

# Performance Monitoring of Vapor Mitigation System New Maintenance Facility at Port of Oakland

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Port of Oakland

Remediation of Chlorinated and Recalcitrant Compounds:  
Fifth International Conference

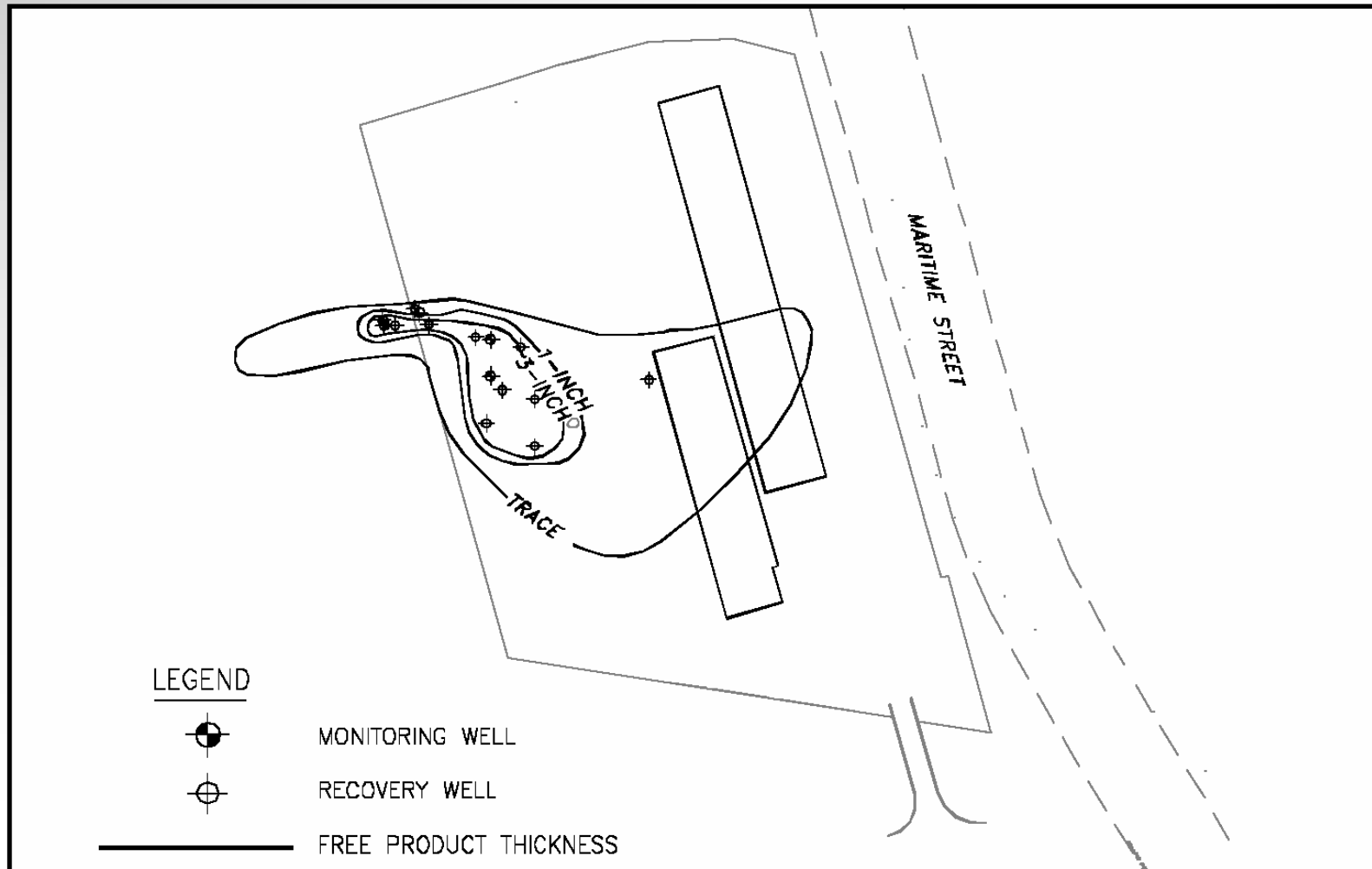
22-25 May 2006 – Monterey, California

# Site Conditions

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- 12 acre site at Seventh and Maritime Streets in Oakland with former industrial operations.
- Former petroleum hydrocarbon leaks affected site conditions.
  - Separate phase heavy-end petroleum hydrocarbons thickness varies from trace to 2 ft.
- Depth to groundwater varies seasonally from 8 ft. to 15 ft. in a silty clay aquifer with sand lenses.
- Elevated methane and VOC concentrations in soil gas samples.
  - Unacceptable estimated risk to commercial workers for an indoor-air exposure scenario for new Port maintenance facility (exceeded 1.25% methane concentration threshold)

