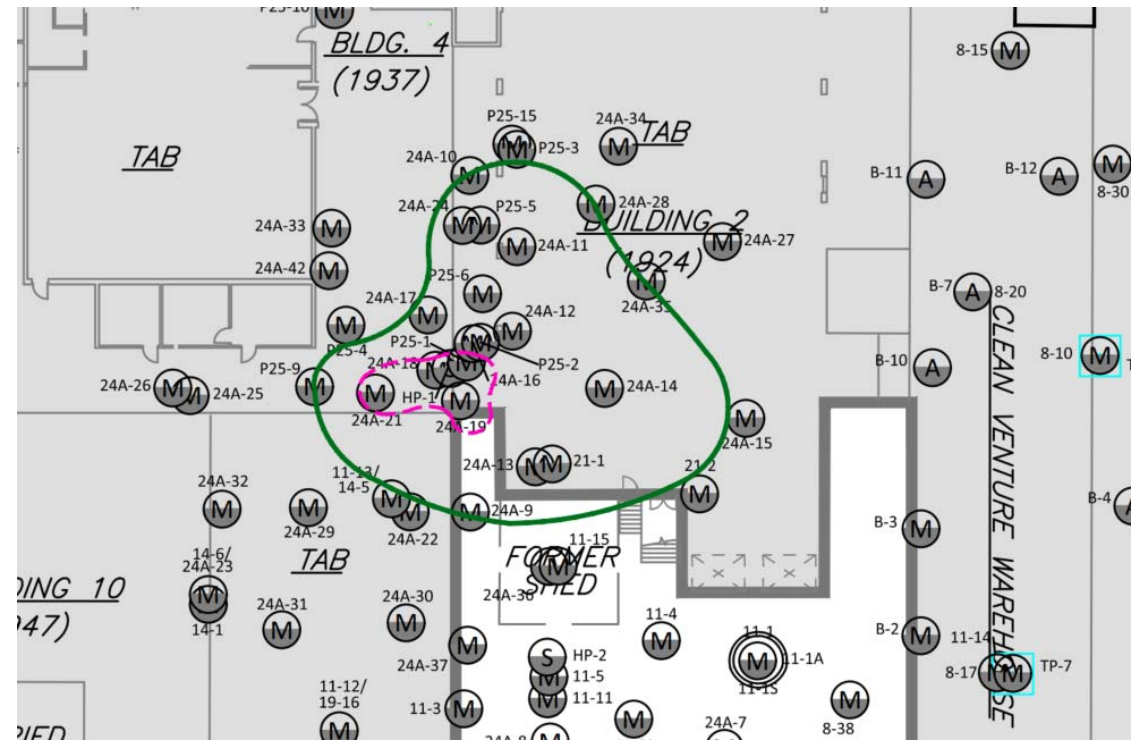
**LEGEND**

- CROSS SECTION
- VAPOR BARRIER
- GROUNDWATER
- FILL
- SILTY CLAY
- SAND
- SOIL BORING
- SILT OZONE INJECTION WELL
- SAND OZONE INJECTION WELL
- SOIL VAPOR EXTRACTION
- TCE ISO-CONTOUR - NON-RESIDENTIAL BELOW GROUNDWATER 20mg/kg & SSIGW ABOVE GROUNDWATER TABLE
- TCE ISO-CONTOUR - 100 mg/kg
- TCE ISO-CONTOUR - 1,000 mg/kg

# TCE AOC



- Soil contamination TCE
  - Maximum concentrations 5,200 mg/kg
  - DNAPL present
- Groundwater contamination TCE
  - Shallow aquifer - 3,800 ug/L
  - Sand aquifer - 8,000 ug/L
  - Bedrock aquifer 300 ug/L



