



NJDEP Vapor Intrusion Technical Guidance

February 2012





The Importance of VI Training

“The story you are about to hear is true;
only the names have been changed to protect the innocent.”

- Based on several phone calls from LSRPs:
 - Petroleum hydrocarbon (PHC) groundwater plume extends offsite
 - Soil gas and indoor air (IA) samples collected from a large warehouse
 - IA results above Rapid Action Levels (RALs)
- Questions from LSRPs:
 - Who reports the Immediate Environmental Concern (IEC)?
 - When do I get involved in the case?





The Importance of VI Training (cont.)

“Just the facts, ma'am.”

- Warehouse was over 400 feet from the edge of the plume
- Warehouse utilizes petroleum products
- SSSG results ND
- RAL exceedance not a petroleum hydrocarbon
- LSRP had his consulting firm do the investigation without oversight (“not my fault if they mess up”)
- Ignored critical distance criteria “just to be safe”





Basis of the Training



NEW JERSEY DEPARTMENT OF
ENVIRONMENTAL PROTECTION
SITE REMEDIATION PROGRAM

VAPOR INTRUSION TECHNICAL
GUIDANCE



January 2012
(Version 2)

<http://www.state.nj.us/dep/srp/guidance/vaporintrusion/>





Class Overview

Introduction



VI Framework



VI Receptor
Evaluation
(Stage 1)



VI Investigation
(Stage 2)



Break



MLE & Data Evaluation



Petroleum
Hydrocarbons



Mitigation
(Stage 3)



OMM (Stage 4) &
Termination (Stage 5)





NJDEP/Stakeholders VI Guidance Committee

Members:

- **Buddy Bealer, Shell**
- **Ken Bird, Cummings Riter**
- **Brian Blum, Langan**
- **John Boyer, NJDEP (Chair)**
- **Michael Draikiwicz, Novartis**
- **Scott Drew, Geosyntec**
- **Diane Groth, NJDEP**
- **Peter Sorge, JM Sorge**
- **Chad Van Sciver, NJDEP**





History of the Committee

The last 20 months . . .

- Committee formed in May 2010
- Meetings began in June 2010 and were frequently held every 2 weeks
- Draft Revised VIT Guidance (Version 2) released on May 12, 2011
- Comment period ended on June 23, 2011
- Final Revised VIT Guidance document released on January 13, 2012





Summary of the Draft VIT Guidance Comments

The May 2011 Draft VIT Guidance generated:

- Nearly 800 mostly technical comments
- Received from 26 individuals & organizations

The Response to Comments (RTC) spreadsheet constitutes:

- 70 pages
- 597 comments
- Editorial and duplicate comments deleted





VIT Changes Based on Comments

The Final VIT Guidance was modified:

- Removed Community Outreach (Chapter 8) and generic letters/tables (now on NJDEP VI website)
- Combined Data Evaluation & Compliance (Chapter 4) and Multiple Lines of Evidence (Chapter 5)
- Removed duplicate statements throughout VIT
- Properly tied use of “shall” to appropriate regs
- Revised document to reflect technical comments
- Streamlined document from 275 to 178 pages





Meet the ITRC Instructors



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VI Framework

Introduction



VI Framework



VI Receptor
Evaluation
(Stage 1)



VI Investigation
(Stage 2)



Break



MLE & Data Evaluation



Petroleum
Hydrocarbons



11

OMM (Stage 4) &
Termination (Stage 5)



Mitigation
(Stage 3)





Vapor Intrusion (VI) Pathway

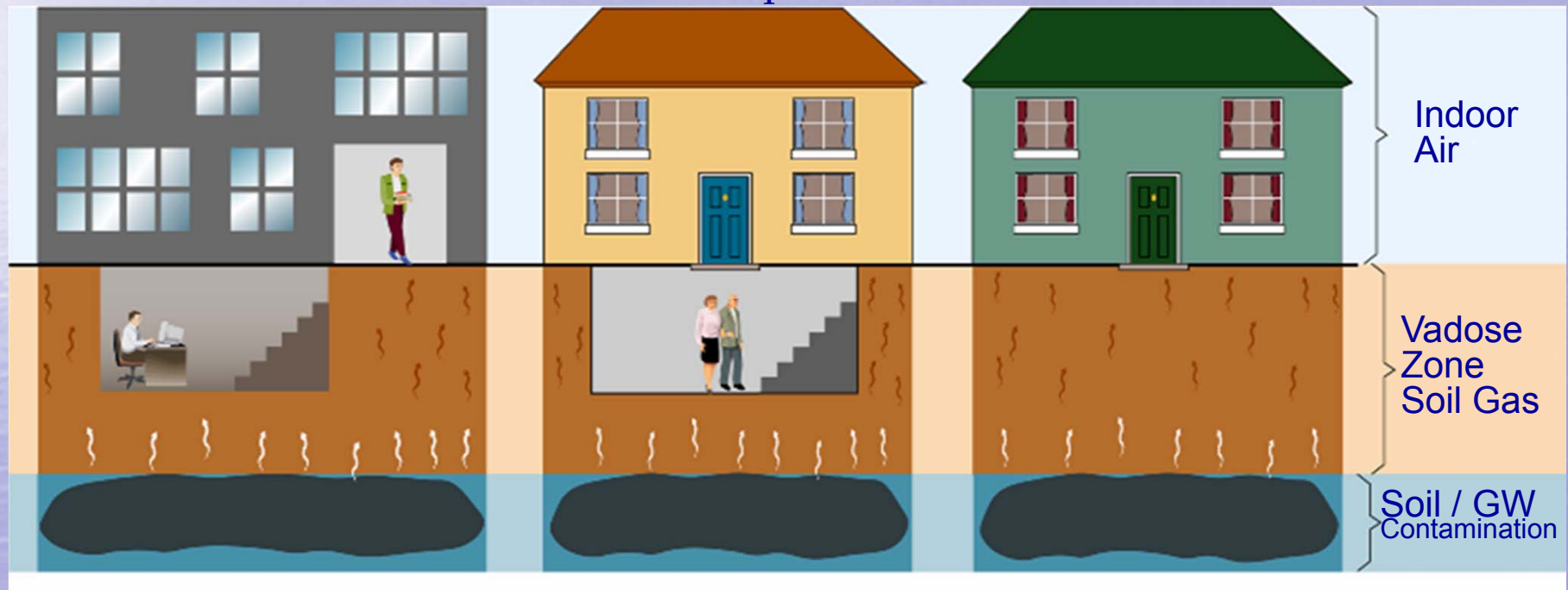
Commercial/Industrial Worker

Resident Living over Plume

Working over Plume

Basement or
Crawl Space

Without Basement



Migration of subsurface vapors to indoor air

Courtesy: ITRC





Vapor Intrusion Screening Levels

The Department's Vapor Intrusion Screening Levels have been removed from the VIT Guidance.



The current version of the VI Screening Levels (March 2007) can now be found at:

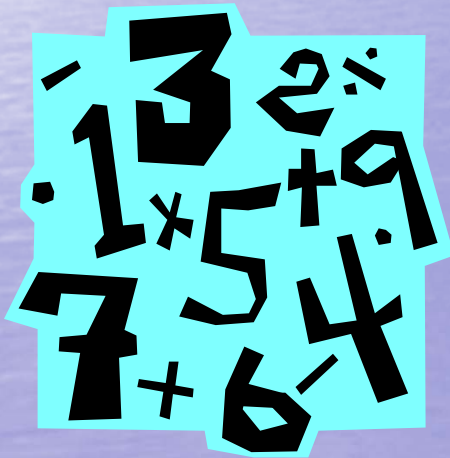
<http://www.state.nj.us/dep/srp/guidance/vaporintrusion/>





Vapor Intrusion Screening Levels

- **Ground Water Screening Level** – Johnson & Ettinger (J&E) with NJ-specific parameters
- **GWSL for Alternative Soil Textures** – Site-specific soil grain size
 - **Indoor Air Screening Level** – residential and non-residential values
 - **Soil Gas Screening Level** – health-based IASLs with 0.02 attenuation factor





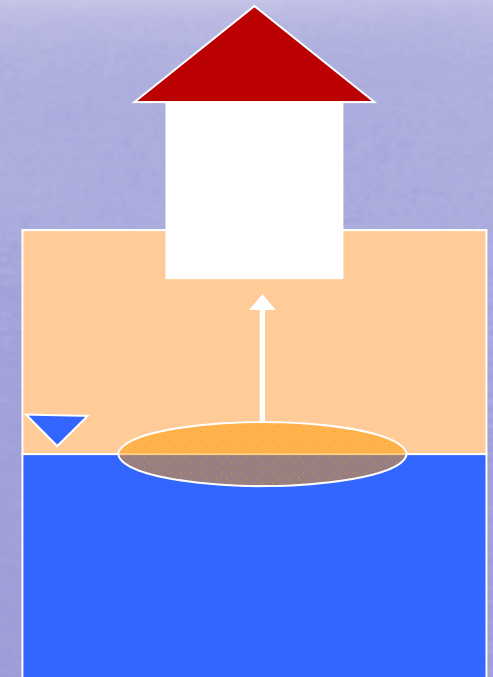
Other VI Screening Levels

Rapid Action Levels (RAL):

