Passive Soil Gas Surveys: The Collection of High Resolution, Time-Integrated Samples to support Site Characterization and VI Investigations

Presented by:

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Hawai'i Department of Health HEER Webinar Series

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What is better… More or Less?

Source: AT&T

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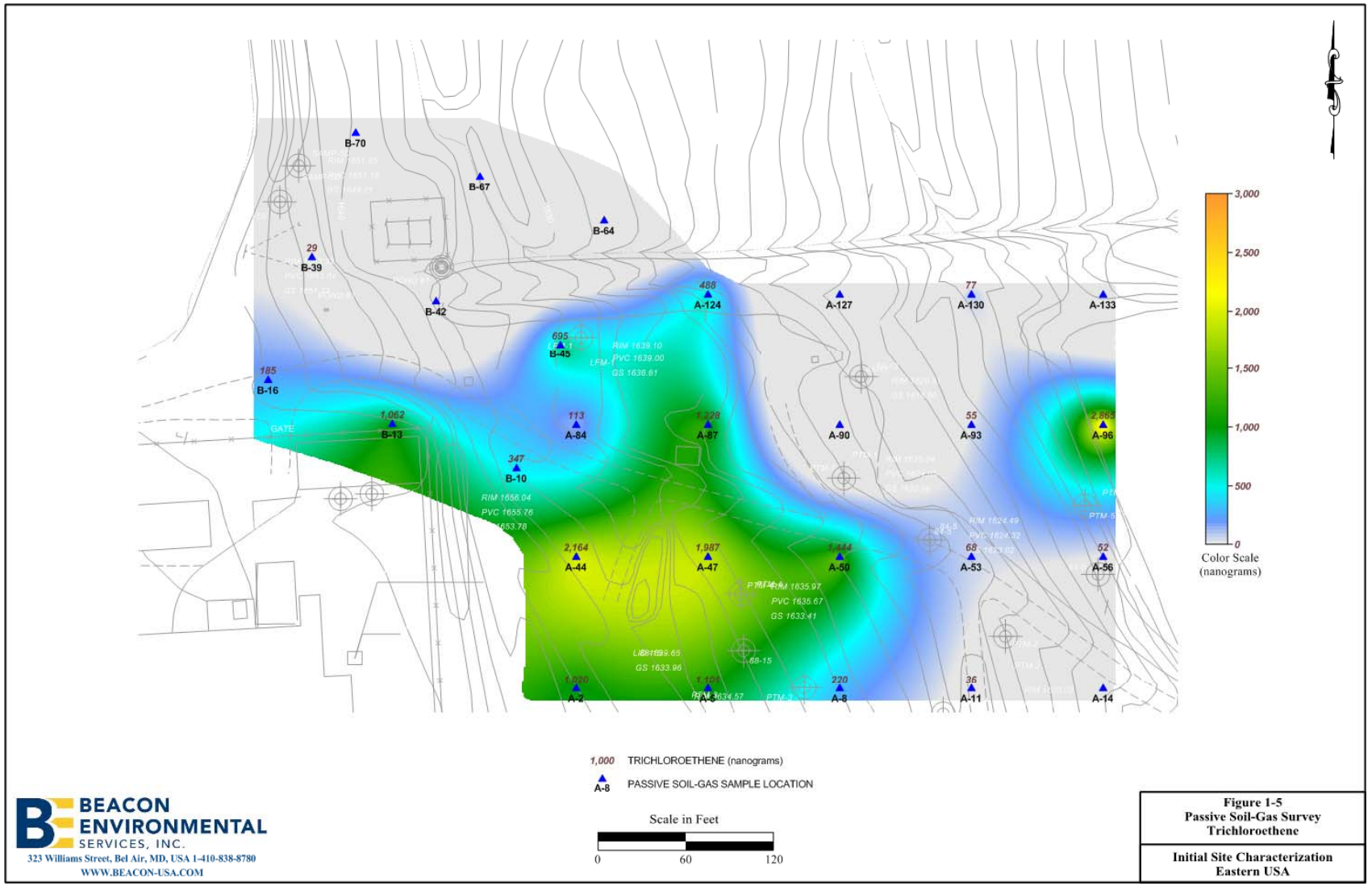
What is high resolution?



Sampling Grid with 90 Foot Spacing

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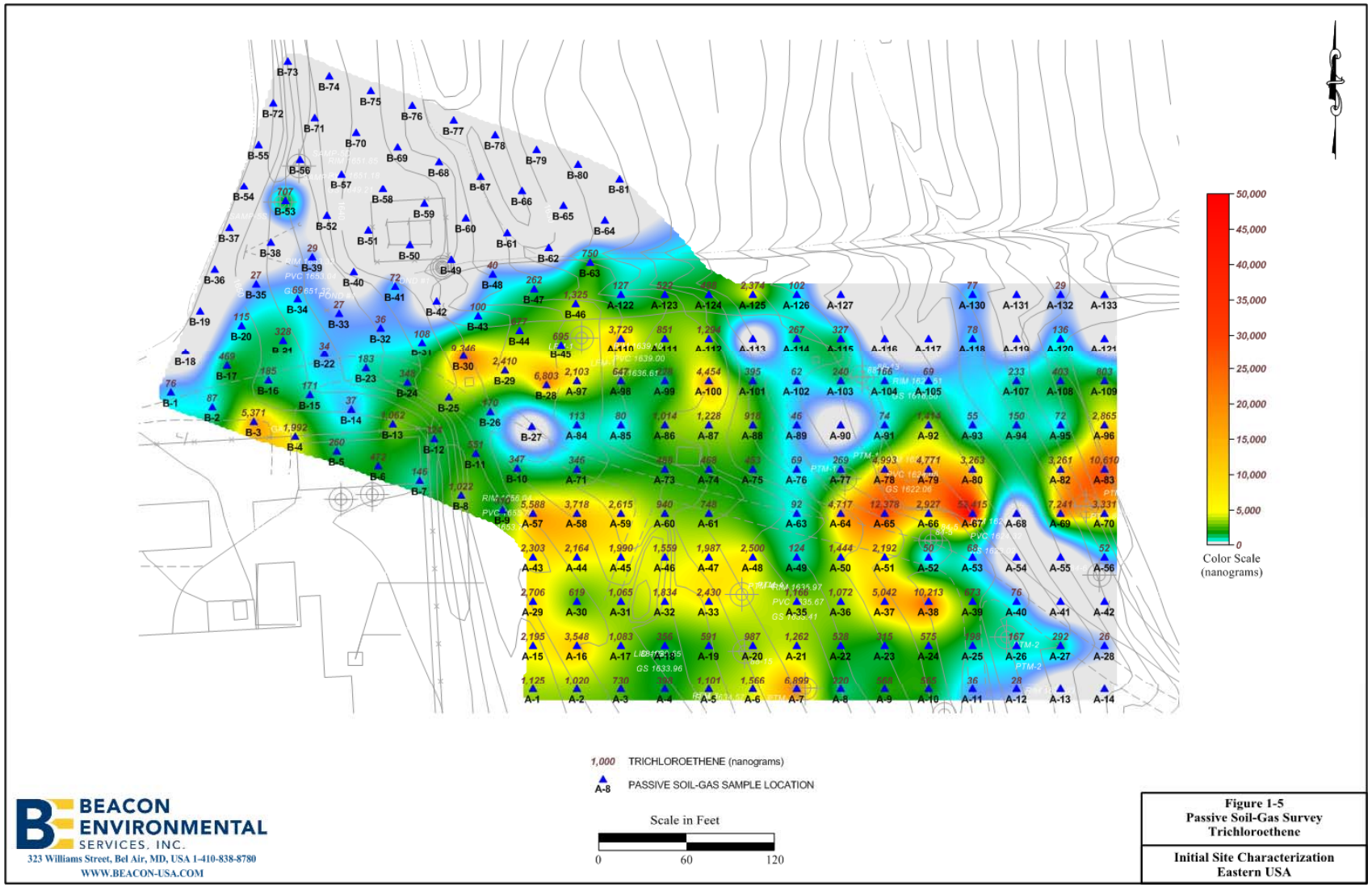
High Resolution – More is Better!



HRSC Sampling Grid with 30 Foot Spacing

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Survey Objectives

... is contamination

... should I collect soil samples

... should I sample groundwater

... is vapor intrusion a risk

... should I focus remediation

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Benefits of HRSC with PSG Surveys

Why PSG Surveys? – Spatial Variability

Overcome the challenges of SPATIAL VARIABILITY of subsurface contamination by allowing you to collect a high resolution data set

Benefits of PSG Surveys:

- Maximize the number of locations that can be sampled
- Reduce uncertainty, surprises, and unforeseen costs
- Make well-informed and appropriate corrective action decisions
- Rapidly collect accurate data

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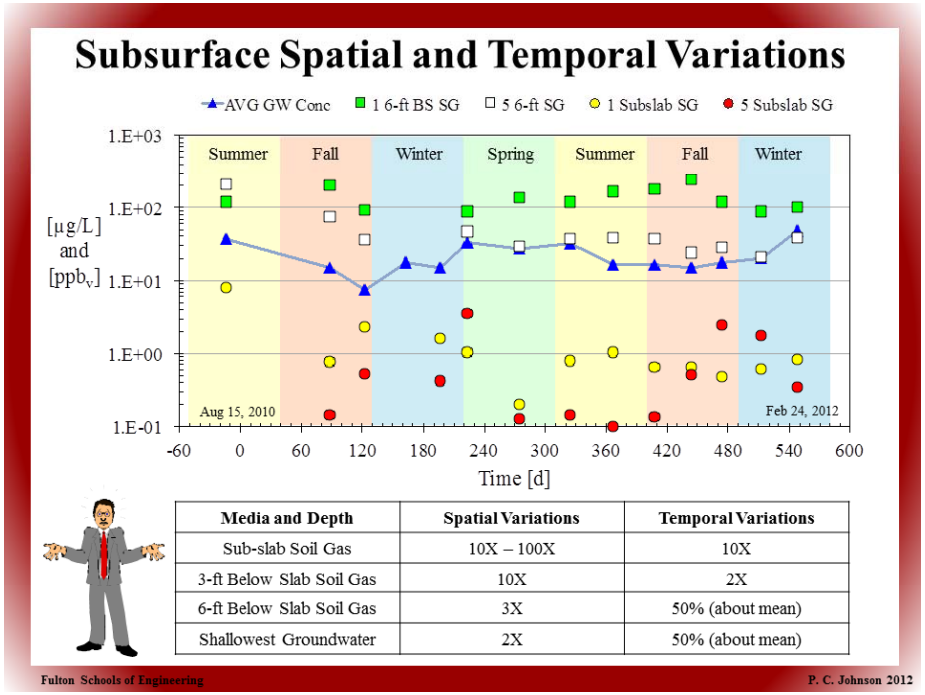
Benefits of HRSC with PSG Surveys

Why PSG Surveys? – Temporal Variability

Overcome the challenges of the TEMPORAL VARIABILITY of soil gas concentrations by collecting time-integrated measurements over several days or weeks



Source: Dr. Paul Johnson, et al. AEHS Conference 2012

Soil gas concentrations can change daily and even hourly at the same location.

On which day and at what time should you collect an active soil gas sample?