LEGEND

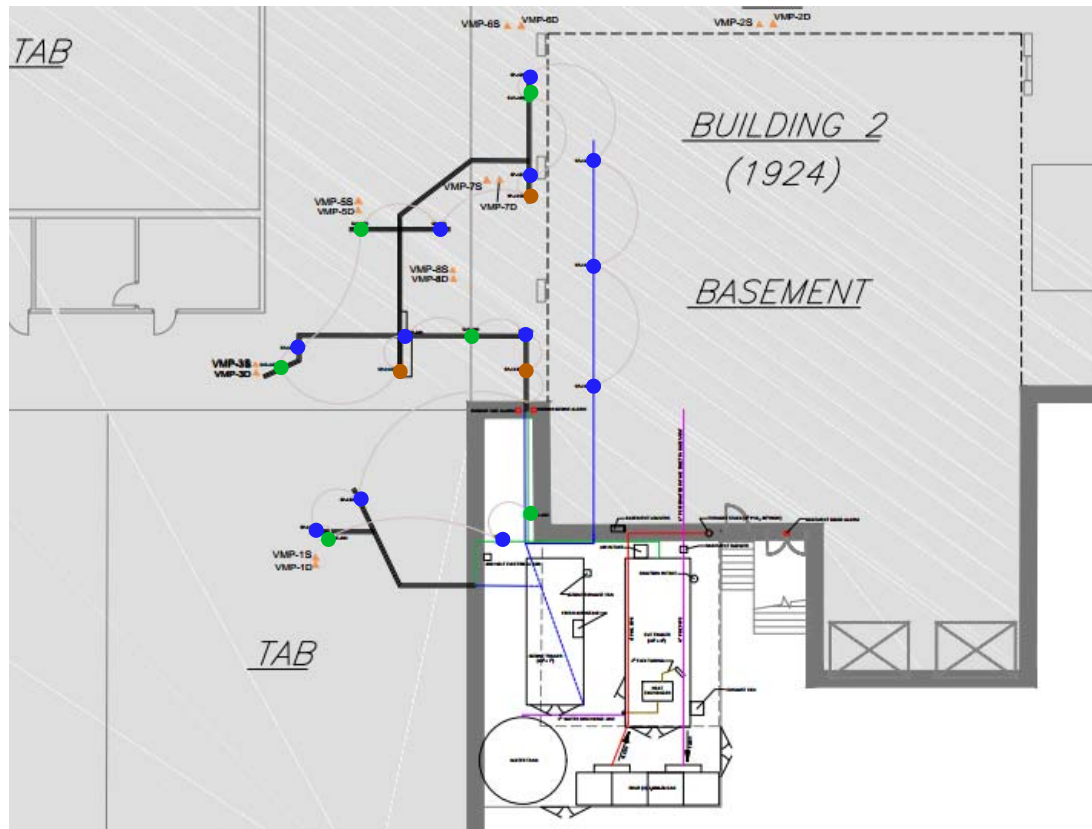
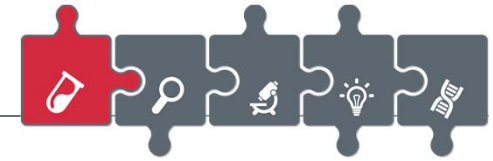