# Project Facility and Free Product Distribution

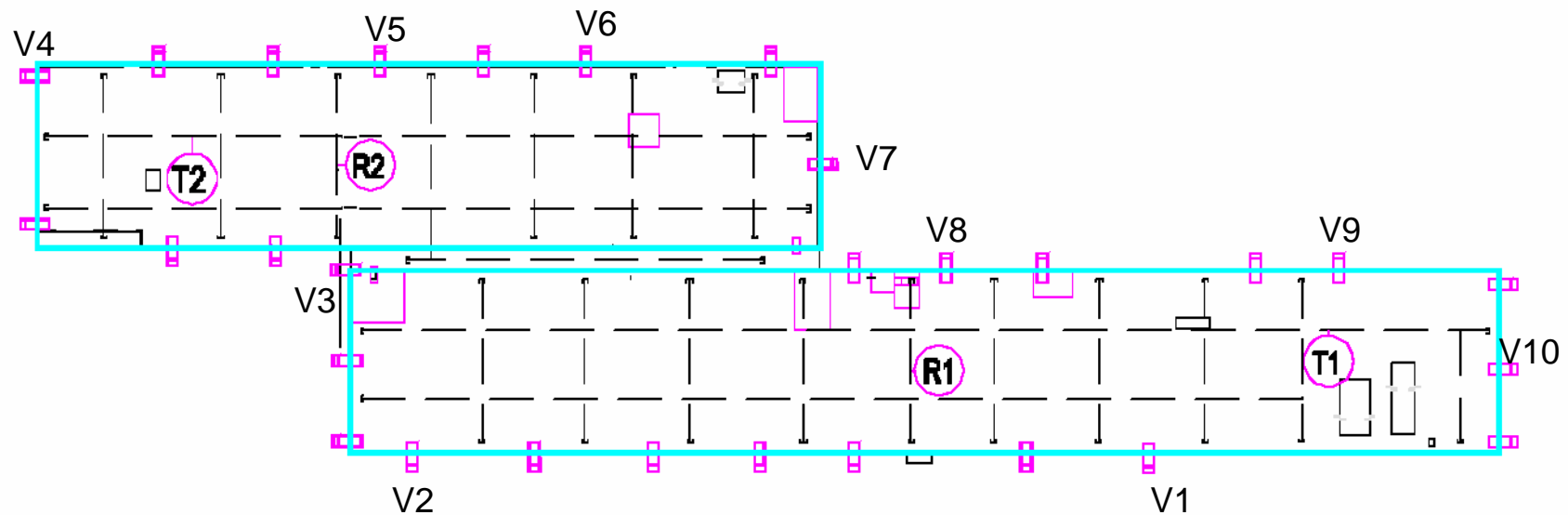


# Passive Soil Vapor Mitigation System (VMS)

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- Purpose of VMS: Reduction of exposure and risks through preclusion of vapor intrusion into indoor air
- VMS Components:
  - Vapor barrier: Liquid Boot® spray-applied membrane
  - Passive collection and ventilation system: 4-in. dia. perforated PVC pipe in gravel layer
  - Perimeter grade beam inlet vents: Allow fresh air make-up in the gravel layer
- System Monitoring: Air flow and methane within VMS
  - Performed to confirm VMS function without indoor air testing