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Passive Soil Gas Sample Collection Kit

Sample Collection Kit

Samplers shipped in Tool Box

Dimensions:
50 cm x 25 cm x 25 cm

Shipped with custody seal

Custom packaged

Detailed kit instructions and installation videos

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Passive Soil Gas Sample Collection Kit

Sample Collection Kit

Samplers shipped in Tool Box

Dimensions:
50 cm x 25 cm x 25 cm

Shipped with custody seal

Custom packaged

No ice or preservatives required

Easy to ship internationally through customs

Detailed kit instructions and installation videos

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BEACON PSG Sampler

Passive Soil Gas Sampler

Actual size: 18 mm x 60 mm

Two types of adsorbents

Two pairs of adsorbents for duplicates

Uniform mass of adsorbents used (verified with analytical balance)

Adsorbents are hydrophobic

Completely inert sampler

No competing adsorptive materials

Design compliant with ASTM Standards D5314 and D7758

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Passive Soil Gas Sampling Media

Adsorbents:

Carbon Molecular Sieves
Graphitized Carbon Blacks
Porous Polymers

Differ by:

- **composition**
- **surface area**
- **hydrophobic properties**
- **affinity to adsorb and then release compounds**

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Passive Soil Gas Sampling Media

Physical Characteristics of Supelco Carbon Adsorbents back to top

Adsorbent	BET surface area[1] (m^2/g)	Density (g/mL)	Porosity (cc/g)			Micropore Diameter (Å)
			micro-	meso-	macro-	
Carbotrap graphitized carbon black (20/40 mesh)						
Carbotrap F	5	0.69	-	-	-	-
Carbotrap C	10	0.68	-	-	-	-
Carbotrap Y	24	0.45	-	-	-	-
Carbotrap B	100	0.37	-	-	-	-
Carbotrap X	240	0.43	-	0.62	-	100
Carbopack graphitized carbon black (60/80 mesh)						
Carbopack F	5	0.64	-	-	-	-
Carbopack C	10	0.68	-	-	-	-
Carbopack Y	24	0.42	-	-	-	-
Carbopack B	100	0.35	-	-	-	-
Carbopack Z	220	0.18	-	1.73	-	255
Carbopack X	240	0.41	-	0.62	-	100
Carbon Molecular Sieve						
Carboxen-1016	75	0.40	-	0.34	-	-
Carboxen-569	485	0.58	0.20	0.14	0.10	5 - 8
Carboxen- 1021[2]	600	0.62	0.30	-	-	5 - 8
Carboxen-1018[2]	675	0.60	0.35	-	-	6 - 8
Carbosieve S-III[3]	975	0.61	0.35	0.04	-	4 - 11
Carboxen-1003	1000	0.46	0.38	0.26	0.28	5 - 8
Carbosieve G	1160	-	0.49	0.02	-	6 - 15
Carboxen-1000	1200	0.48	0.44	0.16	0.25	10 - 12
Carboxen-1012	1500	0.50	-	0.66	-	19 - 21

[1] Brunauer, Emmett, Teller (BET) surface area calculations

[2] microporous, monoporous carbon sieve

[3] closed pore structure

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Sampling Options

Sampler Installation Video on Beacon's Website

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PSG Survey Design Considerations

PSG Sampling Design:

Uniform grids

Random or irregularly spaced grid

Transects perpendicular to groundwater flow

General recommendations:

- 15 to 30 foot spacing in grids to identify source areas
- 50 foot spacing, if necessary due to budget, but tighten grid in areas of greater concern when possible
- Shallow groundwater requires tighter grid spacing
- Utilities can be preferential pathways – consider during design how will impact data

Review Dr. Paul Johnson's recent work at Sun Devil House

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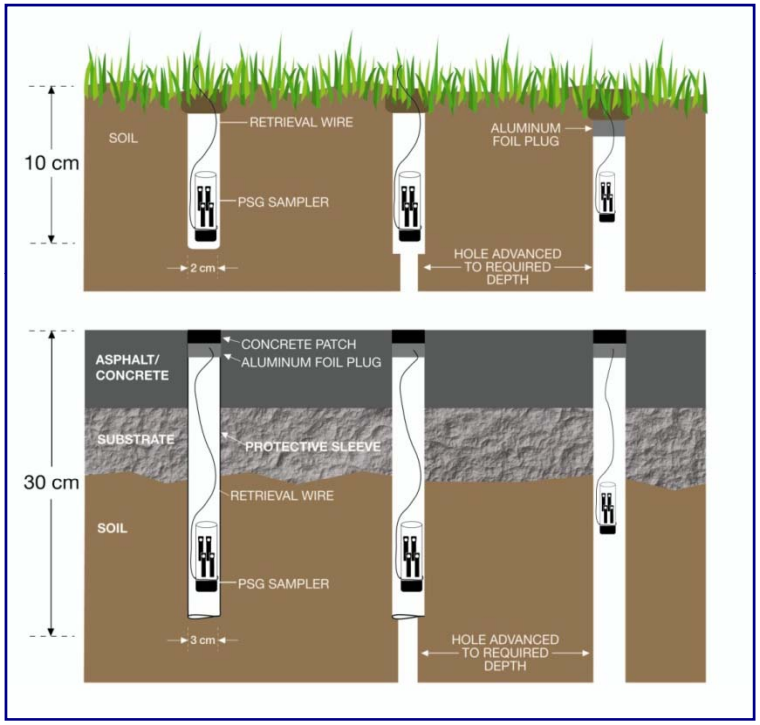
PSG Survey Design Considerations

Sampling Depths:



Beacon PSG Samplers routinely installed in holes advanced to a 1 to 3 foot depth, but the Sampler only needs to be placed in the upper portion of the sampling hole

Beacon has a demonstrated capability with PSG Samplers installed at shallow depths

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PSG Survey Design Considerations

Standard Exposure Periods:

7 days or less for source area or vapor intrusion pathway identification

14 days for tracking groundwater contamination

Actual sampling periods are dependent on site conditions (e.g., soil porosity and soil moisture) and compounds of concern (e.g., VOCs or SVOCs)

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Routine Targets

Below are routine compounds targeted in a PSG Survey

Halogenated compounds

- PCE
- TCE
- DCEs
- Vinyl chloride
- TCA
- Carbon tetrachloride
- Chloroform
- Freons
- Chlorobenzene
- Dichlorobenzenes
- Trichlorobenzenes

1,4-Dioxane

Complex mixtures

- Stoddard solvent
- Paint thinners

Petroleum Blends

- Gasoline
- Fuel oil
- Diesel
- Jet Fuel

BTEX, MTBE and PAHs

- Naphthalene
- 2-Methylnaphthalene

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Additional Targets

Heavier PAHs

- Acenaphthalene, Fluorene, Pyrene

Ketones

Alcohols

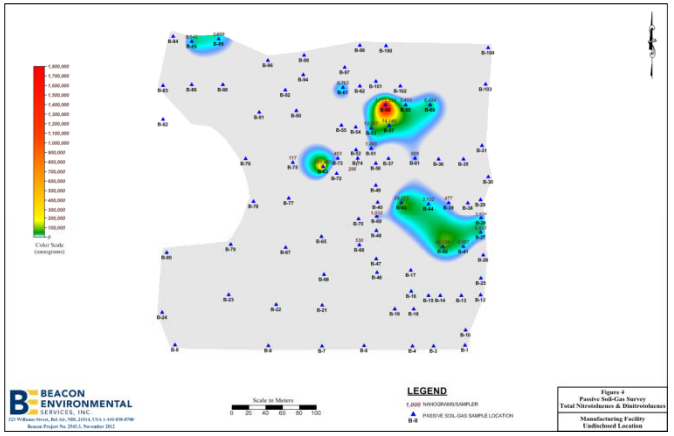
Explosives

- Nitrotoluenes, Dinitrotoluenes, Nitrobenzenes

Pesticides

Chemical Warfare Agent (CWA) and Breakdown Products

- Mustard, GB, VX, 1,4-Thioxane, 1,4-Dithiane, Thiodiglycol



Total Nitrotoluenes & DNTs

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Quality Control -- High Quality Analytical Method

- Analysis by thermal desorption-gas chromatography/mass spectrometry (TD-GC/MS) following EPA Method 8260C
- Analytical results based on 5-point initial calibration
- Internal standards and surrogates included with each analysis
- System daily tunes
- Method blanks
- Daily continuing calibration checks
- MDLs; LODs & LOQs Quarterly
- Third Party Proficiency Tests Biannually

PJLA Testing DoD ELAP

State-of-the-Art Analytical Instruments

- Method Detection Limits (MDLs) ranging from 0.0005 – 0.005 ug
- Meets requirements of EPA Level III/Level IV data quality objectives

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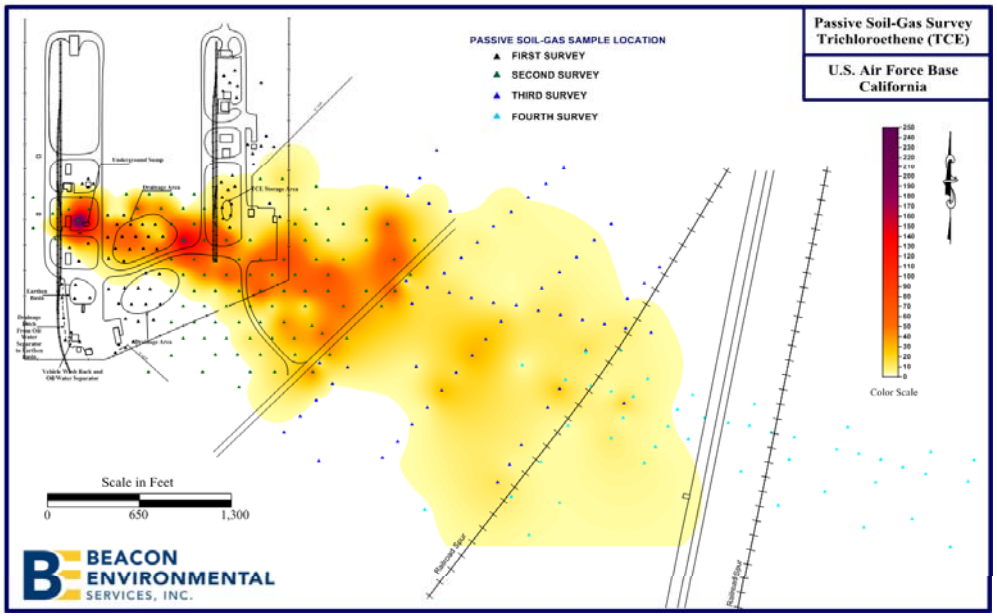
Quality Control – Why Important

Uniformity in both sampler design and analytical procedures will produce data that best reflects changes in subsurface concentrations.