TCE - > 20 mg/kg



INFERRED DNAPL  
SOURCE AREA BOUNDARY

# TCE Remediation Layout



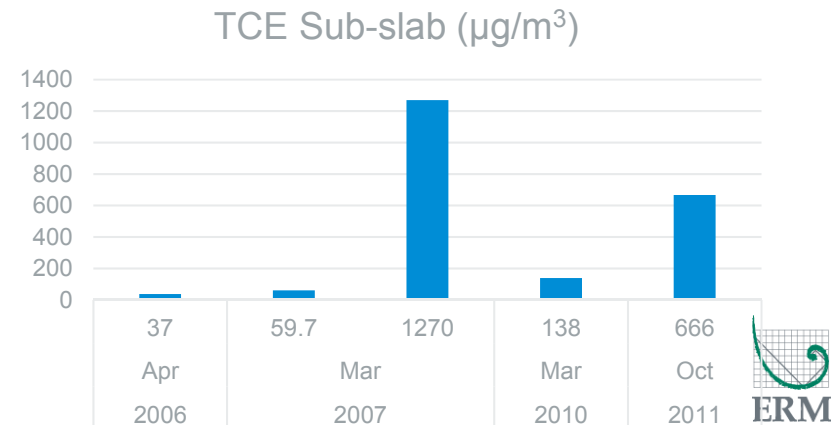
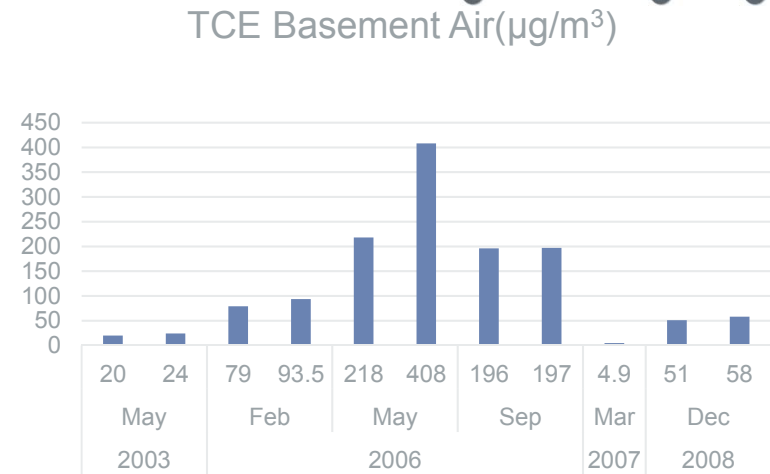
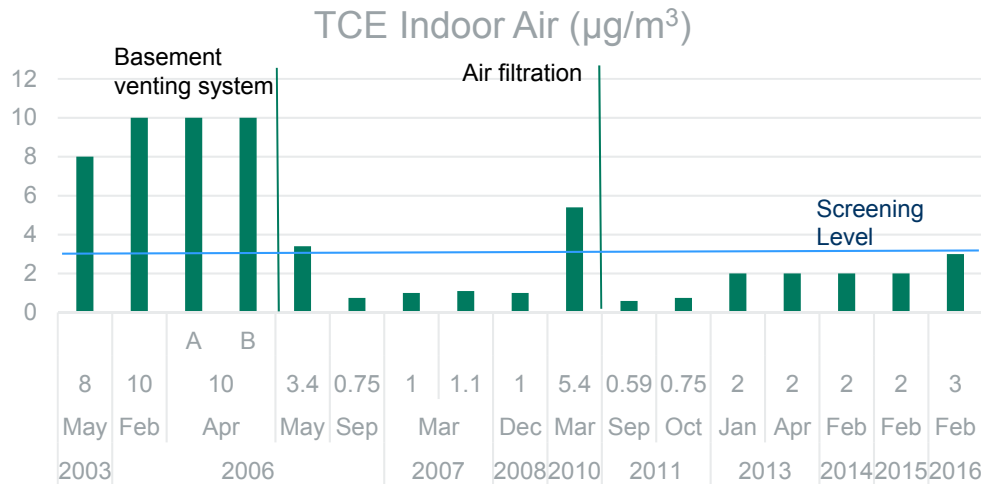
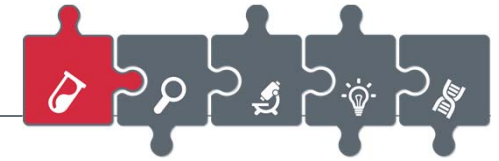
## LEGEND

-  SPARGE POINT
-  DEEP SPARGE POINT
-  SVE POINT

## NOTES:

1. WELLS SHOWN IN THE BASEMENT ARE LOCATED IN THE BASEMENT FLOOR AND DO NOT EXTEND TO THE FIRST FLOOR.
2. SVE LINES SHOWN WITHIN THE TRAILER COMPOUND ARE LOCATED IN PLANE ALONG THE SOUTHWEST & NORTHEAST WALLS.
3. SPARGE POINT LINES ARE LOCATED ON THE FLOOR OF THE COMPOUND AND RUN UNDER AND UP INTO THE OZONE TRAILER.