- Trigger IEC
- 100X cancer health-based residential IASL
- 2X non-cancer health-based residential IASL

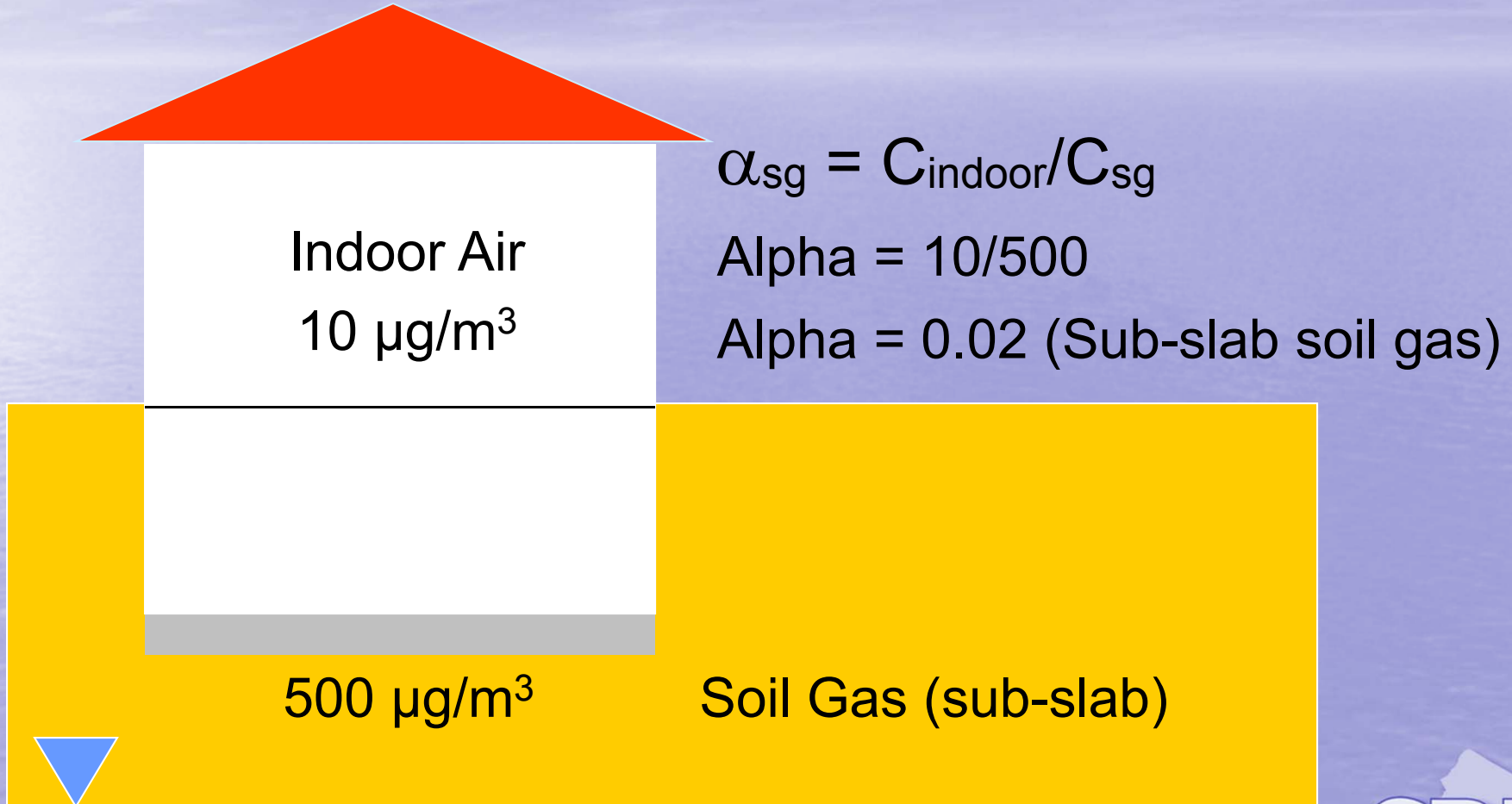
Health Department Notification Levels (HDNL):

- Trigger levels for the immediate notification of the local health department and/or NJDHSS
- Some jurisdiction resides with the Health Department





Attenuation Factor Concept





Critical Distance Criteria

Dissolved petroleum hydrocarbons	30 feet
All other dissolved compounds	100 feet
Free product	100 feet



The critical distance criteria applied to edge of GW plume to determine which buildings are investigated.

- NOT acceptable to collect a GW sample at a distance less than prescribed criteria and assume no contamination implies the VI pathway is incomplete.





VI Receptor Evaluation Triggers

Groundwater Data:

- Dissolved PHCs above GWSL within 30 feet of a building
- Non-petroleum VOCs above GWSL within 100 feet of a building
- Free product within 100 feet of a building

Soil Gas Data:

- Soil gas results above the SGSL

Indoor Air Data:

- Indoor air results above the IASL





Other VI Receptor Evaluation Triggers

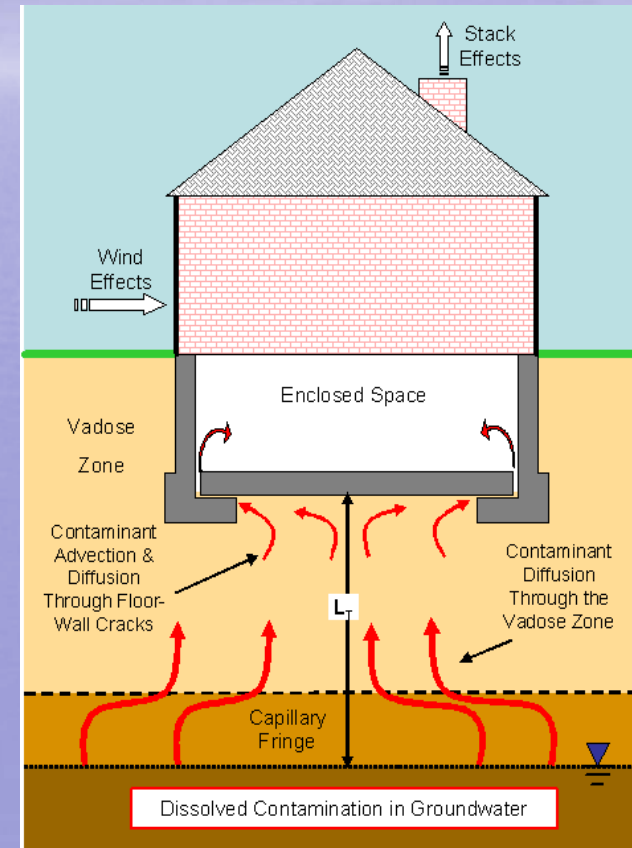
- A landfill located on or adjacent to the site
- A wet basement/sump with free product and/or detectable dissolved compounds
- Potentially explosive methanogenic conditions
- Any other information that indicates human health impact





Multiple Lines of Evidence (MLE)

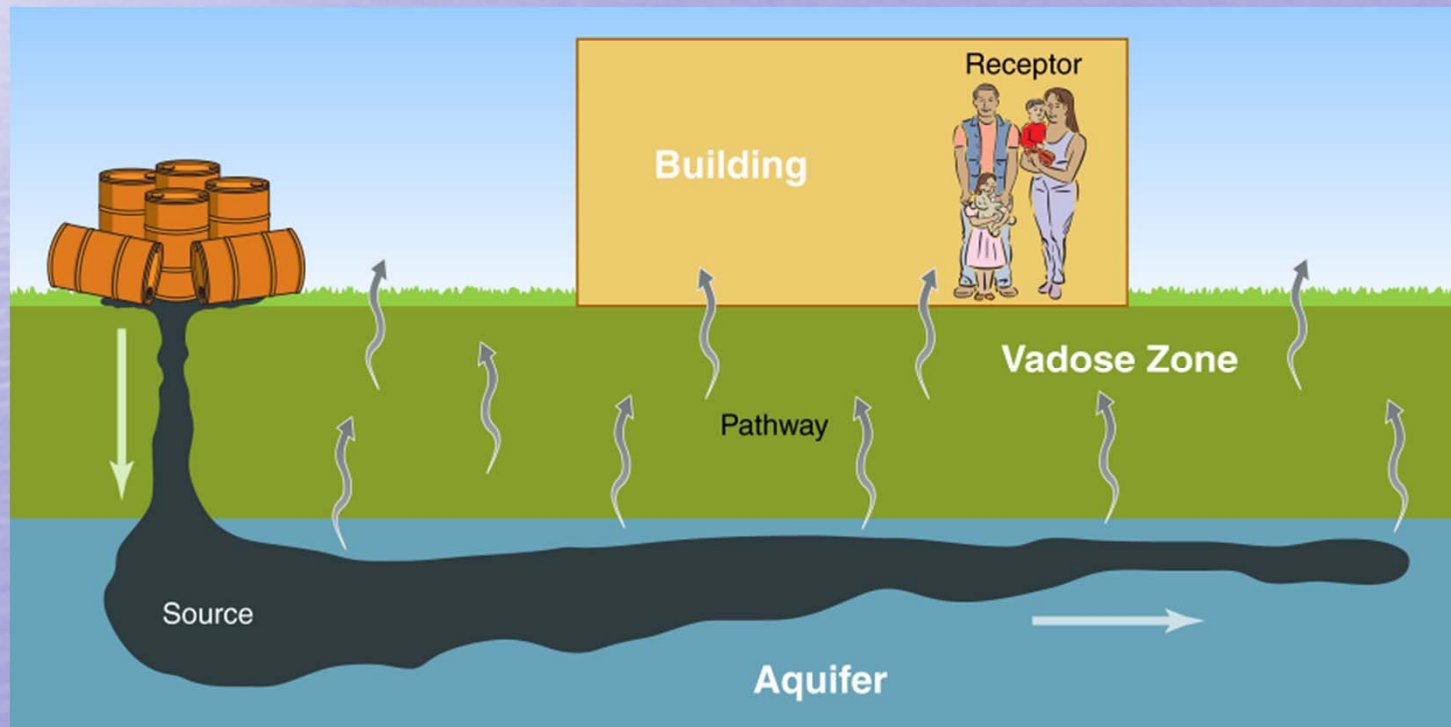
Evaluating more than just one line of evidence is necessary for the VI pathway (unlike other matrices)