A quality passive soil gas survey should be able to identify hot spots and VI risks while also delineating low concentrations in groundwater



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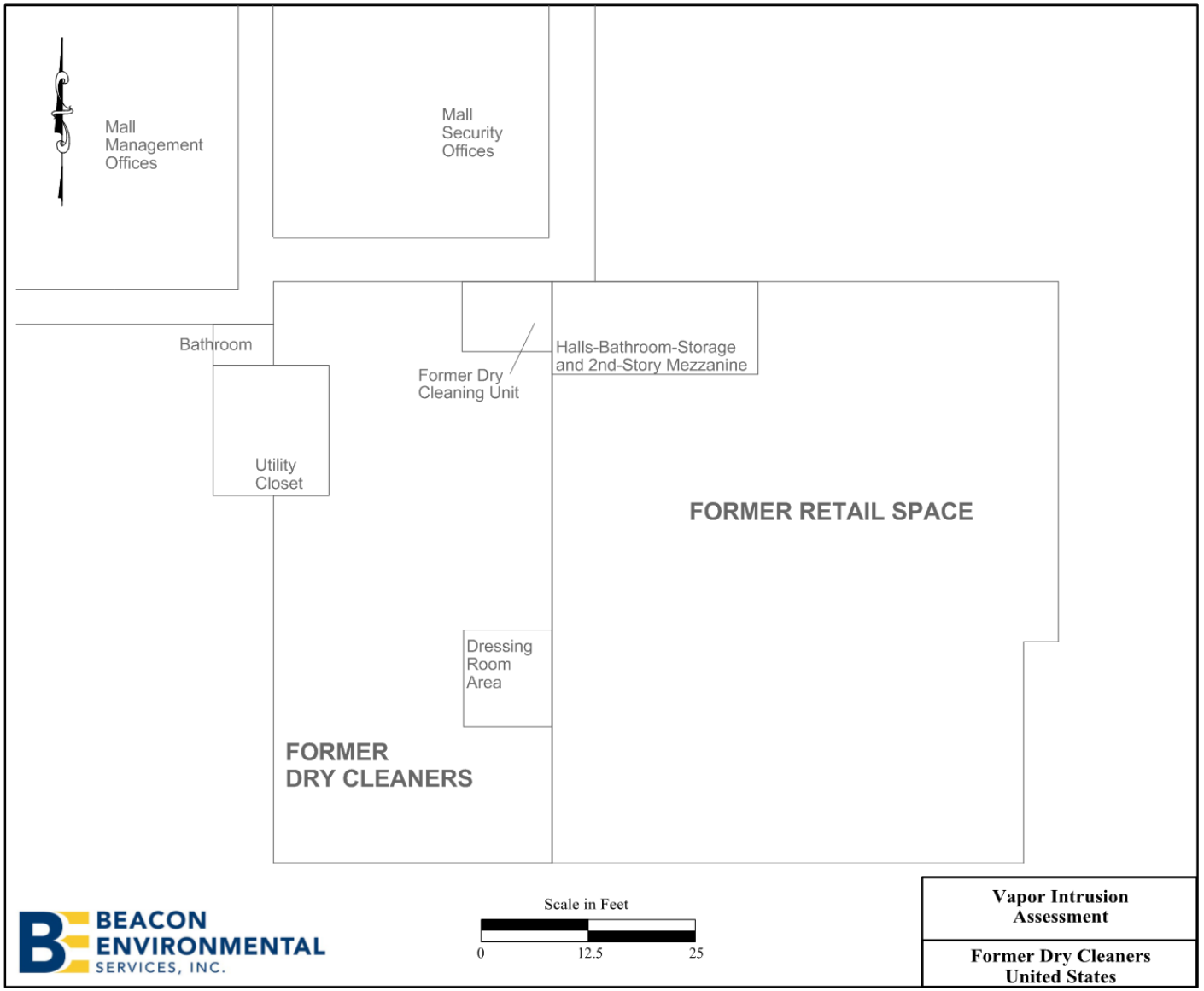
Dry Cleaner Investigation Case Study



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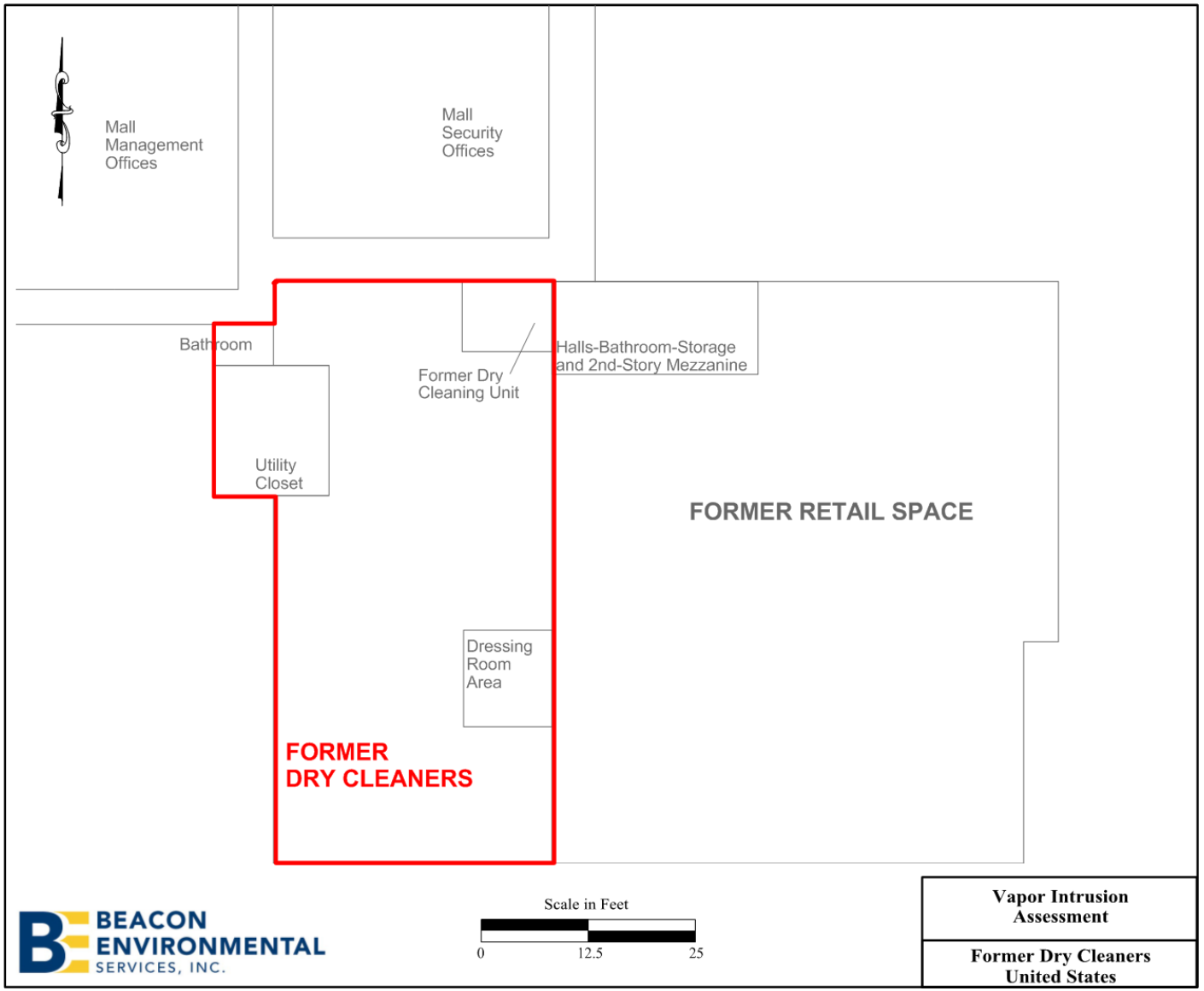

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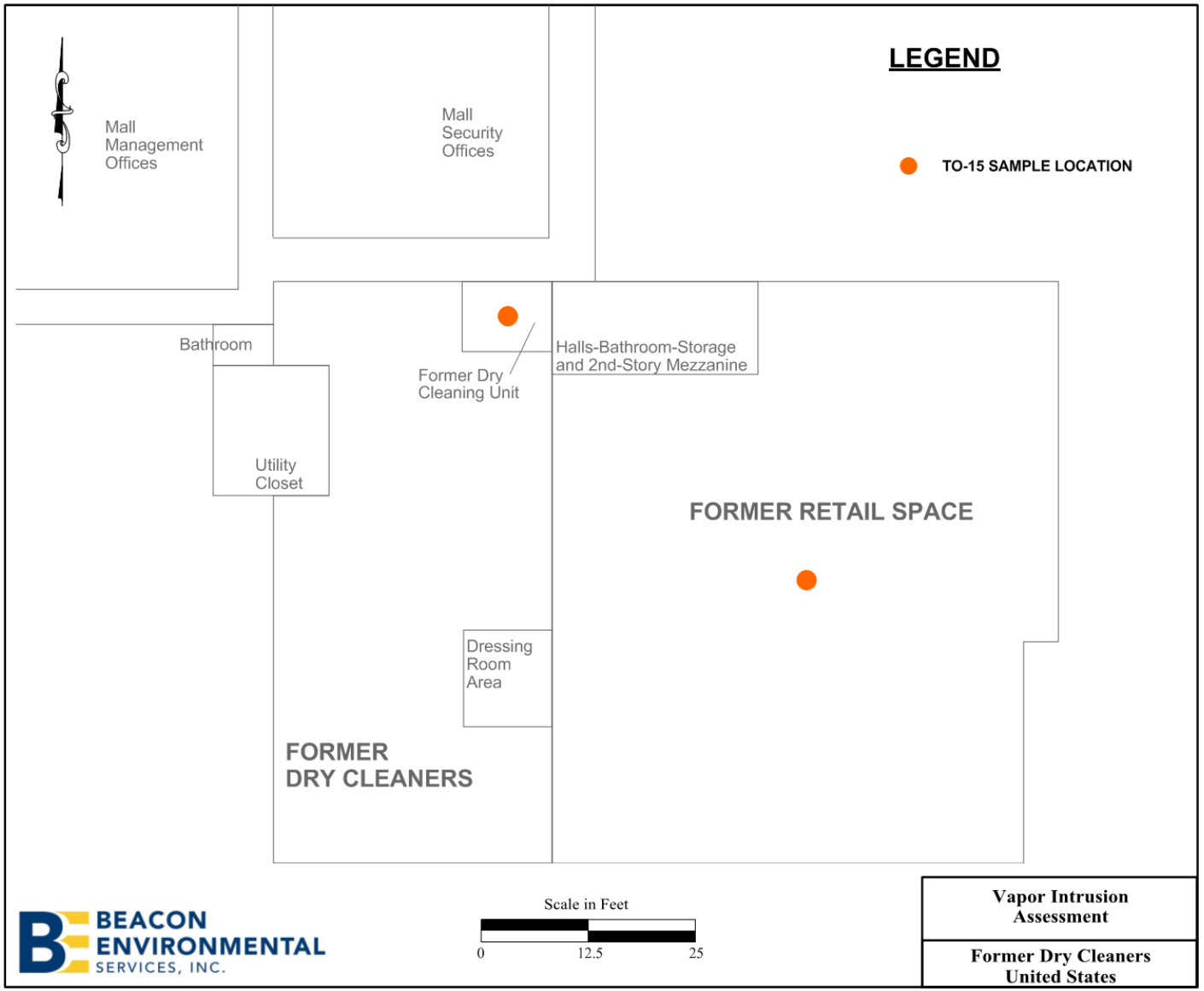