# Evaluation of the VI Pathway



## Pre-remediation mitigation actions

- Vapor barrier between basement and first floor
- Basement fresh air exchange system
- Three 1,900 CFM carbon air filter units

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# Approach for Indoor Monitoring & Mitigation



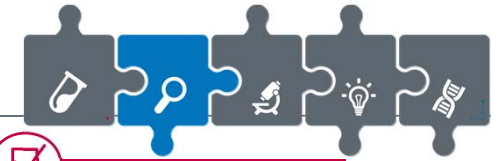
Plan for indoor air monitoring and mitigation

- Weekly indoor air monitoring with PID (ppm) and Ozone meter
- Weekly inspections of engineering controls (i.e. vapor barriers, basement blower, and indoor air carbon filters).
- Monthly screening of well heads, trenching, and vapor barriers with PID and Ozone meter
- Monthly laboratory analysis of indoor air
- Action levels for field measurements
- Contingent mitigation steps and strategy
- 9 ■ Post mitigation confirmation sampling

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# Indoor Air Investigation Timeline



July 2016

- Ozone system start up



August 2016

- Indoor air sampling (TCE > Screening Level (SL))
- System shut down
- Crack and well sealing
- Start SSDS



September 2016

- Post mitigation sampling (TCE < SL)



October 2016

- Restart ozone system
- New tenant moves into warehouse
- Follow up air sampling (TCE > SL)
- ppb RAE used to investigate cracks
- Additional crack and well sealing
- Ozone system restarted
- Indoor air resampled (TCE > SL)



# Frog-4000™ Investigation



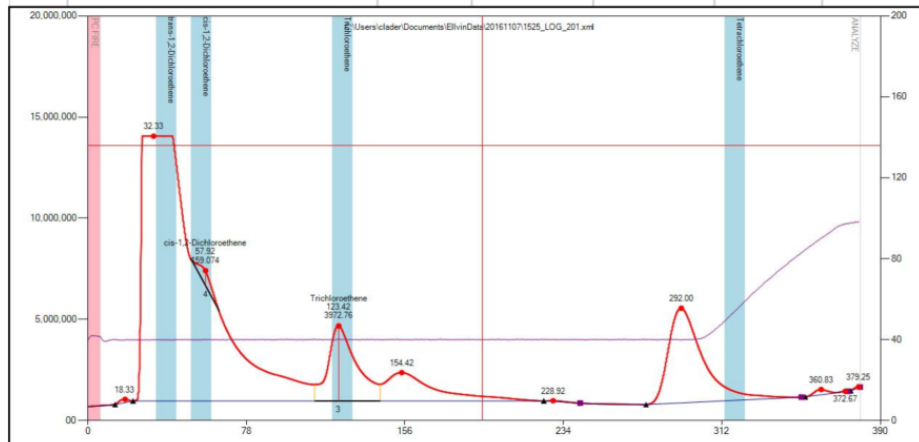
## Frog GC Log of Inventory

FROG-0033: Ta=300, Tb=60, Tc=20, Ct=40, Ht=100, collect=60, clean=4, presettle=4, settle=2, fire=6  
 Dilution = 1.0  
 Inventory-3