Conceptual Site Model (CSM)

Simplified version (pictures and/or descriptions) of a complex real-world system that approximates its relationships





Stages of VI Pathway

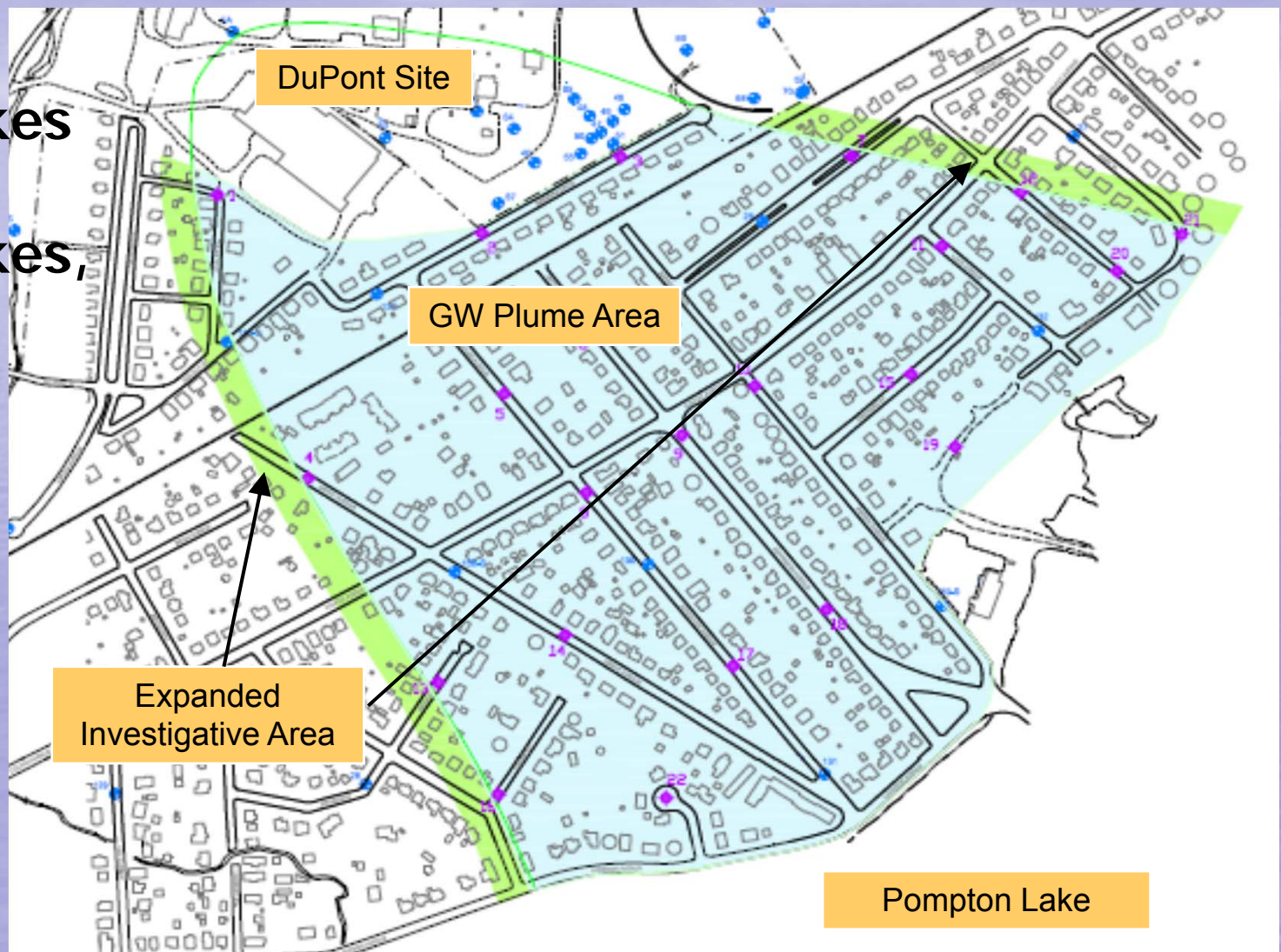
- VI Receptor Evaluation (Stage 1)
- VI Investigation (Stage 2)
- VI Mitigation (Stage 3)
- Operation, Maintenance & Monitoring (Stage 4)
- Termination (Stage 5)





Case Study: Pre-emptive Mitigation

DuPont
Pompton Lakes
Works Site,
Pompton Lakes,
New Jersey





Case Study: Pre-emptive Mitigation

Vapor Intrusion Investigation (March 2008)

- Sub-slab soil gas results
- 7 out of 439 structures sampled
- DuPont decided on pre-emptive mitigation for all 439 structures



	PCE	TCE
Soil Gas Screening Level	16	11
House #1	1,900	860
House #2	680	210
House #3	1,800	640
House #4	3,100	810
House #5	1,600	320
House #6	66	ND
House #7	180	42





Case Study: Pre-emptive Mitigation

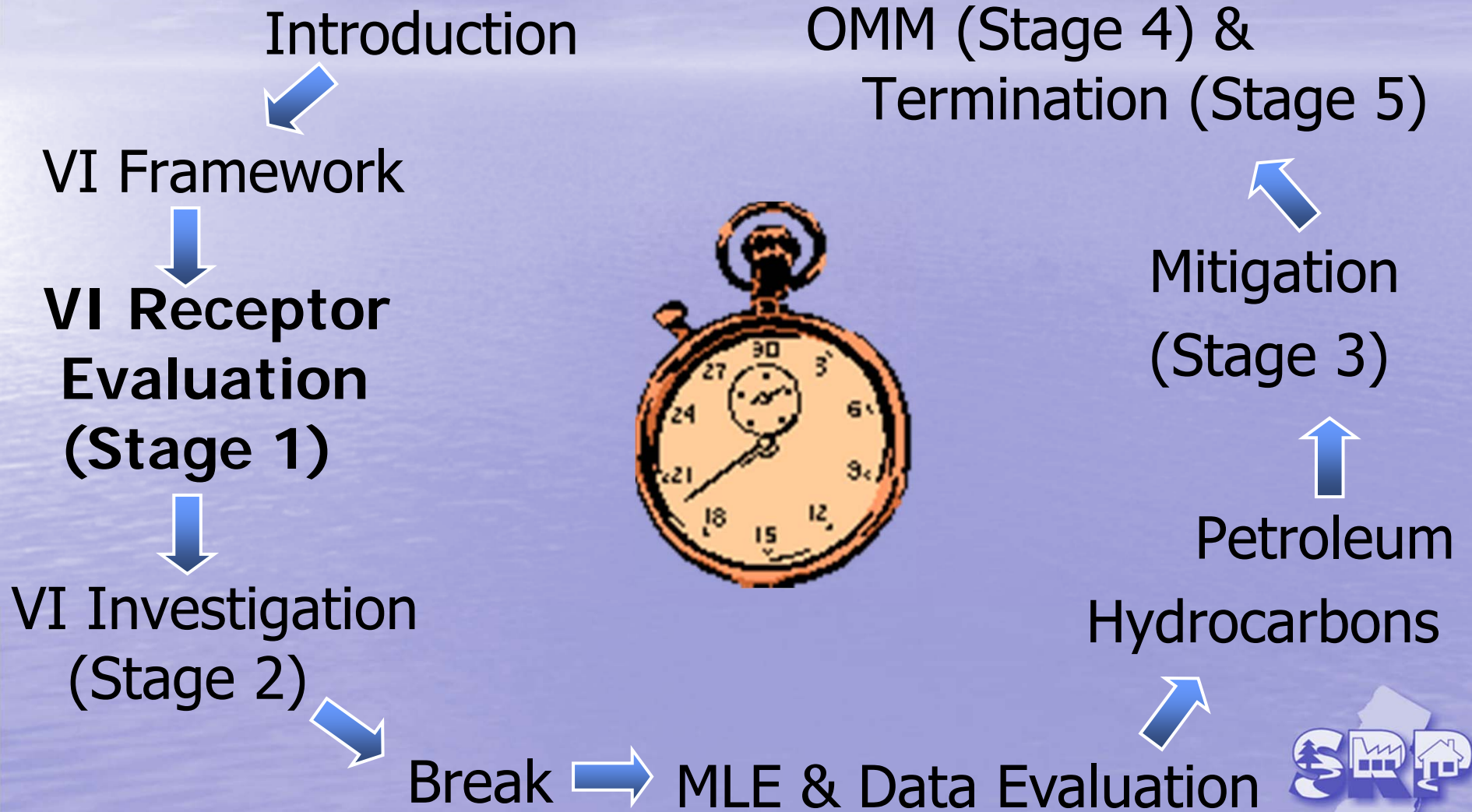
Vapor Interim Remedial Measures Work Plan (June 2008)