# VMS Design – Plan View



## LEGEND

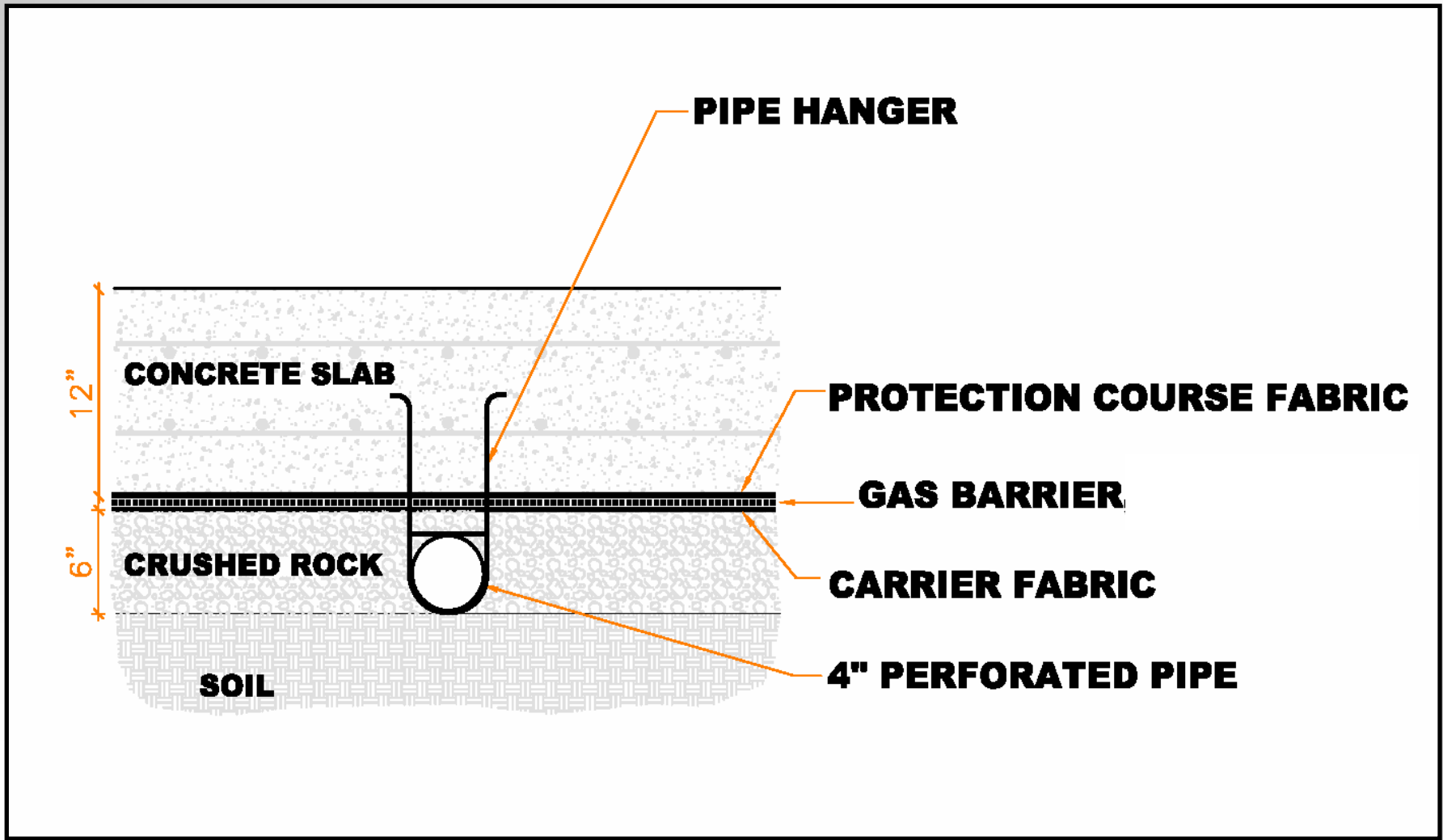
— — 4" DIA. SCH. 40 PERFORATED PVC PIPE

□ PERIMETER GRADE BEAM VENT

⊙ R1 WIND ASSISTED RISER

⊙ T1 UNDERSLAB SOIL GAS TEST PORT