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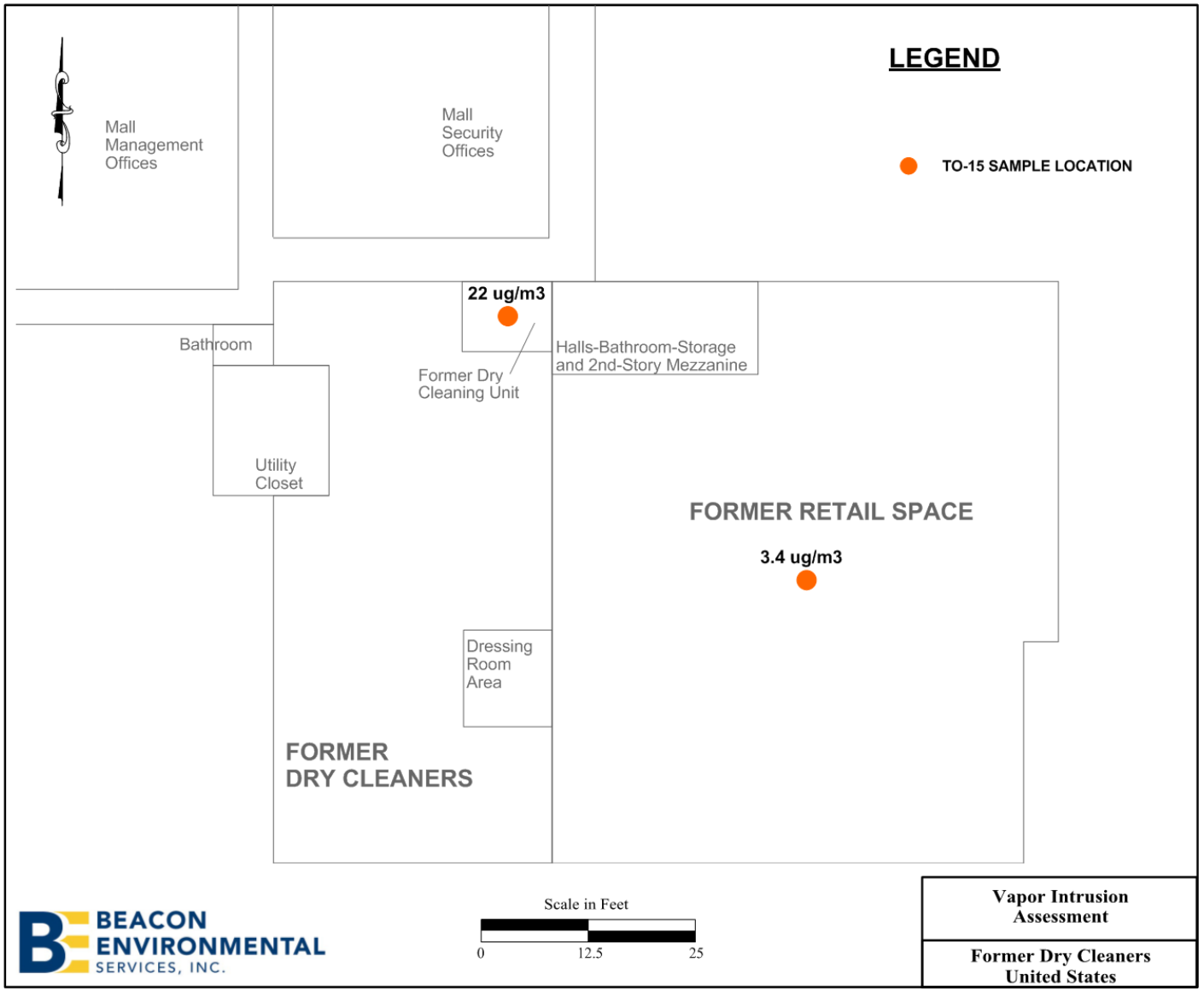

Initial indoor air results within former dry cleaner exceeded state acceptance criteria of 8 ug/m3

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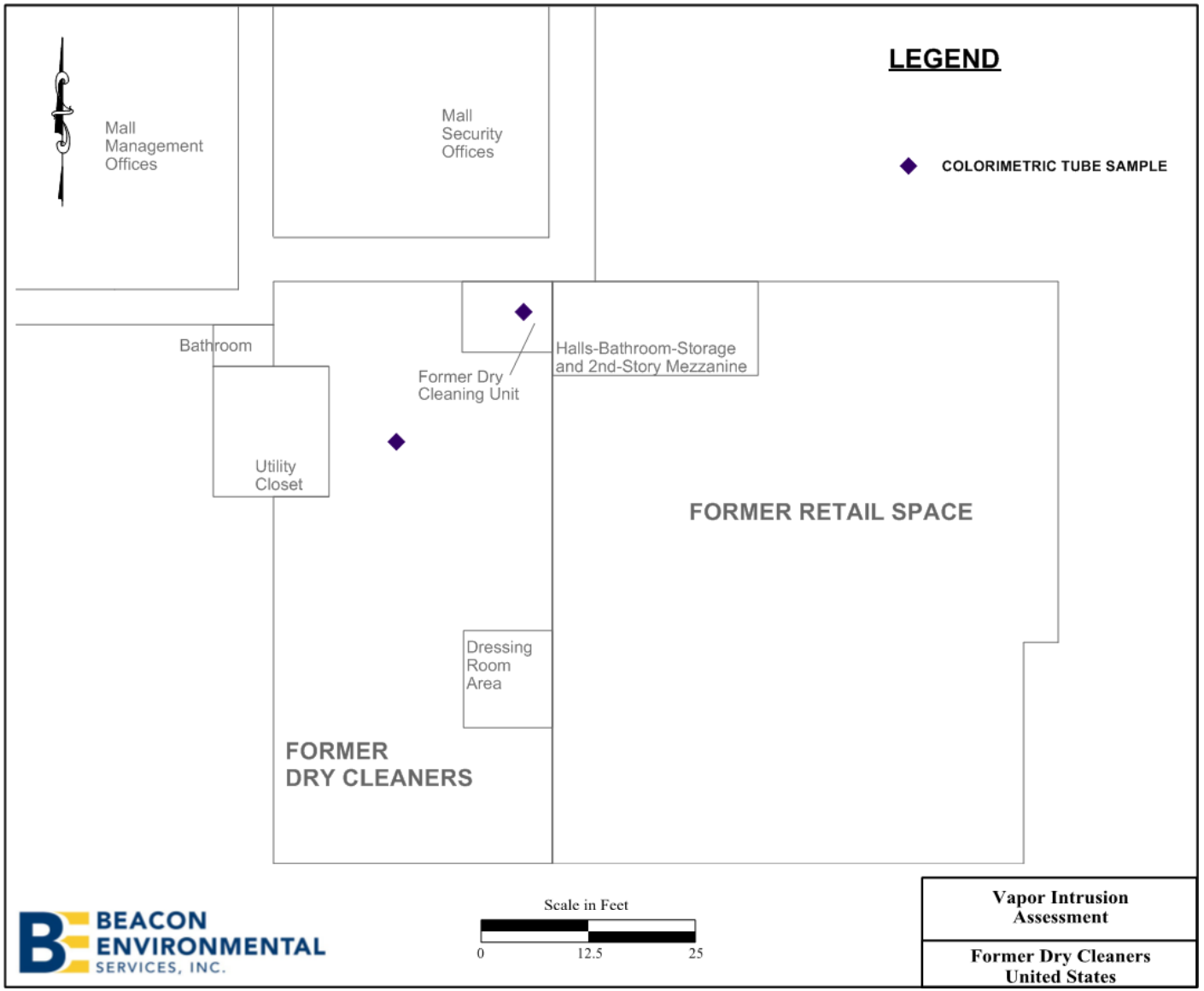

Colorimetric tubes were used to sample subslab soil gas in the area of greatest concern

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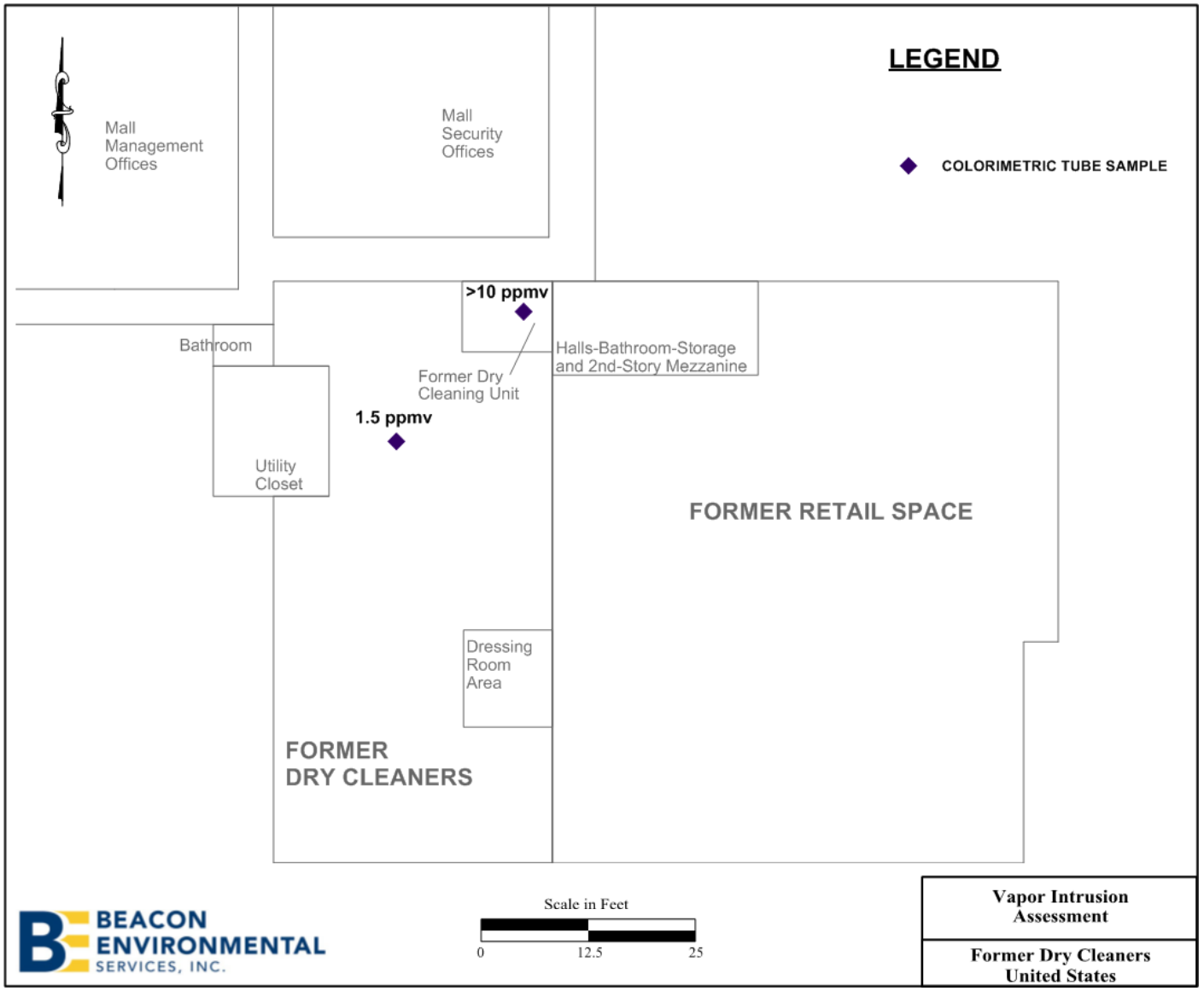