1. Investigate a 100-ft. buffer around the perimeter of the GW plume area – referred to as the Expanded Investigation Area (71 structures)
2. Collect sub-slab soil gas and indoor air samples from a representative population of structures – referred to as the Conceptual Site Model Investigation.
3. Verify shallow groundwater plume delineation
4. Pro-active installation of vapor mitigation systems on all structures within the GW plume area – referred to as the Vapor Mitigation Area (439 structures)





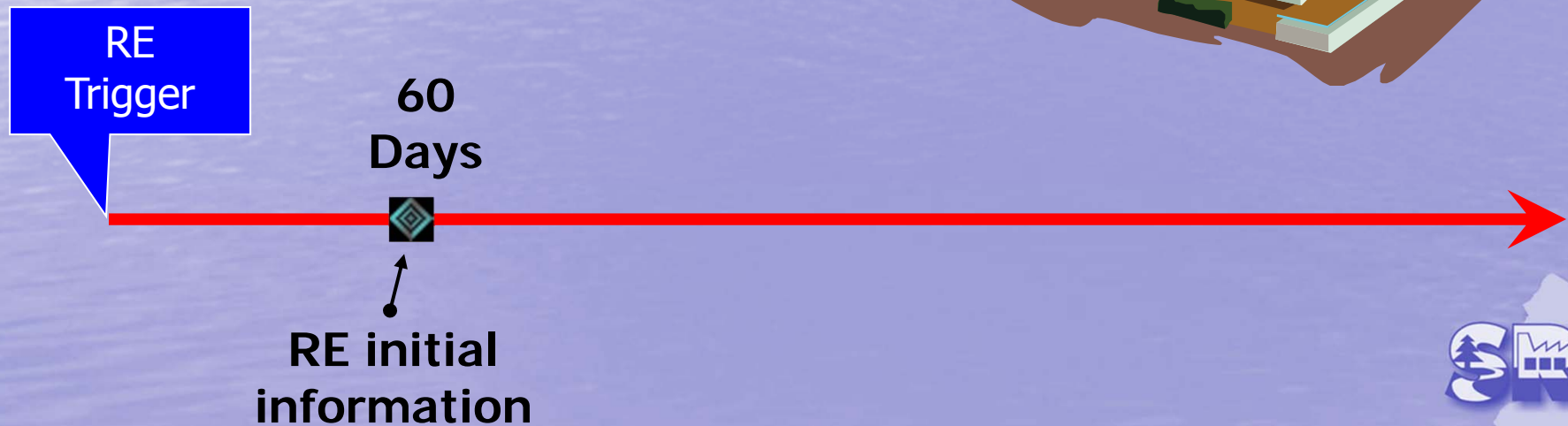
Receptor Evaluation (Stage 1)





Receptor Evaluation Timeframes

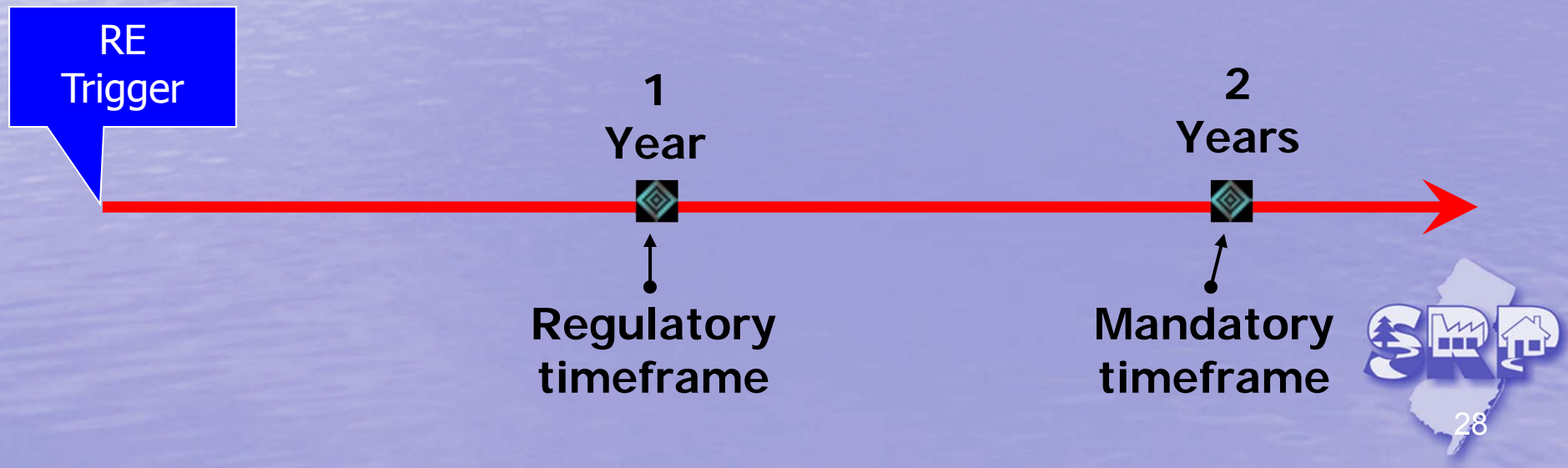
Initial gathering of information to assess potential receptors and routes of exposure based on known limits of contamination or triggers





Receptor Evaluation Submittal

Timeframe for submitting the
Receptor Evaluation Form / Report





VI Receptor Evaluation

Within 60 days of the trigger:

- Identify buildings and subsurface utilities 200 feet from GW contamination or other triggers
- Determine building...
 - Use (e.g., sensitive receptors)
 - Size
 - Characteristics
 - Subsurface utilities
- Establish GW flow direction
- Determine if free product is present





Buildings vs. Structures

Buildings – “an enclosed construction over a plot of land, having a roof, door(s) and usually window(s) that is or can be occupied by people.”

residential, commercial, retail, and/or industrial uses

Structures - “a smaller construction that has limited access capability with minimal exposure potential to those individuals that may enter the structure for a much shorter period of time.”

a shed, small pump house or utility vault.





Preferential Pathway

What are preferential pathways, and when are they significant?

- Site conditions that result in significant lateral transport, enhanced convective flow, or a source within a building
 - Large subsurface utilities (e.g. storm drains)
 - Basement sumps
 - Elevator shafts
 - Shallow rock
 - Vertically fractured soil
- Models typically assume soil gas convection
 - COCs entry into building through cracks is considered common
 - Utility connections not considered preferential pathways





Clarifying Subsurface Utilities

All VI investigations shall assess presence of subsurface utilities pursuant to N.J.A.C. 7:26E-1.18 (b), including use, invert depth, diameter of the conduit, and the construction specifications.

Optional Variance

Typical subsurface utilities (water, gas, etc.) are not identified for residential & other similarly sized buildings.

Exception: when subsurface utilities run through or close to source materials.

- Identify lateral lines serving large residential, commercial, retail or industrial buildings, or main lines serving groups of buildings, as well as utility vaults or underground structures.





Iterative Nature of Receptor Evaluation

Iterative - \ 'i-tə-rā-tiv, -rə-\ involving repetition: as expressing repetition of a verbal action, or relating to or being iteration of an operation or procedure



- As more data are obtained, new buildings are identified that require VI investigation
- RE starts over with new timeframe