# VMS Design – Typical Cross-section



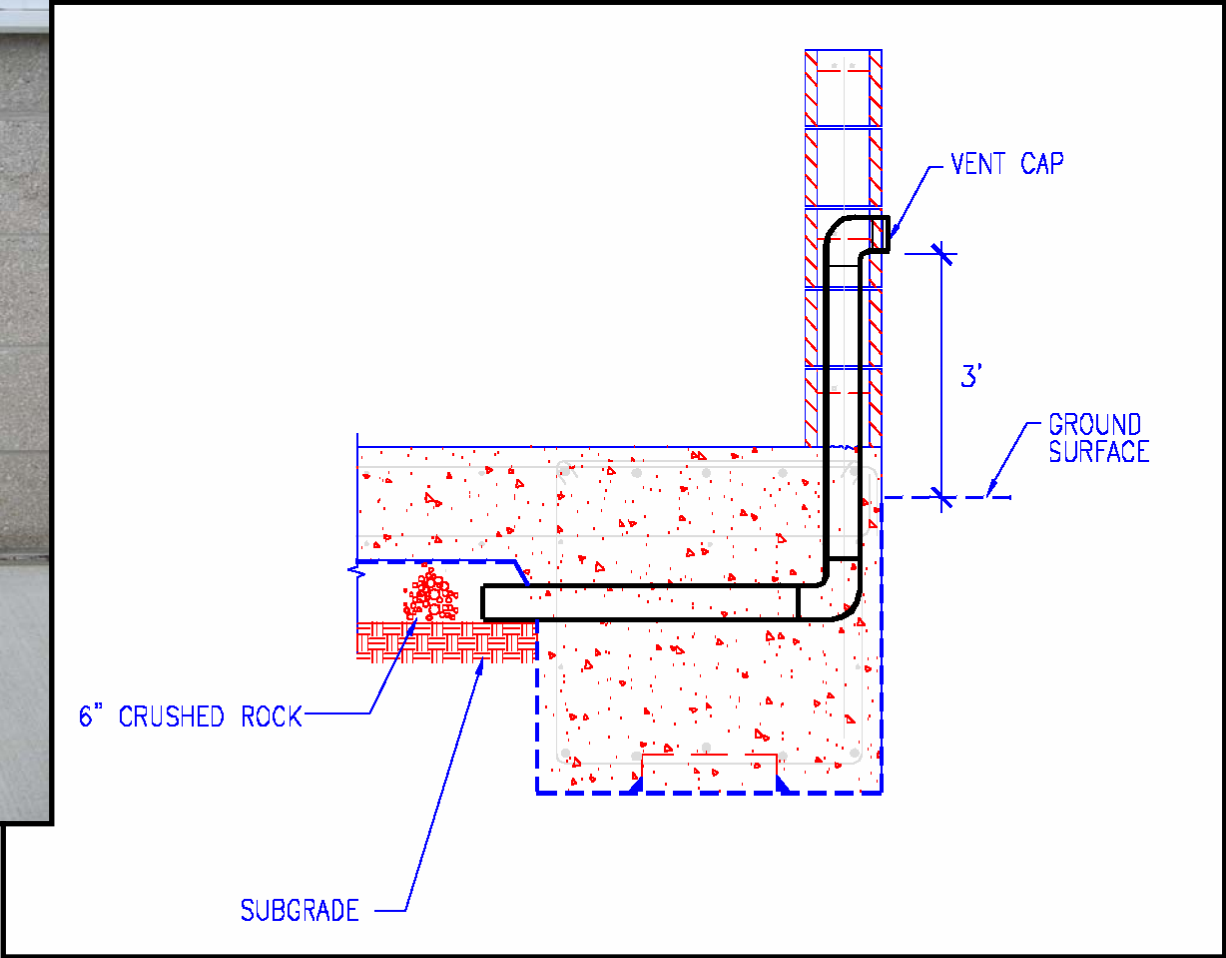
# Venting System Collection Pipe Layout



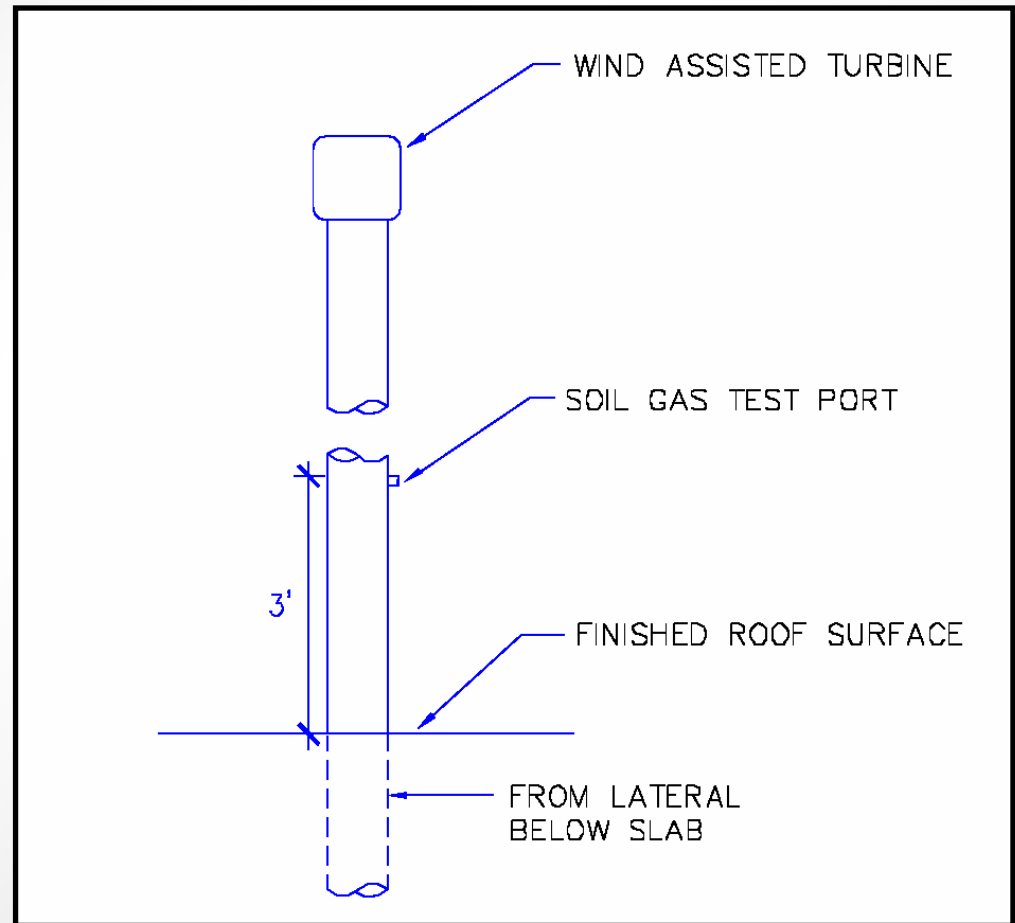
# Liquid Boot<sup>®</sup> Membrane Application