Colorimetric tubes were used to sample subslab soil gas in the area of greatest concern

Measurements suggested further characterization required

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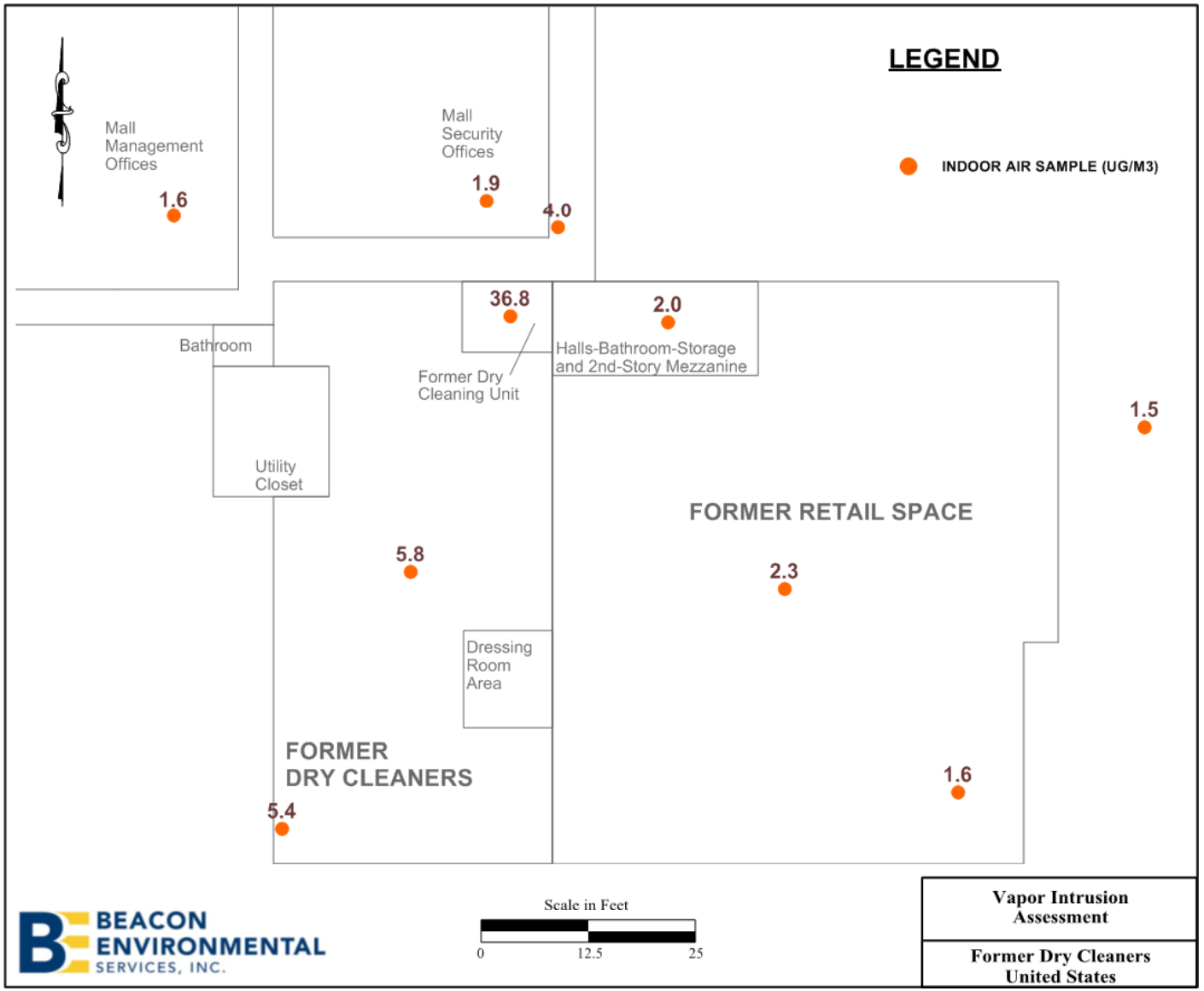

Indoor air samples were collected simultaneously over an 8 hour period using sorbent tubes and low-flow pumps (Method TO-17)

Former dry cleaner of primary concern, but assessed adjacent spaces

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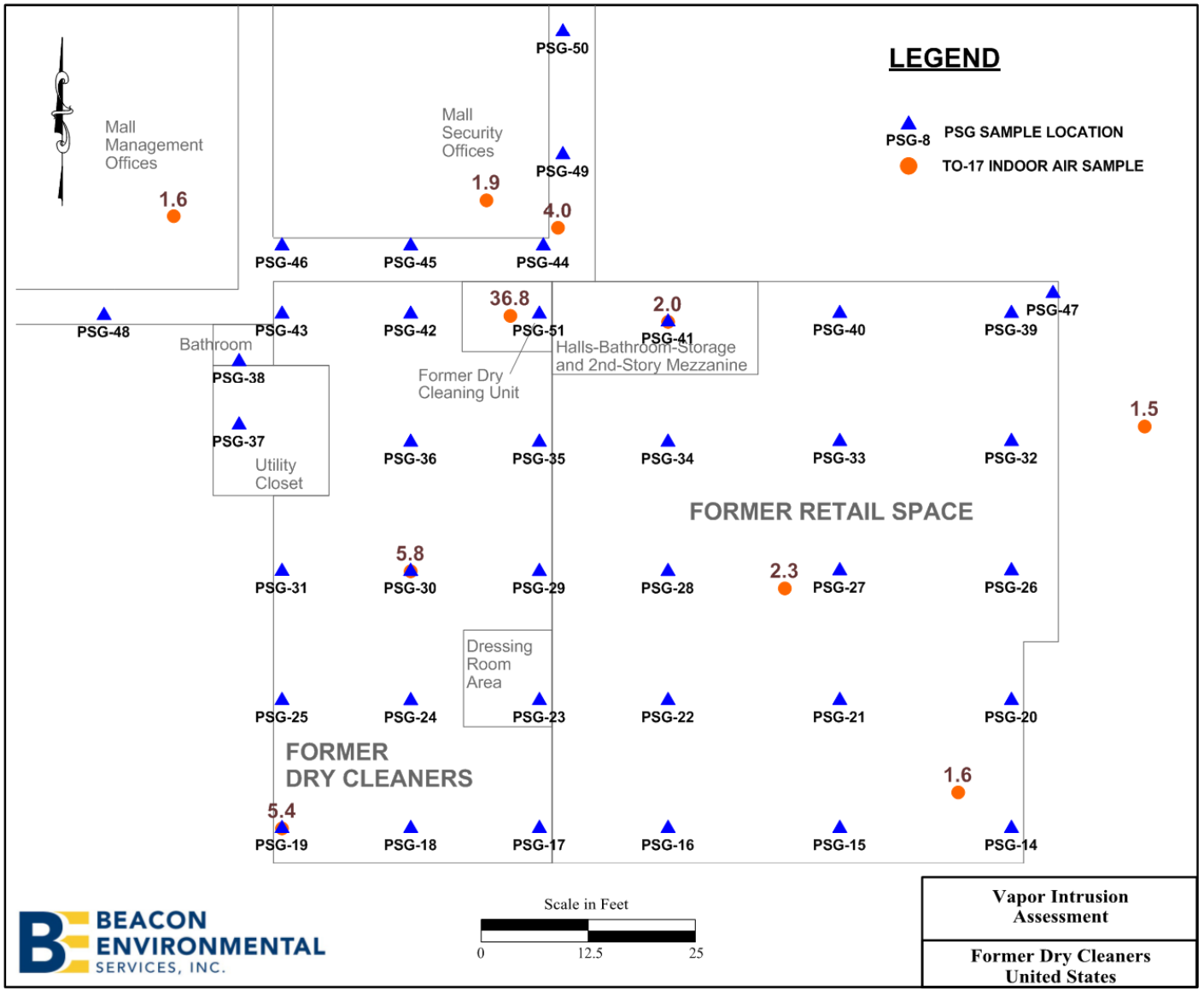

PSG Survey:

Samples collected in grid with 15 ft and 20 ft spacing between sample locations

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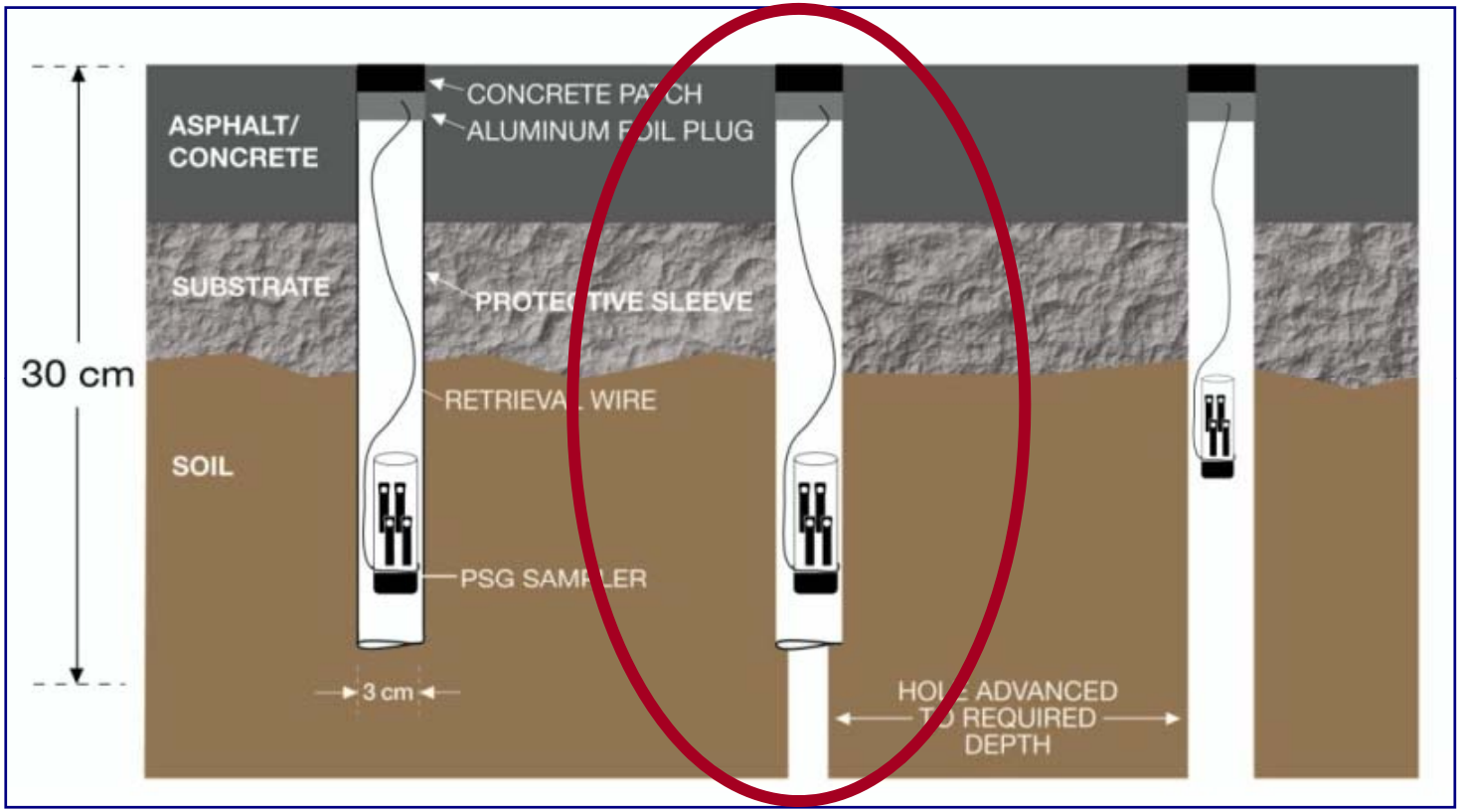
Sampling configuration used



PSG Samplers were installed in holes advanced to a 90 cm depth

Aluminum sleeves (2.5 cm x 30 cm long) were used to protect the samplers from contaminant in gases that can migrate laterally in the more porous subgrade material beneath the surfacing.