Unoccupied Buildings & Vacant Land

Unoccupied buildings

- If the pathway is complete, some form of mitigation will be necessary

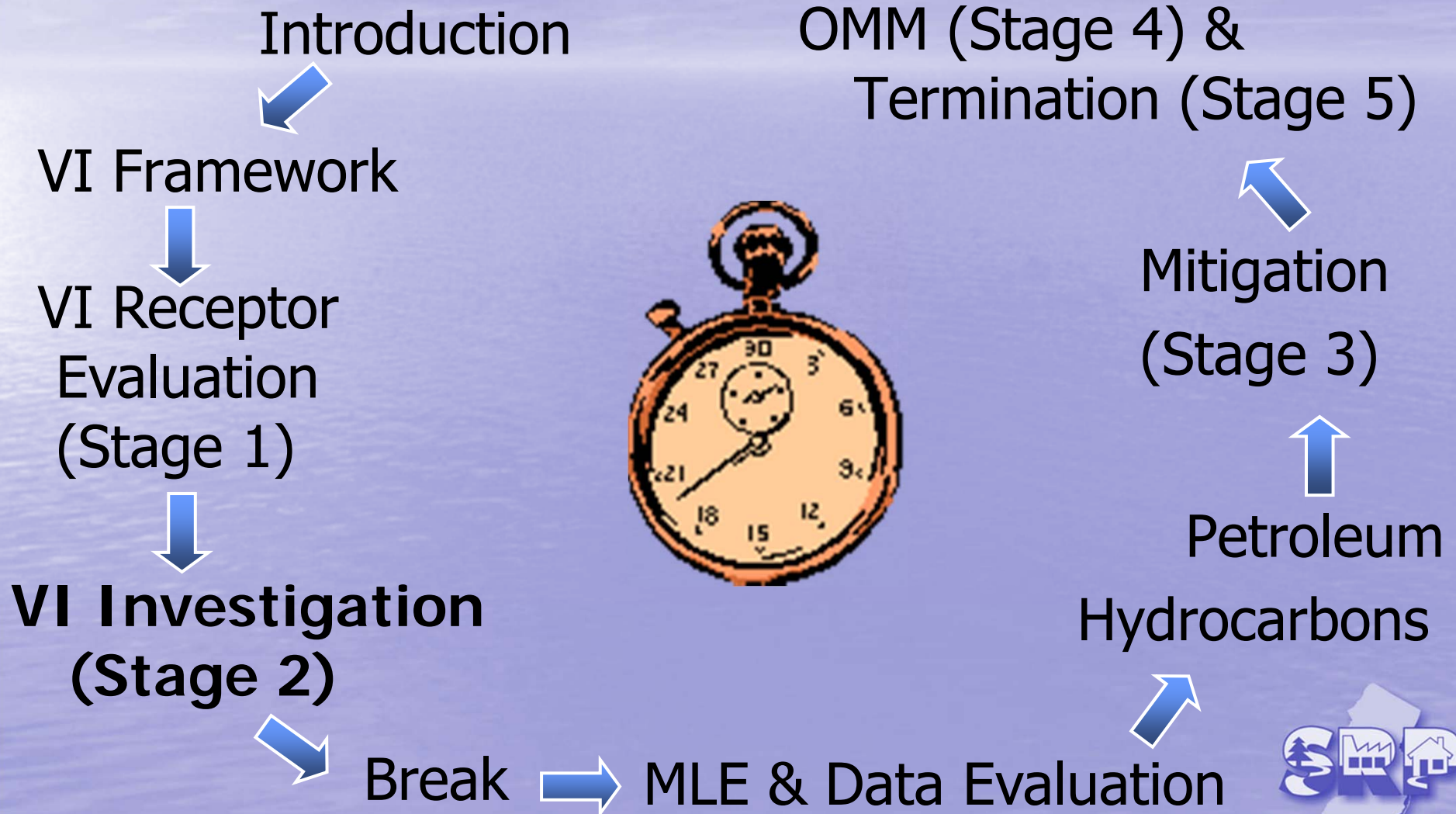
Vacant Land

- The TRSR do not require VI investigation of vacant lands
- Triggers are specifically tied into buildings
- Future use is addressed through CEA and biennial certification





VI Investigation (Stage 2)





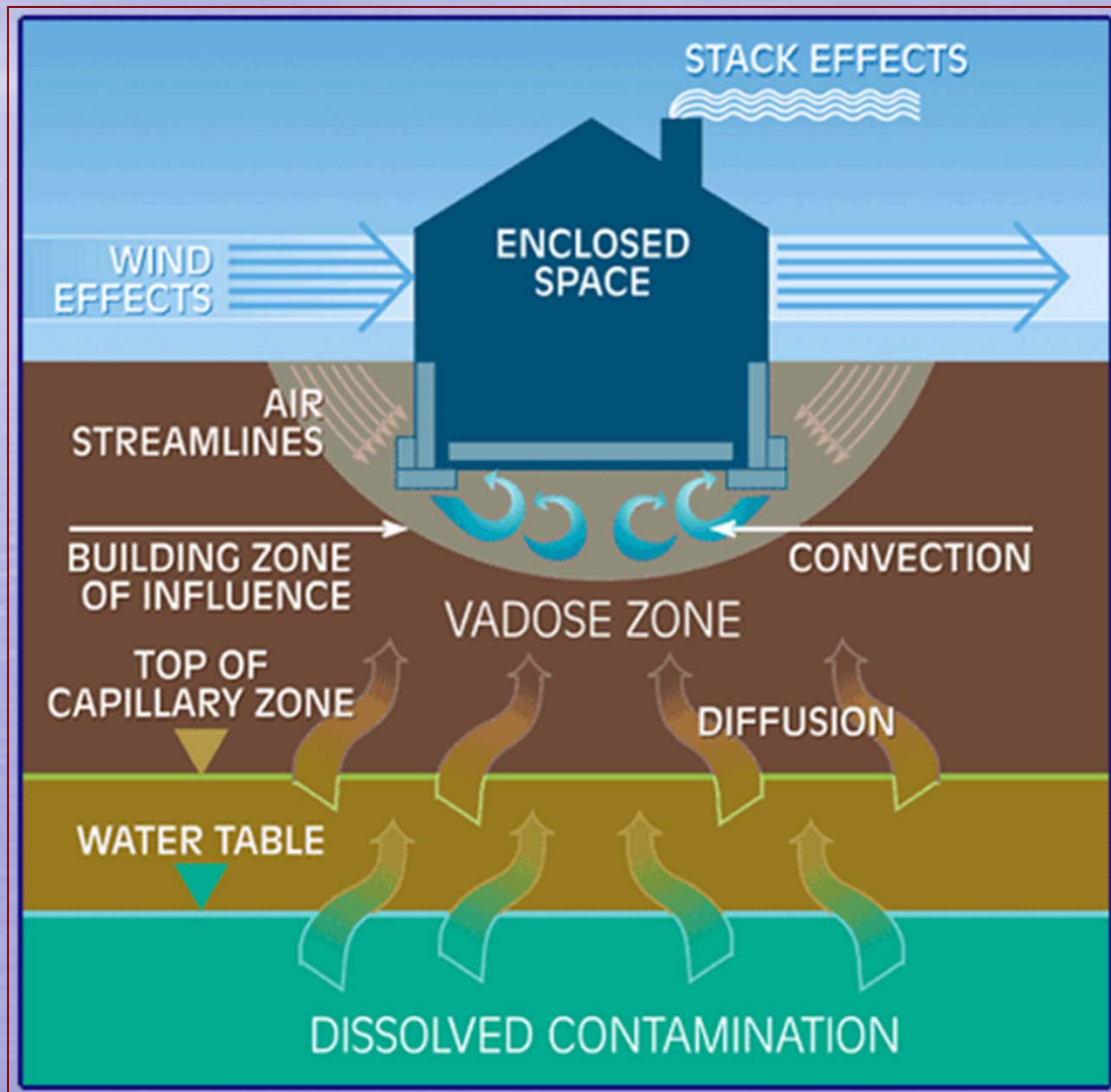
VI Investigation Overview

- Conceptual Site Model (CSM)
- Develop/Implement a VI Investigation
 - Stage 2A - Groundwater
 - Stage 2B - Soil Gas
 - Stage 2C - Indoor Air
- Timeframes
- VCs verses IECs



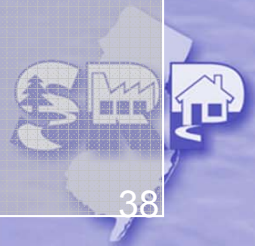
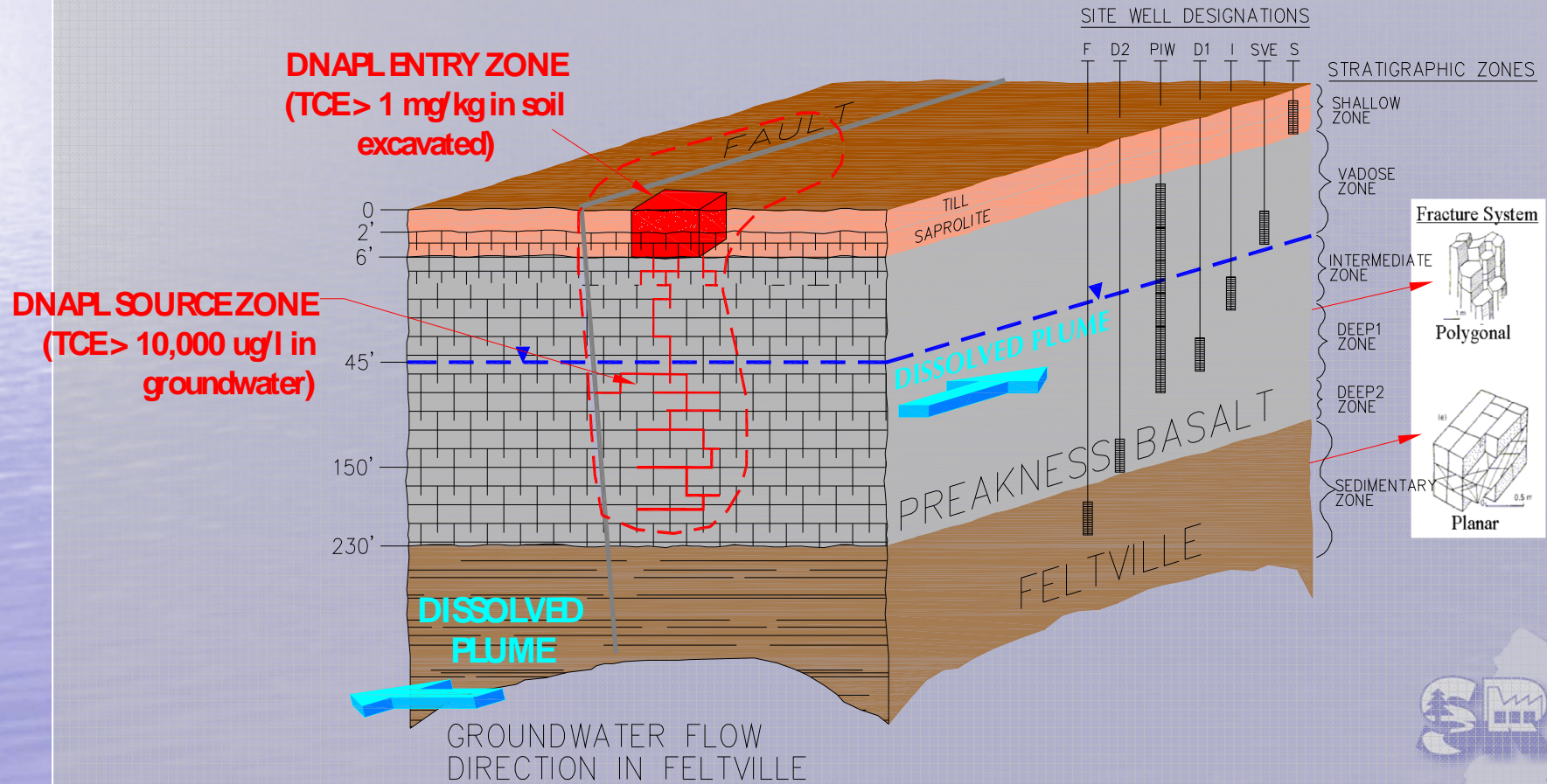