Sample taken from pallet of 4x10 envelopes

ppb: 2829

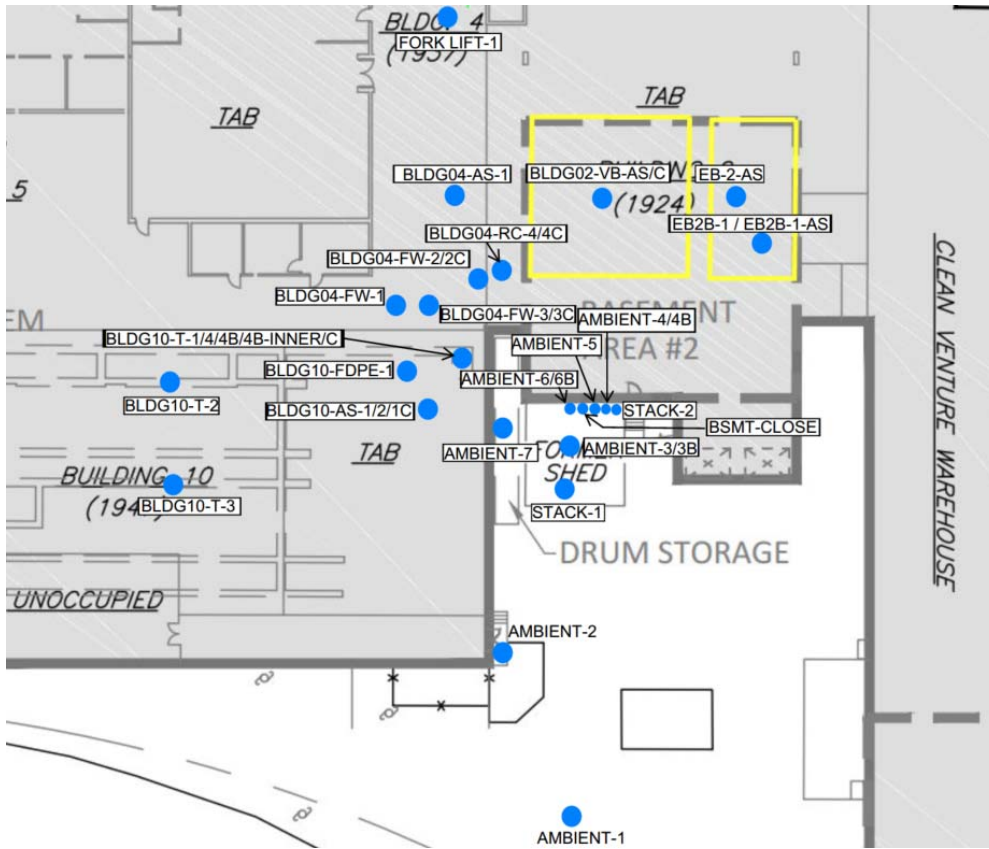
Peak	Analyte Name	Time	Concentration	x Dilution	Area	Height
3	Trichloroethene	123.42	3972.76	3972.76	60674410	3714890
4	cis-1,2-Dichloroethene	57.92	159.074	159.074	5562724	742778



## Goals

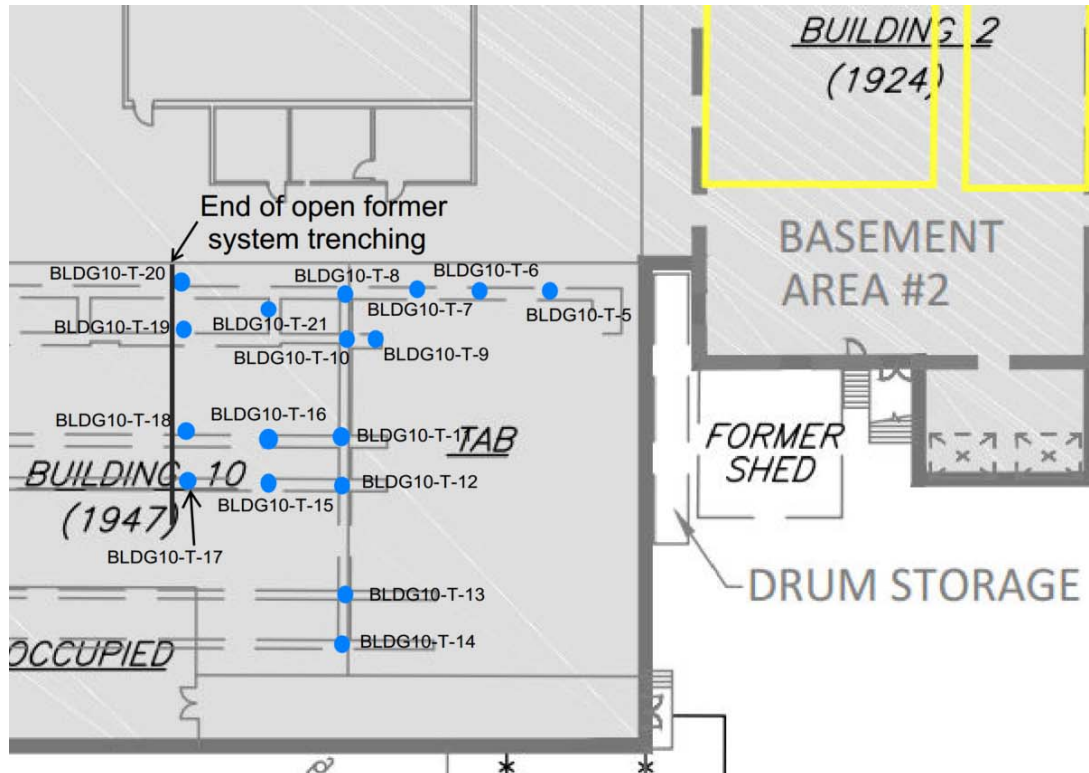
- Identify additional leaks in building
- Determine if background sources present
- Distinguish between ozone related releases and background