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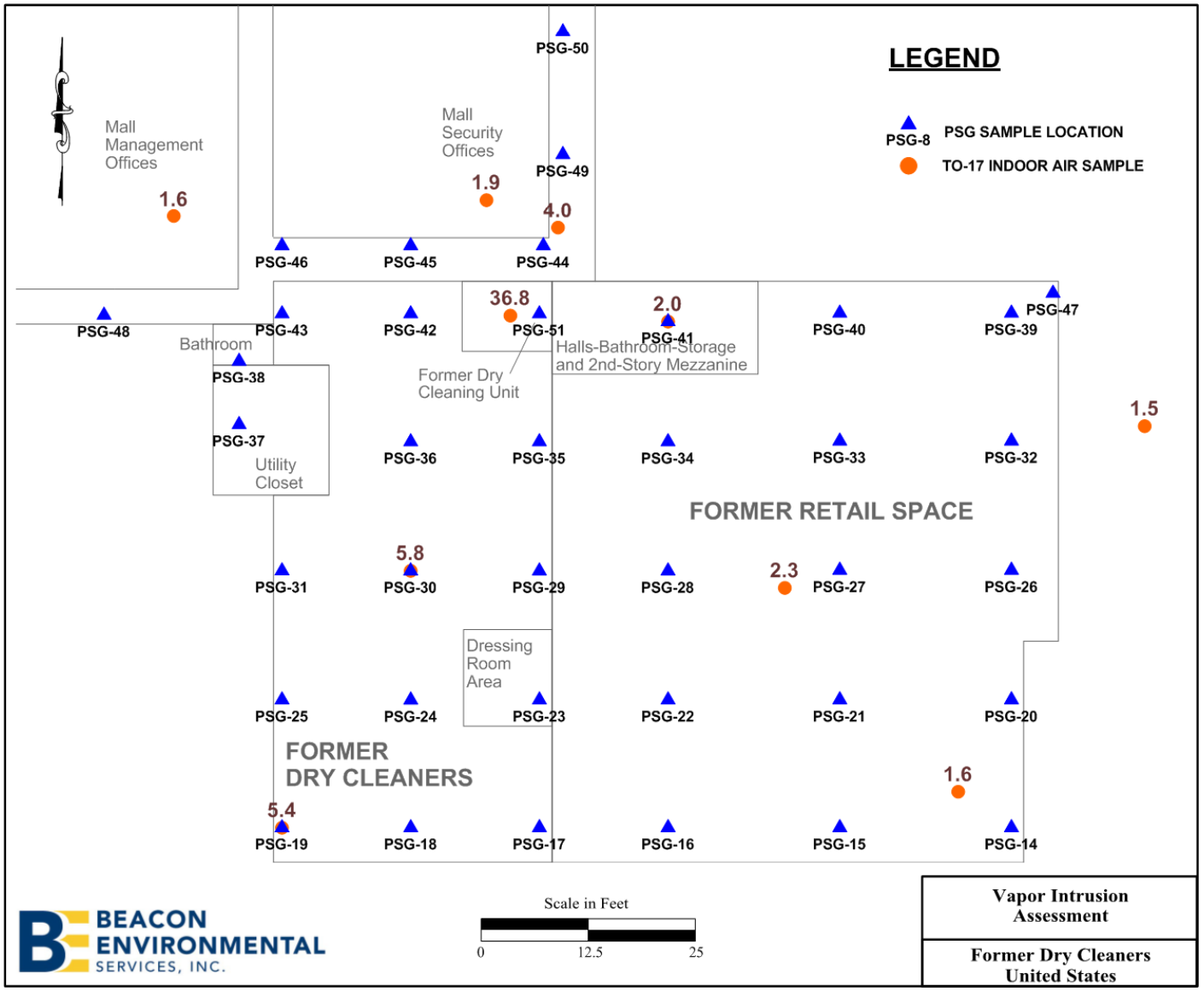

PSG Survey:

Samples collected in grid with 15 ft and 20 ft spacing between sample locations

Installation required 4 hours for a two person team

Exposure period was 7 days

Retrieval required 2 hours

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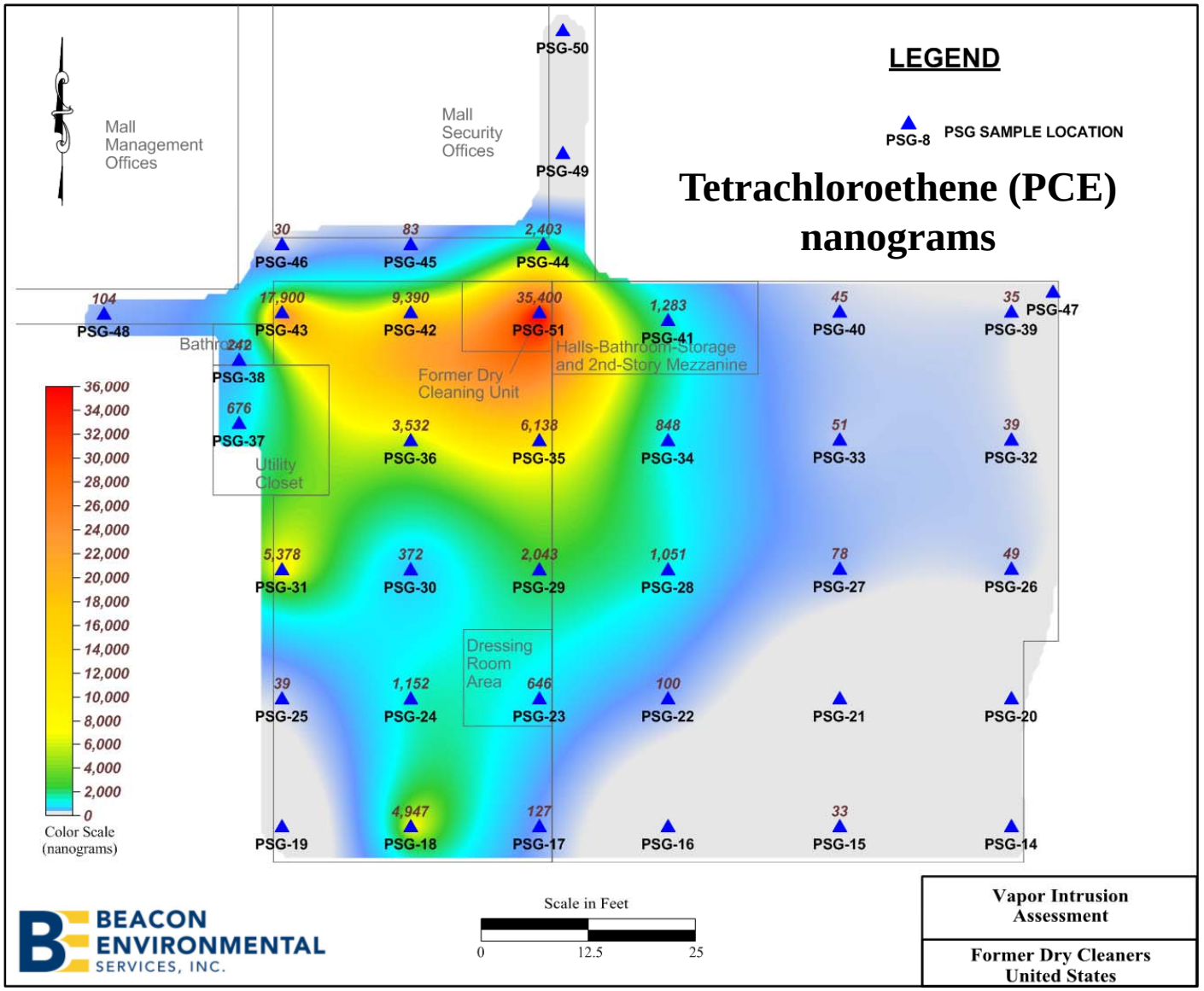

PSG Survey:

Results provided in units of mass

Nanograms (ng)

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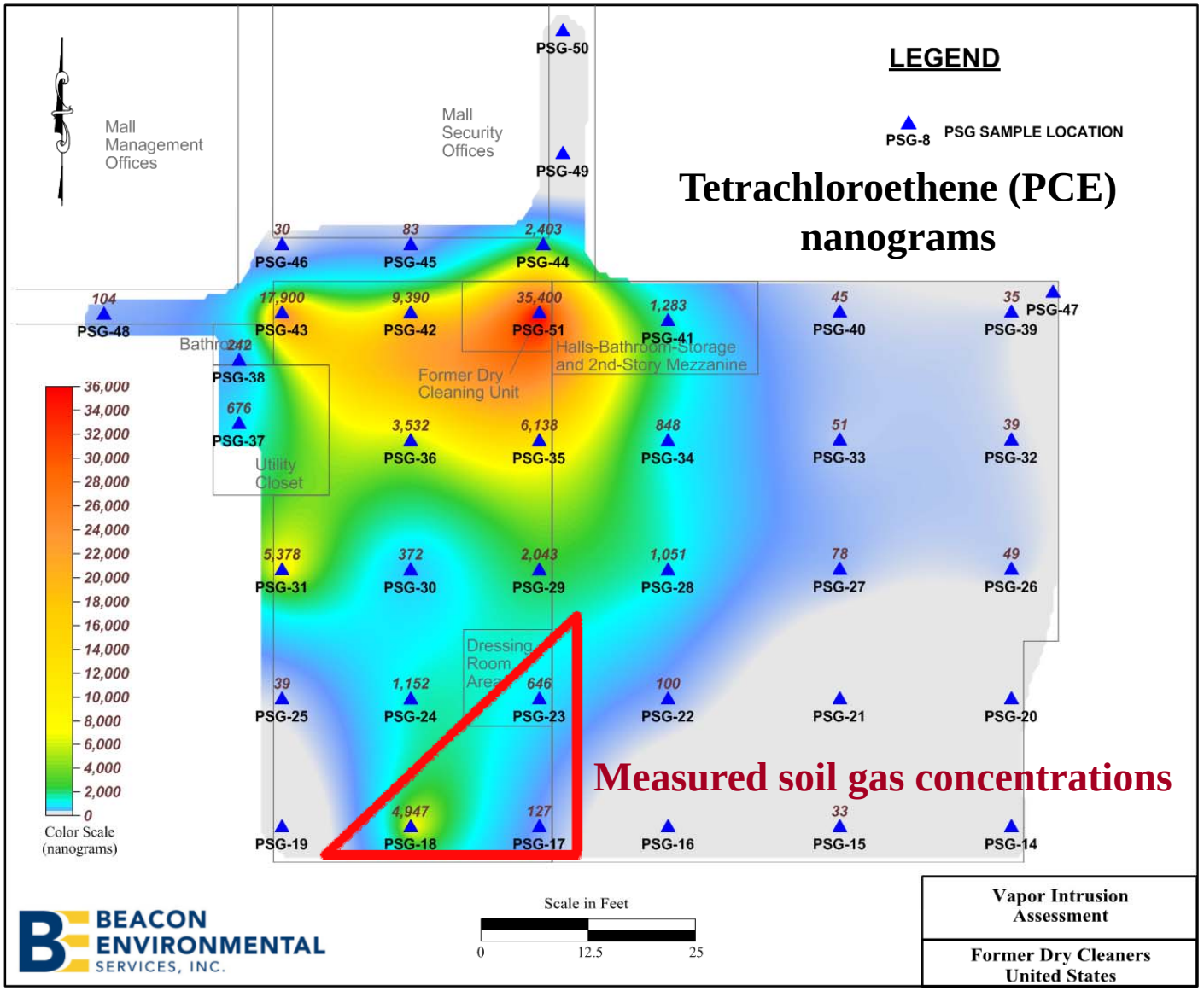