Conceptual Site Model Starting Point





Conceptual Site Model



INTERMEDIATE ZONE TCE PLUME

PARKING AREA

WOODED
AREA

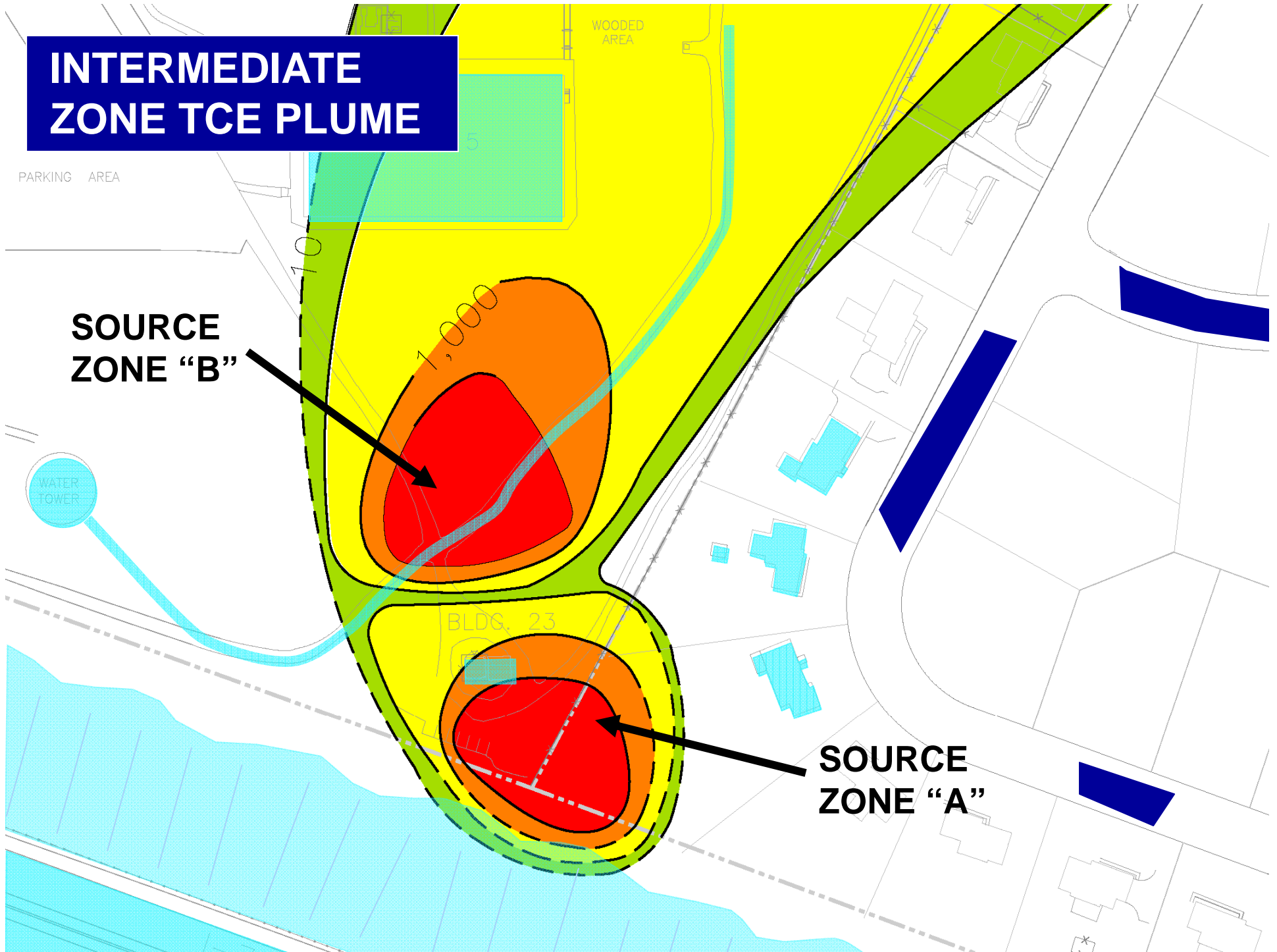
SOURCE
ZONE "B"

1,000

WATER
TOWER

BLDG. 23

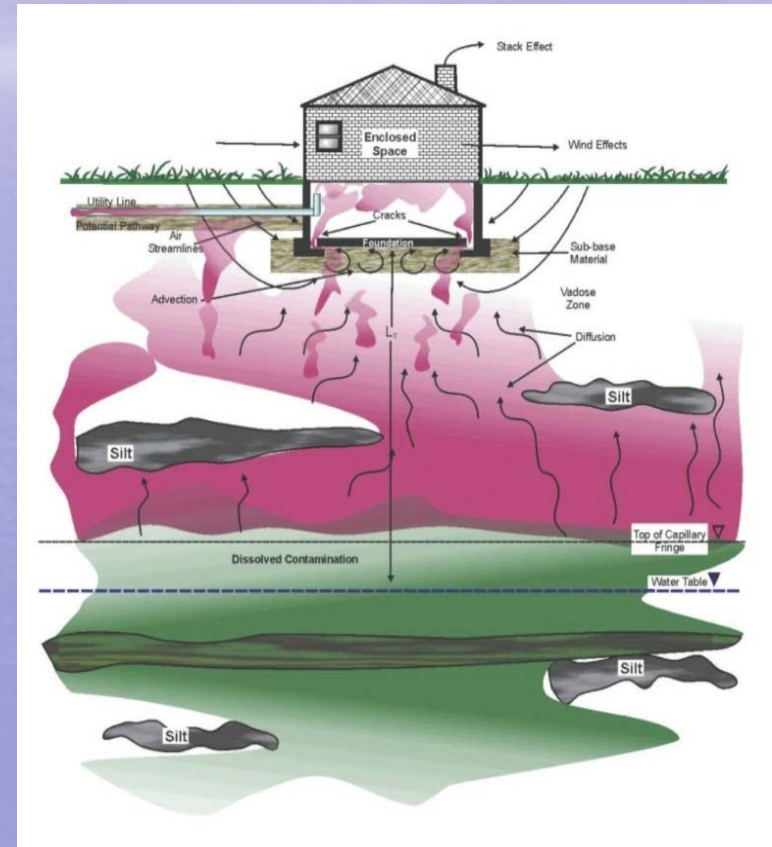
SOURCE
ZONE "A"





Environmental Factors Affecting Transport

- Chemical Type and Concentration
- Source Location
- Groundwater Conditions
 - Fluctuating water table
- Soil Conditions
 - Dry, organic, etc.
- Weather
 - Wind, temperature, etc.
- Biodegradation
- Subsurface Confining Layers





Building Factors Affecting Transport

- Foundation/Slab Type and Integrity
 - Cracking, Joints, Sumps, Waterproofing/Vapor Barrier
- Subsurface Features Penetrating the Building
 - Sewer, Electrical, Gas, Foundation, Elements, etc.
- Operation of HVAC Systems
- Heated Buildings
- Air Exchange Rates