# Results: Frog Indoor Investigation



Vapor Sample Identifier	ppbRAE reading (ppb)	1,2-Dichloroethene (cis)	Trichloroethene
<b>Building 2</b>			
FR-2-AS	NA	1,942	ND
EB2B-1	NA	1,871	2,978
EB2B-1-AS	NA	1,107	26
BLDG02-VB-AS	435	2,092	34
BLDG02-VB-AS-C	NA	1,516	ND
<b>Building 10</b>			
BLDG10-T-1	357	878	1.3
BLDG10-T-2	496	1,170	ND
BLDG10-T-3	516	2,144	ND
BLDG10-T-4	856	1,576	256
BLDG10-T-4B	NA	1,154	81
BLDG10-T-4B-C	NA	1,257	ND
BLDG10-T-4B-INNER	11,300	2,119	39,713
BLDG10-FDPE-1	NA	831	ND
BLDG10-AS-1	NA	1,658	ND
BLDG10-AS-1C	NA	1,331	85
BLDG10-AS-2	NA	953	2.5
<b>Building 4</b>			
BLDG04-FW-1	NA	1,036	ND
BLDG04-FW-2	492	2,174	2,240
BLDG04-FW-2C	NA	1,698	ND
BLDG04-FW-3	405	2,001	28
BLDG04-FW-3C	NA	1,832	ND
BLDG04-RC-4	834	2,111	4,465
BLDG04-RC-4C	NA	1,233	ND
BLDG04-AS-1	NA	1950.3	4.7

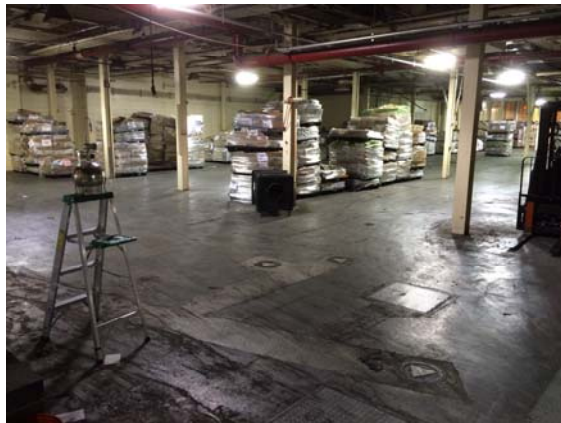
# Frog Trench Investigation



Vapor Sample Identifier	ppbRAE reading	1,2-Dichloroethene (cis)	Trichloroethene
<b>Former System Trenching</b>			
BLDG10-T-5	632	1650	325
BLDG10-T-6	590	1256	217
BLDG10-T-7	569	1146	165
BLDG10-T-8	740	839	233
BLDG10-T-9	169	1150	12.8
BLDG10-T-10	463	547	121
BLDG10-T-11	410	724	8.02
BLDG10-T-12	579	1312	99.8
BLDG10-T-13	213	1666	11.6
BLDG10-T-14	269	1855	59.1
BLDG10-T-15	415	1646	68.7
BLDG10-T-16	483	1095	246
BLDG10-T-17	362	1524	67.8
BLDG10-T-18	320	1229	166
BLDG10-T-19	539	433	219
BLDG10-T-20	660	484	317
BLDG10-T-21	623	551	173