Active Soil Gas:

Soil gas concentrations of PCE were also measured at three (3) locations downgradient from suspected hot spot

Samples collected from 12” depth using sorbent tubes and low flow pumps over 30 minute period

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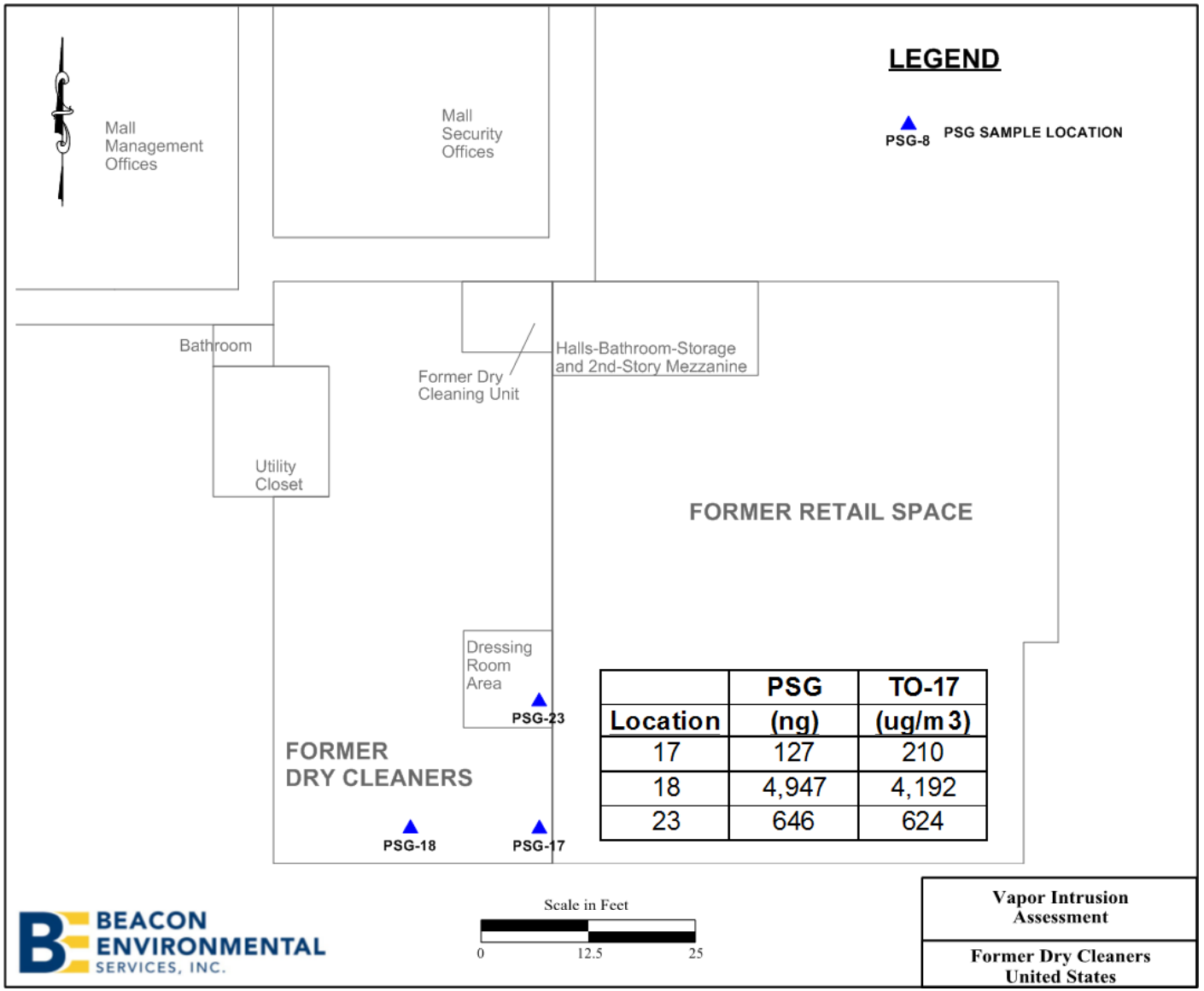

Location	PSG (ng)	TO-17 (ug/m3)
17	127	210
18	4,947	4,192
23	646	624

Comparison of passive and active soil gas measurements

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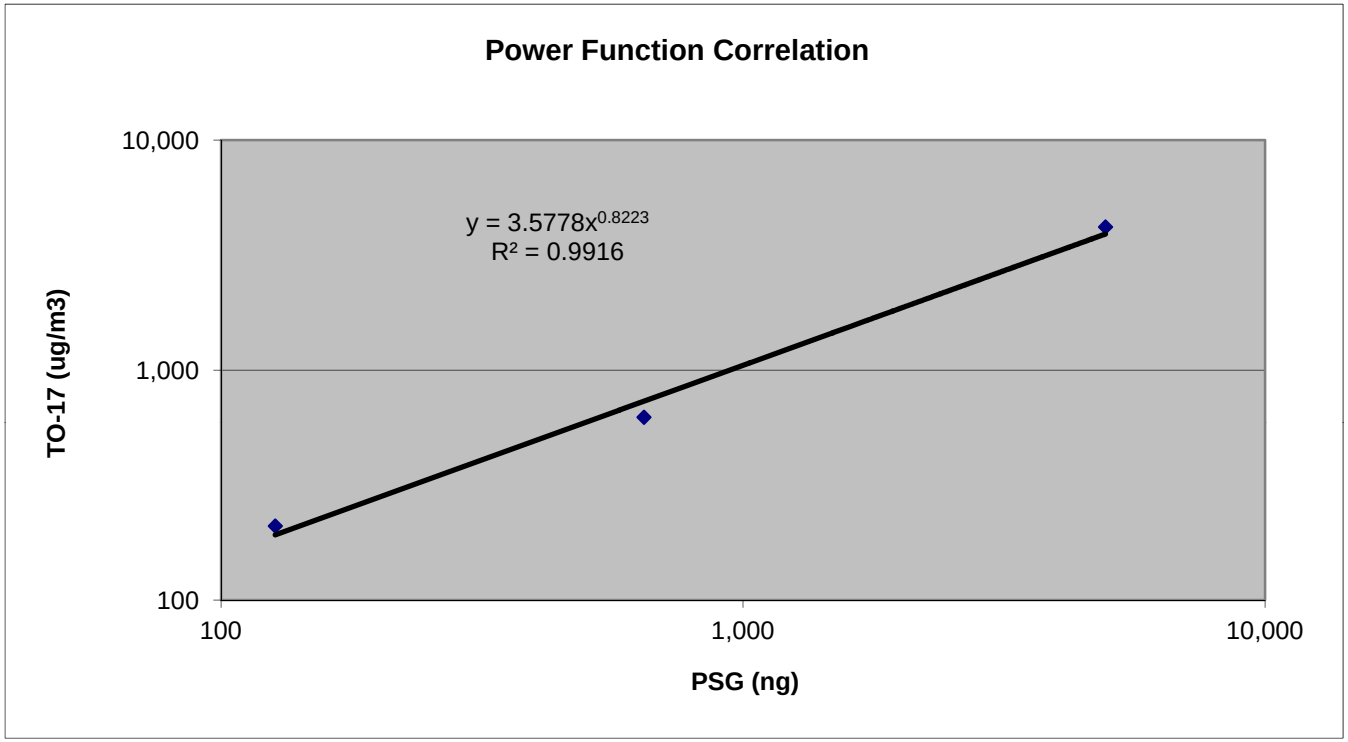
Dry Cleaner Investigation Case Study

Location	PSG (ng)	TO-17 (ug/m3)
17	127	210
18	4,947	4,192
23	646	624



Location	Passive Soil Gas (ng)	Method TO-17 (ug/m3)	Calculated Concentration (ug/m3)	RPD (%)
17	127	210	192	8.9%
18	4,947	4,192	3,904	7.1%
23	646	624	732	15.9%