Groundwater Investigation - Stage 2A

1. Saturated Zone Features
2. Acceptable Use of Existing Data
3. Collecting New Data





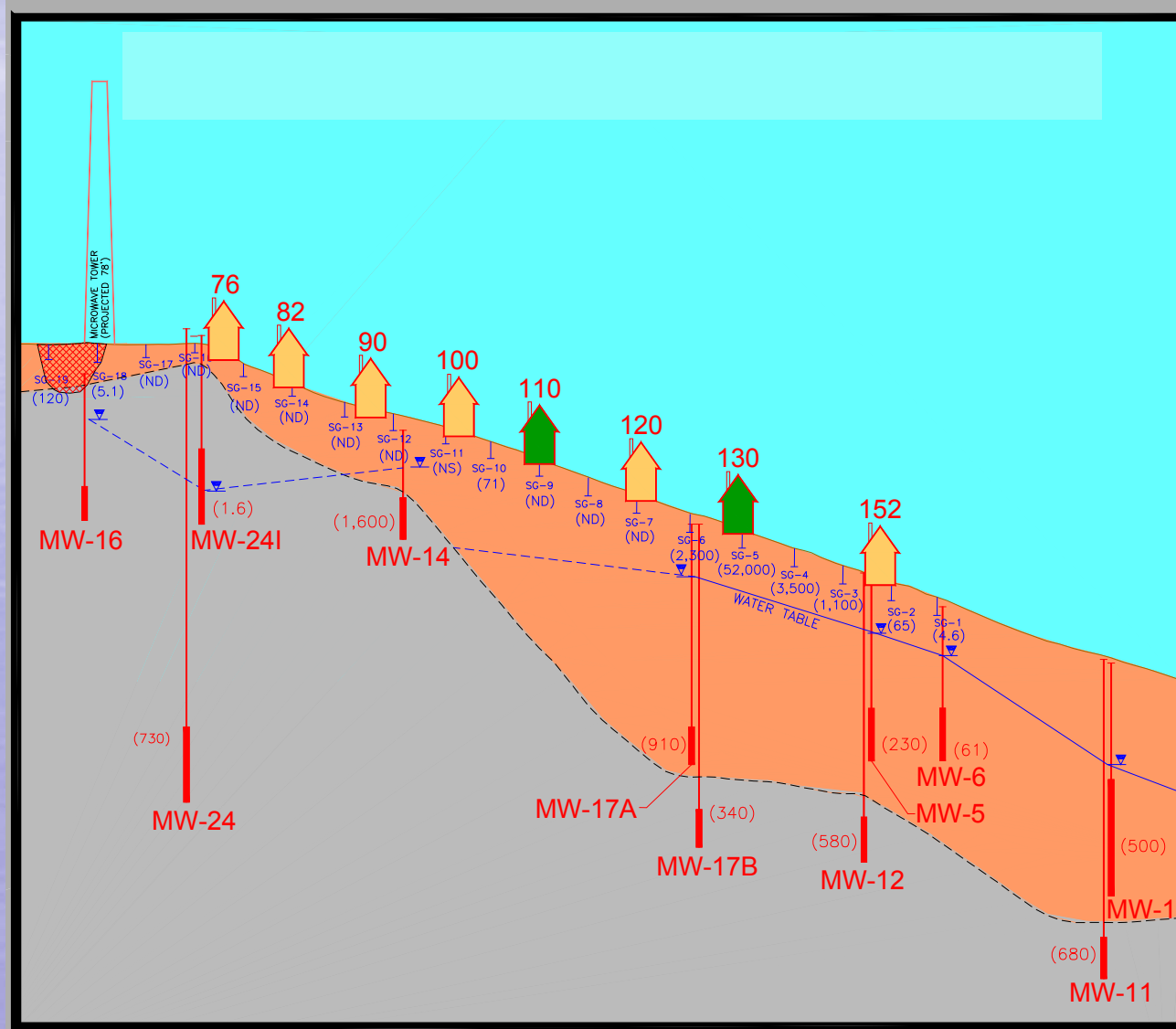
Saturated Zone Features

- Clean Water Lens
 - > 3 ft < 6 ft - Periodic Monitoring
 - > 6 ft - Precludes Stage 2B – Soil Gas Sampling
- Depth to Water
- Stratigraphy
- Proximity to Preferential Pathways





Generalized Cross-Section





Groundwater Existing / New Data

- Properly Constructed Wells and Alternative GW Sampling Methods Data
- Interpolation
- Water Supply Wells

Existing Data

New Data

- 10 ft Screen Across Upper Saturated Interval
- Vertical Profiling – Establish Clean Top 6 ft of the Saturated Zone
 - 0 – 3 ft
 - 3 – 6 ft
 - 6 – 10 ft





Soil Sampling

The Department does not have VI screening levels for soil contamination

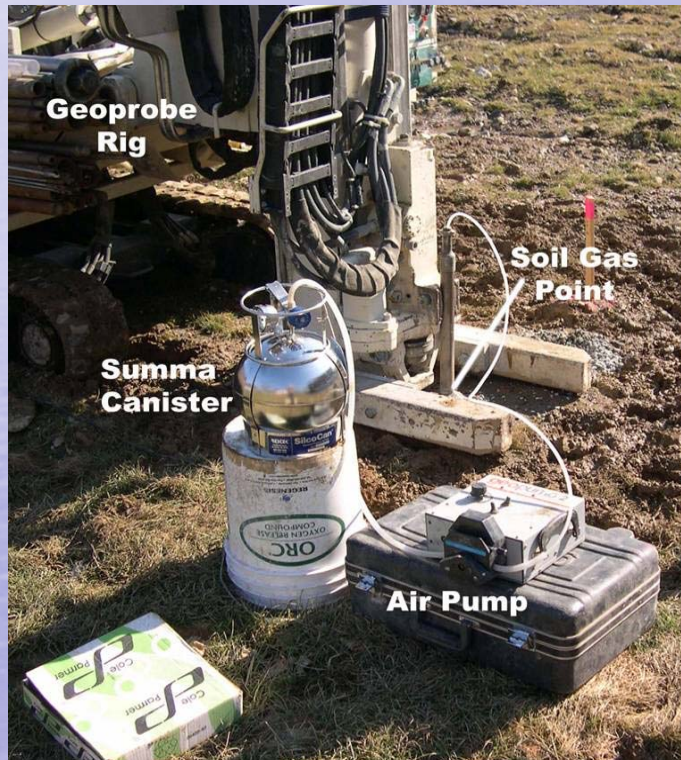
- LSRP should use professional judgment to determine need for VI investigation
- Soil data generally not acceptable in VI investigations to eliminate the pathway
- Sampling – minimize volatile organic compound (VOC) loss





Soil Gas Sampling - Stage 2B

Sub-Slab vs. Near Slab



Typical Soil Gas Sampling



Typical Sub-Slab Vapor Sampling





Soil Gas Sampling

- Sub-slab soil gas sampling is preferred
- TO-15 (NJDEP certified method)
 - 1 Liter Canister
 - 6 Liter Canister
- Alternative methods okay for screening
- Full parameter list expected for initial sampling event
- Perform leak check





Leak Check for SG Sampling

Leak Check - quality control measure to evaluate the potential for dilution of a sample from ambient air.

- Most common type is the helium shroud.
- Helium released into shroud with a target concentration of 10 - 20%
- Use a Tedlar® bag to collect a SG sample
- A leak occurring when helium concentration is $>10\%$ of the concentration within the shroud





Shut-in Test of Sampling Train

- Shut-in test** - Leak check of above-ground apparatus (valves, lines, and fittings downstream of probe)
- Evacuate lines to a measured vacuum ($\sim 100''\text{wc}$)
 - Close valves on opposite ends of the sample train
 - Sampling train tight if the vacuum is maintained after 1 minute
 - If not conducting helium shroud, use shut-in test at each sample location & each sampling event





Minimum Number of SSSG Samples

Square footage of floor	Number of sub-slab samples
Up to 1,500	2
1,501 to 5,000	3
5,001 to 10,000	4
10,001 to 20,000	5
20,001 to 50,000	6
50,001 to 250,000	8
250,001 to 1,000,000	10
>1,000,000	12 +

Fine Print: Numerous features or conditions are included that may alter the appropriate number of samples





Factors Modifying SSSG Sample #s

- Presence of sensitive populations
- past usage (e.g., dry cleaners, vapor degreasers, USTs)
- building construction (separate foundations, type of slab, footers, utility lines etc.)
- presence of earthen or damaged floors
- presence of sump pits
- requests from building owner
- elevator pits
- portion of building overlying or contacting the highest levels of VOCs
- areas of greatest exposure (play rooms, family rooms, class rooms, offices)
- homogeneity and composition of sub-slab material





Near Slab Soil Gas Sampling

- Acceptable under certain circumstances
 - Homeowner refusal
 - Water table within 2 ft of slab
- Limited tool for evaluating VI





Near Slab Soil Gas Sampling (cont'd)

- Sample taken 5 ft bgs
- Sample two sides of building in question
- Bias toward plume and just above saturated zone
- Multiple Lines of Evidence (MLE) approach





Landfill Gas (LFG) Trigger





Landfills and Methane

TRSR require performing VI investigation if landfill is located on or adjacent to a site. Presence of methane-generating conditions that may cause an explosion will also trigger a VI investigation.

- may request a variance from the landfill trigger (N.J.A.C. 7:26E-1.18(a)4.ii) if no other triggers exist at the site that require a VI investigation.
- Landfills and the gas generated from them (LFG) can greatly influence the CSM and the investigative approach.