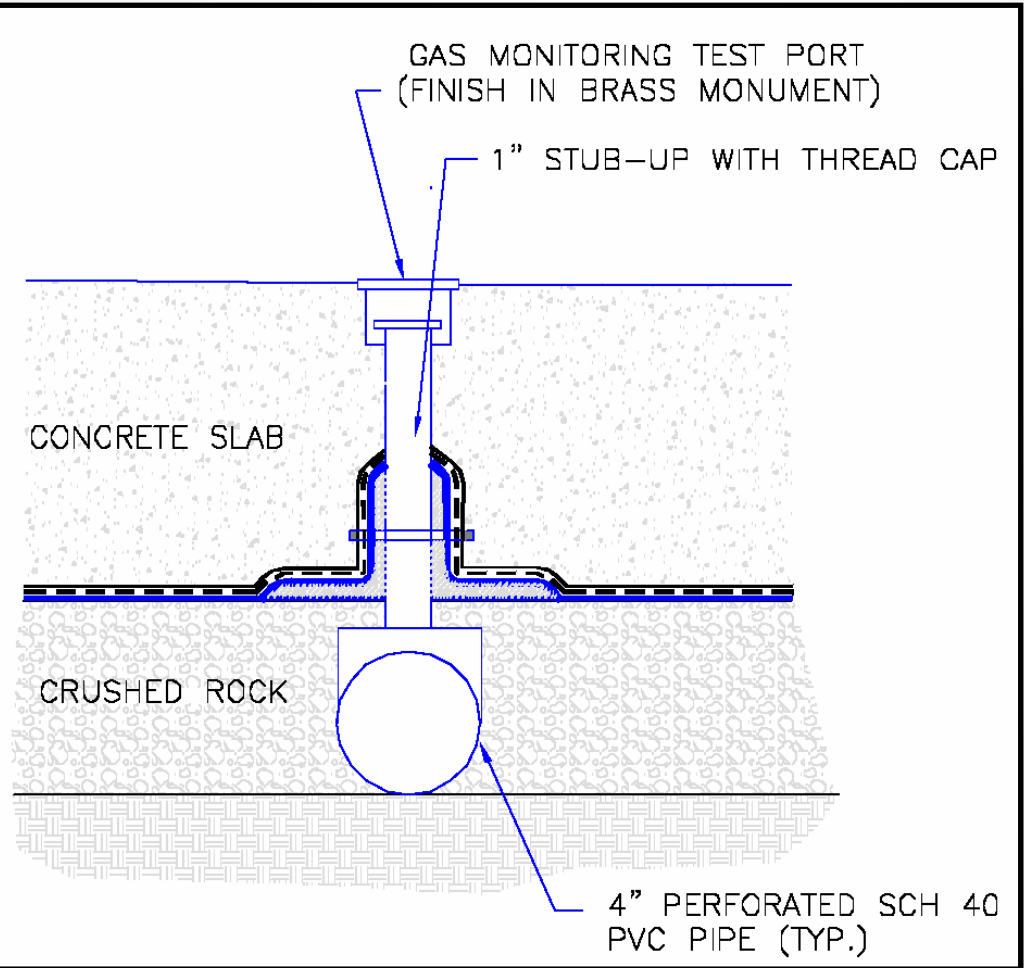
# Perimeter Grade Beam Inlet Vents



# Riser Pipe and Wind Turbine at Roof Level



# Collection System Test Port

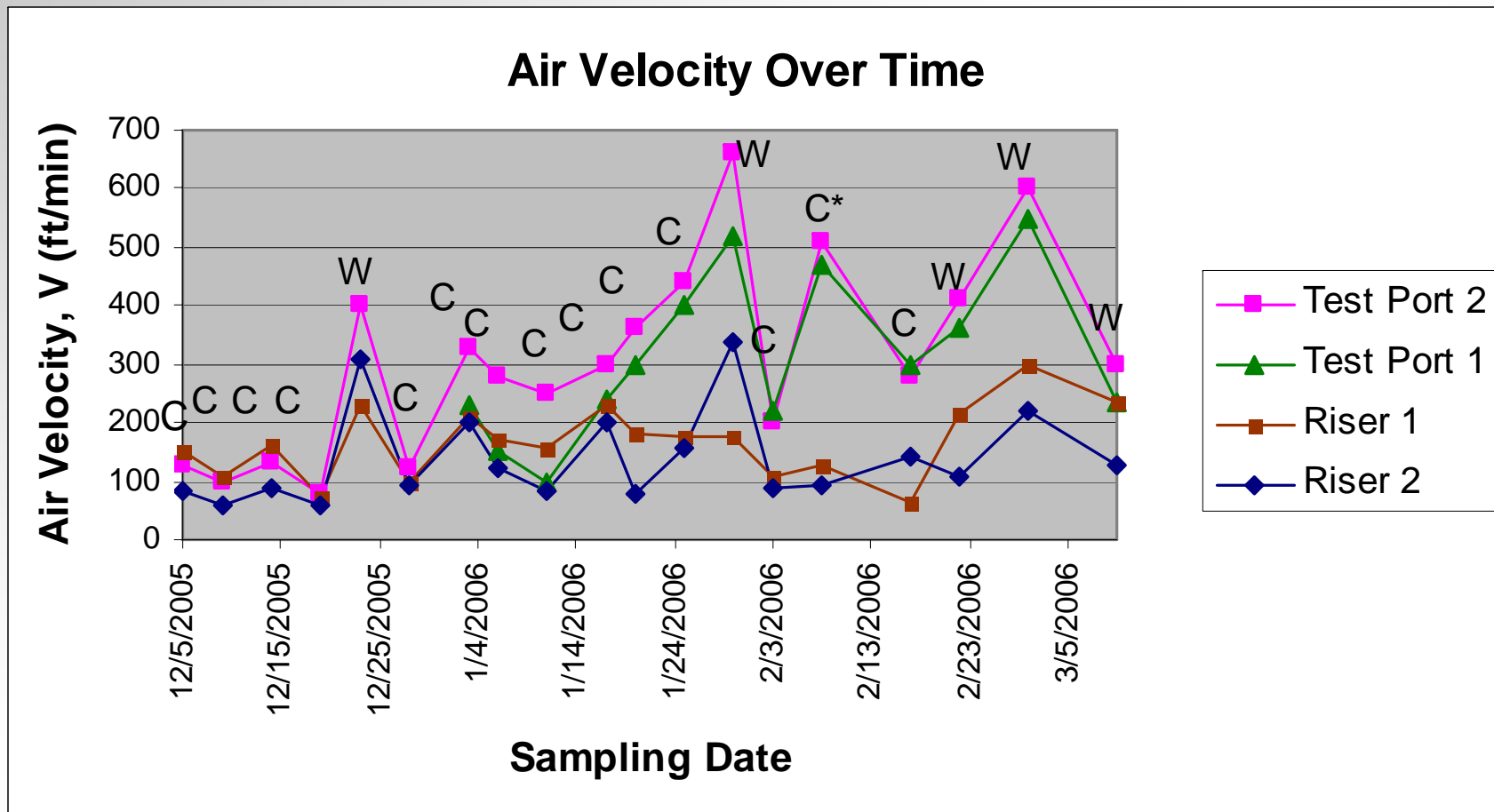


# Post-Construction Monitoring Program