1,2-DCE and TCE results in  $\mu\text{g}/\text{m}^3$

# Frog Inventory Investigation



**View of Building 10 Inventory**

**View of Building 4 Inventory**



Vapor Sample Identifier	ppbRAE reading (ppb)	1,2-Dichloroethene (cis)	Trichloroethene
<b>Inventory</b>			
INVENTORY-1	2,645	1,773	ND
INVENTORY-2	1,654	2,029	ND
INVENTORY-3	2,829	626	21,091
INVENTORY-4	1,065	1,871	2,097
INVENTORY-5	1,774	2,064	3,509
INVENTORY-6	3,416	2,155	10,349
INVENTORY-7	NA	1,308	276
INVENTORY-8	2,876	1,505	748
INVENTORY-9	3,005	2,131	233
INVENTORY-10	2,265	13,835	934
INVENTORY-11	2,792	261,512	1,954
INVENTORY-12	3,269	263,130	3,074
INVENTORY-13	2,505	98,976	653
INVENTORY-14	3,510	277,900	1,088
INVENTORY-15	3,327	86,651	955
INVENTORY-16	2,466	22,556	398

1,2-DCE and TCE results in  $\mu\text{g}/\text{m}^3$

# Lessons Learned



- Pre-planning indoor assessment and mitigation strategy decreased mitigation response time
- Incremental use of increasingly sensitive equipment improved the investigation
  - Identify migratory pathways between sub slab and indoor air (MiniRAE ppm)
  - Identify minor migratory pathways between sub slab and indoor air (ppbRAE ppb)
  - Identify inventory as potential source of indoor air quality impacts
  - Recognize need to speciate VOC detections (ppbRAE ppb)
- Real time field analytical methods (Frog-4000™) provided result confirmation
  - Confirmed presence of TCE from inventory
  - Allowed a large number of samples collected per day
  - Allowed for real time decision making during course of the investigation

# Conclusion

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- Regulatory agency accepted data and allowed discontinuation of indoor air sampling for VOCs
- New methods will be needed to investigate and evaluate background sources as VI expands into operating facilities
  - The tenant stored bulk mail (sales flyers: heavy card weight and high gloss)
  - Inventory changing daily
  - No printing or manufacturing conducted onsite, no bulk chemical to provide clues of background source
  - Other non target VOC sources
    - Truck traffic
    - Forklift use



# Contact Info

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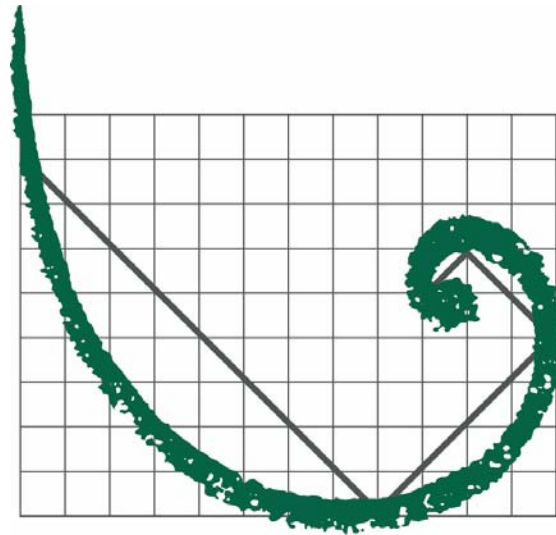


## Conference on Remediation of Chlorinated and Recalcitrant Compounds

April 8-12, 2018 | Palm Springs, CA



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