Building Walkthrough & Survey

Select sampling location & educate building occupant

1. Occupants
2. Building characteristics
- 3 & 4. Outside / inside contaminant Sources



New Jersey Department of Environmental Protection

INDOOR AIR BUILDING SURVEY and SAMPLING FORM

Preparer's name: _____ Date: _____

Preparer's affiliation: _____ Phone #: _____

Site Name: _____ Case #: _____

Part I - Occupants

Building Address: _____

Building Block: _____ Lot: _____

Property Contact: _____ Owner / Renter / other: _____

Contact's Phone: home () _____ work () _____ cell () _____

of Building occupants: Children under age 13 _____ Children age 13-18 _____ Adults _____

Part II - Building Characteristics

Building type: residential / multi-family residential / office / strip mall / commercial / industrial

Describe building: _____ Year constructed: _____

Sensitive population: day care / nursing home / hospital / school / other (specify): _____

Number of floors below grade: _____ (full basement / crawl space / slab on grade)

Number of floors at or above grade: _____

Depth of basement below grade surface: _____ ft. Basement size: _____ ft²

Basement floor construction: concrete / dirt / floating / stone / other (specify): _____

Foundation walls: poured concrete / cinder blocks / stone / other (specify) _____

Basement sump present? *Yes / No* Sump pump? *Yes / No* Water in sump? *Yes / No*

Type of heating system (circle all that apply):
hot air circulation hot air radiation wood steam radiation
heat pump hot water radiation kerosene heater electric baseboard
other (specify): _____

Type of ventilation system (circle all that apply):
central air conditioning mechanical fans bathroom ventilation fans
individual air conditioning units kitchen range hood fan outside air intake
other (specify): _____

Type of fuel utilized (circle all that apply):
Natural gas / electric / fuel oil / wood / coal / solar / kerosene



Building Walkthrough & Survey

Select sampling location & educate building occupants

5. Misc items – IA quality

6. Sampling info

7. & 8. Weather / general observations (e.g., occupancy exposure)





Indoor Air Sampling – Stage 2C





Indoor Air (IA) Sampling

- Option 1 – Collect IA sample after soil gas results are known to exceed SGSL
- Option 2 – Collect and analyze IA sample concurrently with soil gas sample
- Option 3 – Collect IA and soil gas concurrently. Analyze IA only if triggered by soil gas results (most common).

Do not collect IA where current operations handle the same COCs





Typical IA Sampling Sequence

- Setup 6-liter canister for 24 hr sample collection (8 hr sample with proper technical justification)
- Collect ambient air samples during the same time period as IA
- Upon completion of IA sampling, proceed to SSSG sampling





Ambient Air Sampling

- provides background concentrations outside of the building being investigated
- should have the same sample collection time and be analyzed in the same manner as the interior sample
- Location:

Residential - at breathing zone height & in close proximity to building (not near trees)

Commercial - may elect to collect near HVAC intake locations





Minimum Number of IA Samples

Square footage of floor	Number of indoor air samples
Up to 1,500	1-2
1,501 to 5,000	2
5,001 to 10,000	3
10,001 to 20,000	4
20,001 to 50,000	5
50,001 to 250,000	6
250,001 to 1,000,000	7
>1,000,000	9

Fine Print: Numerous features or conditions are included that may alter the appropriate number of samples





Indoor Air Sampling

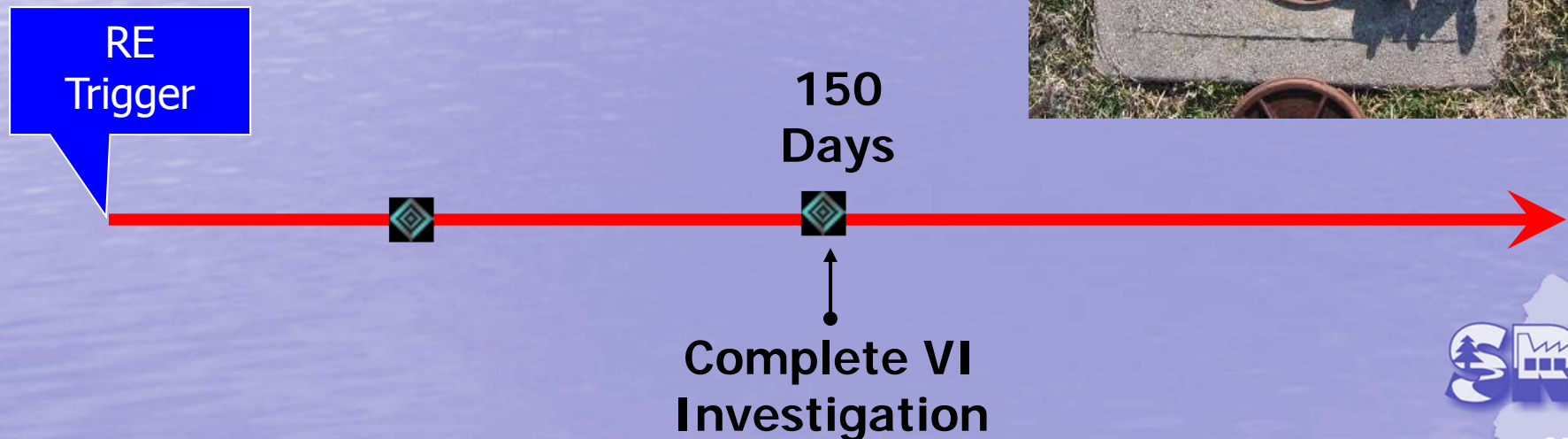
- Take potential exposure / pathway into account
- Sample basements or lowest floor space
- Sample crawl space / first floor as a contingency
- Sample elevator pits
- Sample November 1 to March 31
- April 1 to October 31 okay if COC results are an order of magnitude below IASL





VI Investigation Timeframe

Based on the initial gathering of information during the receptor evaluation, the VI investigation is conducted





VI Investigation

Within 150 Days of the RE Trigger:

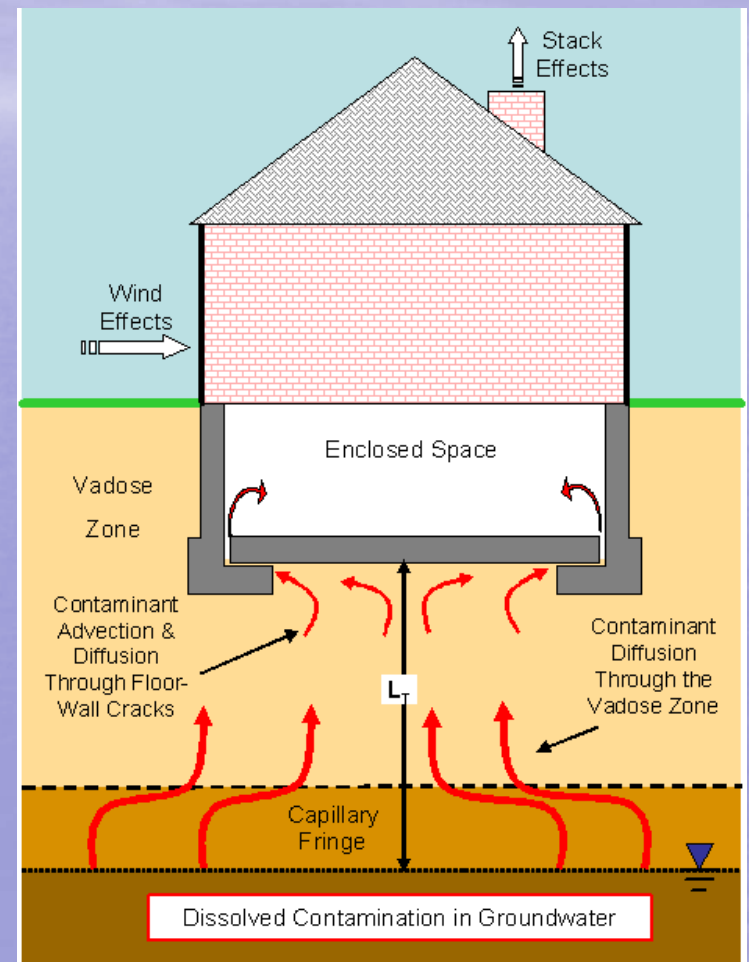
- Notify NJDEP 7 days prior to IA/SG sampling using *Potable Well/IA Sampling Notification* form
- Implement VI investigation
- Evaluate data
- Provide results to:
 - NJDEP
 - NJDHSS
 - Individuals
 - 911 (?)





When is the VI Pathway Complete?

- 1) There is a source related to a discharge;
- 2) There is a migration pathway; and,
- 3) A receptor (current or future) is adversely impacted by a subsurface vapor contaminant migrating into a structure.





What Constitutes a VI VC?

A VI Vapor Concern exists at a structure if:

- 1) The results of an indoor air sample exceeds the appropriate NJDEP Indoor Air Screening Levels and is at or below the Rapid Action Level; and,
- 2) The indoor air exceedance is resulting from a completed vapor intrusion pathway (evaluate potential background sources).





What Constitutes a VI IEC?

A VI IEC exists at a structure if:

- 1) The results of an indoor air sample exceeds the appropriate NJDEP Rapid Action Level; and,
- 2) The indoor air exceedance is resulting from a completed vapor intrusion pathway (evaluate potential background sources).





How Are VCs Different from IECs?

- No immediate call to NJDEP Hotline (submit *VC Response Action* form within 14 days)
- Interim Remedial Actions not required for VC
- Source Control is addressed outside the VC timeframe
- Must submit a VC Mitigation Plan
- Timeframe for regulatory requirements is less compressed

Both IEC & VC have NJDEP case managers





Questions?