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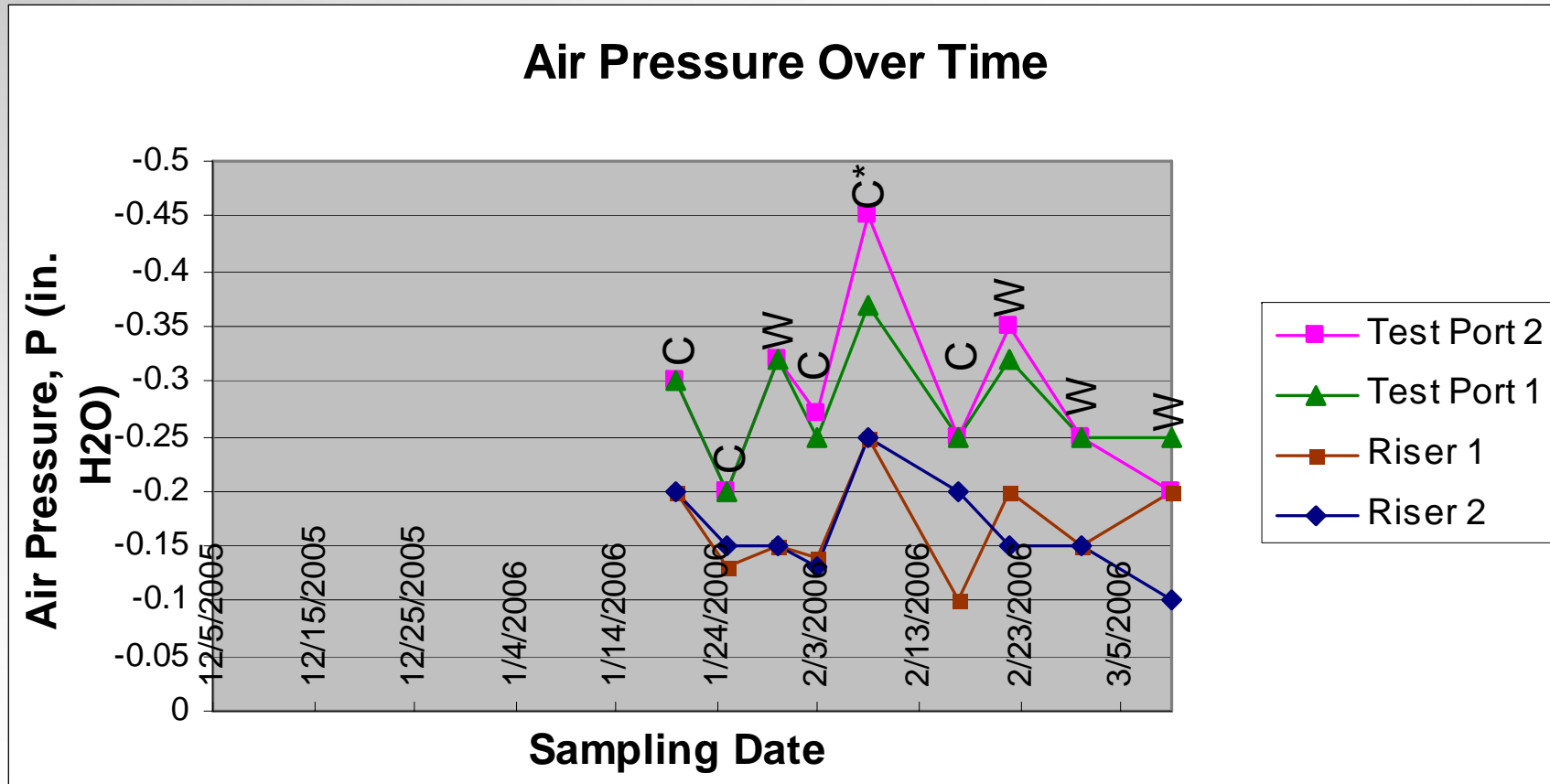
- Purpose: Performed to confirm VMS function without indoor air testing
- 19 sampling events between 5 December 2005 and 10 March 2006
- Parameters monitored at test ports (T1, T2, R1, and R2):
  - Air velocity (ft/min)
  - Volumetric air flow (cfm)
  - Methane concentrations (ppmv)
  - Oxygen concentrations (% by volume)
  - Vacuum (in. H<sub>2</sub>O)
- Smoke test @ perimeter grade beam inlet vents (V1 through V10)