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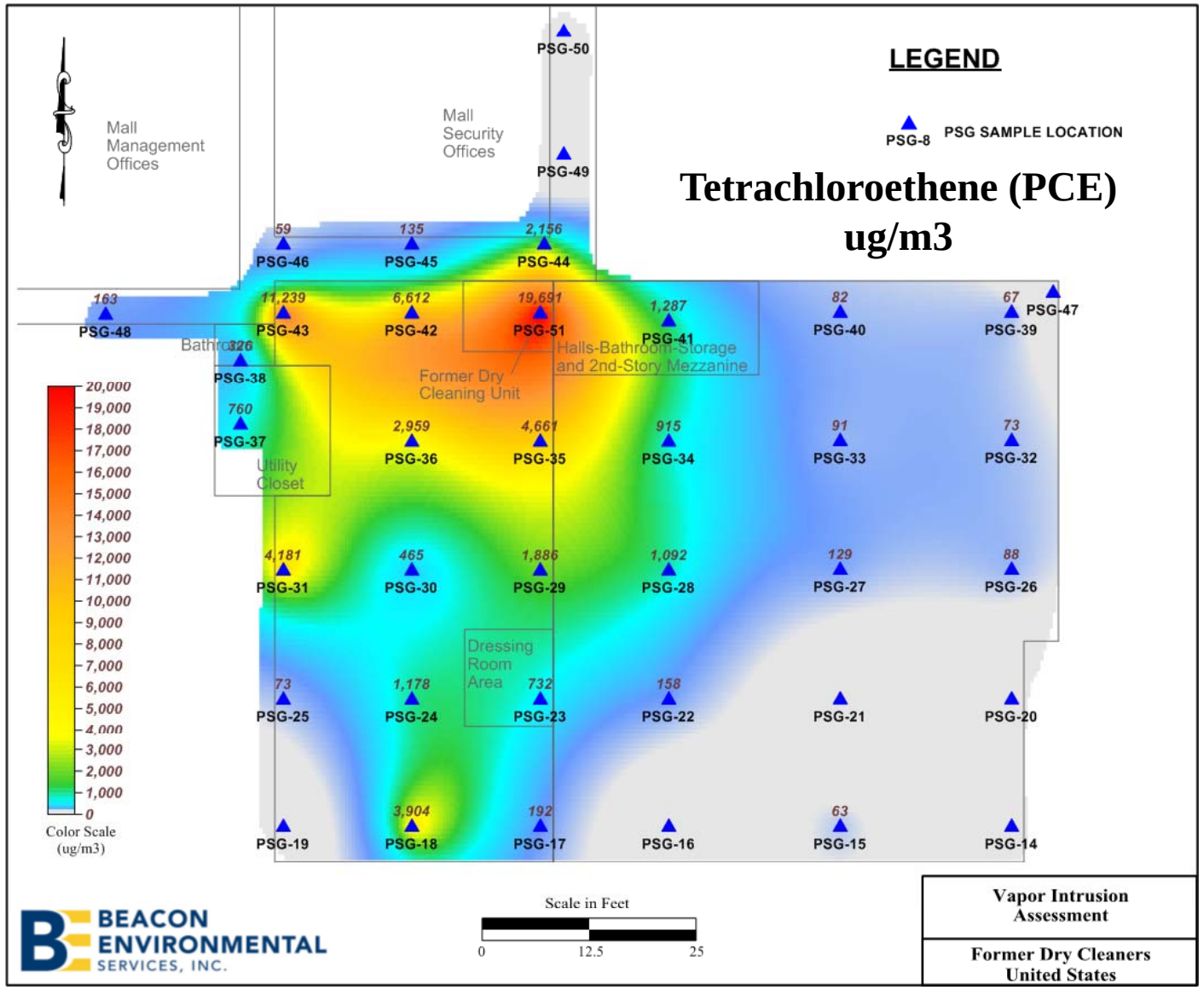

M-to-C Tie In:

Estimated results provided in unit of concentration by applying the power function relationship between soil gas concentration measurements (ug/m3) and PSG results (ng) to all PSG sample locations

Mass-to-Concentration Tie-In

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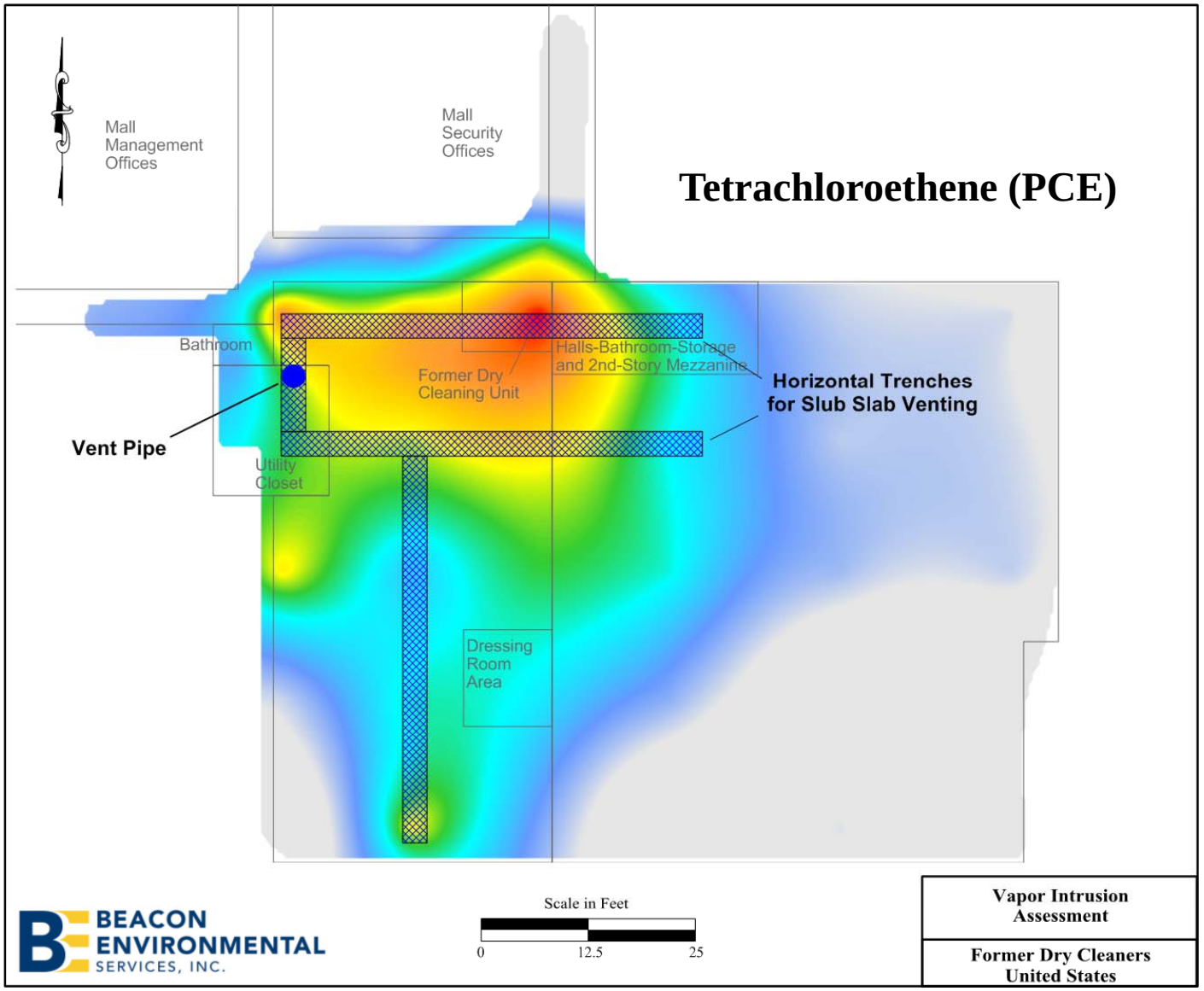

Subslab depressurization system installed

PSG survey focused the design of the system to optimize results

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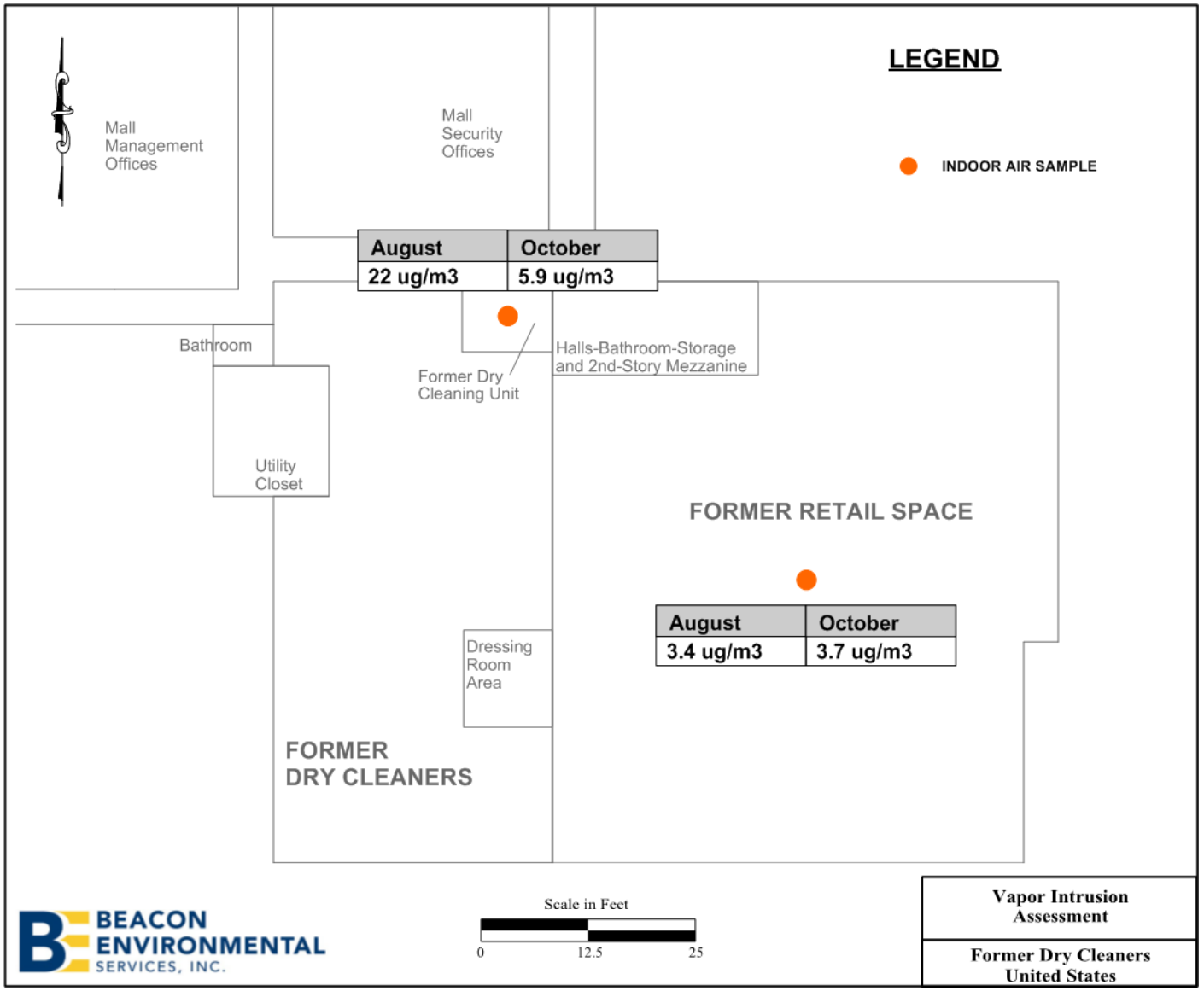

Measured indoor air concentrations in October following installation of depressurization system came down to levels below the 8 ug/m3 action level

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Conclusions

- **Spatial variability in subsurface soil gas concentrations is the norm. A true high resolution site characterization plan significantly increases the probability of identifying whether contamination is present and better defines the lateral extent of contamination… more is better**

- **There is temporal variability in soil gas concentrations and time integrated measurements produce data that is less likely to result in false negatives**

- **PSG Surveys using quality sorbent samplers coupled with a quality analytical method will provide data that best reflects subsurface contaminant concentrations**

- **Sorbent technologies can target a broad range of VOCs and SVOCs and provide a cost-effective means to locate contamination and guide your remediation strategy**

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Any Questions?

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Thank you

Please contact us if you have any questions

or to discuss technology applications:

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PJLA Testing DoD ELAP

PJLA Field Sampling & Measurement Organization

Thank you!

Beacon… We can be your guide

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