# System Air Flow Data



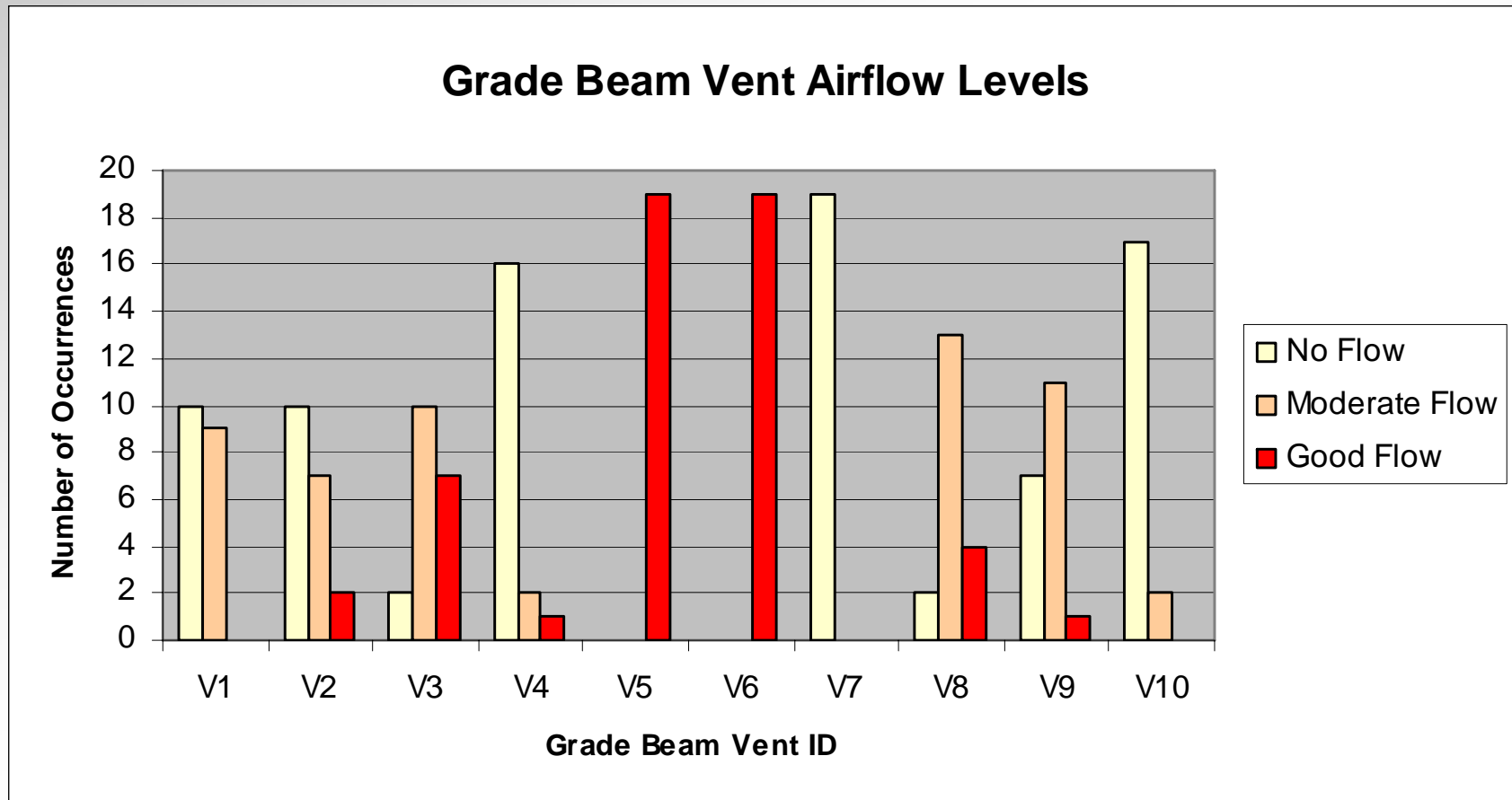
- There is air movement within the system at all times, even on calm days when the wind turbine is not spinning.

# System Air Pressure Data



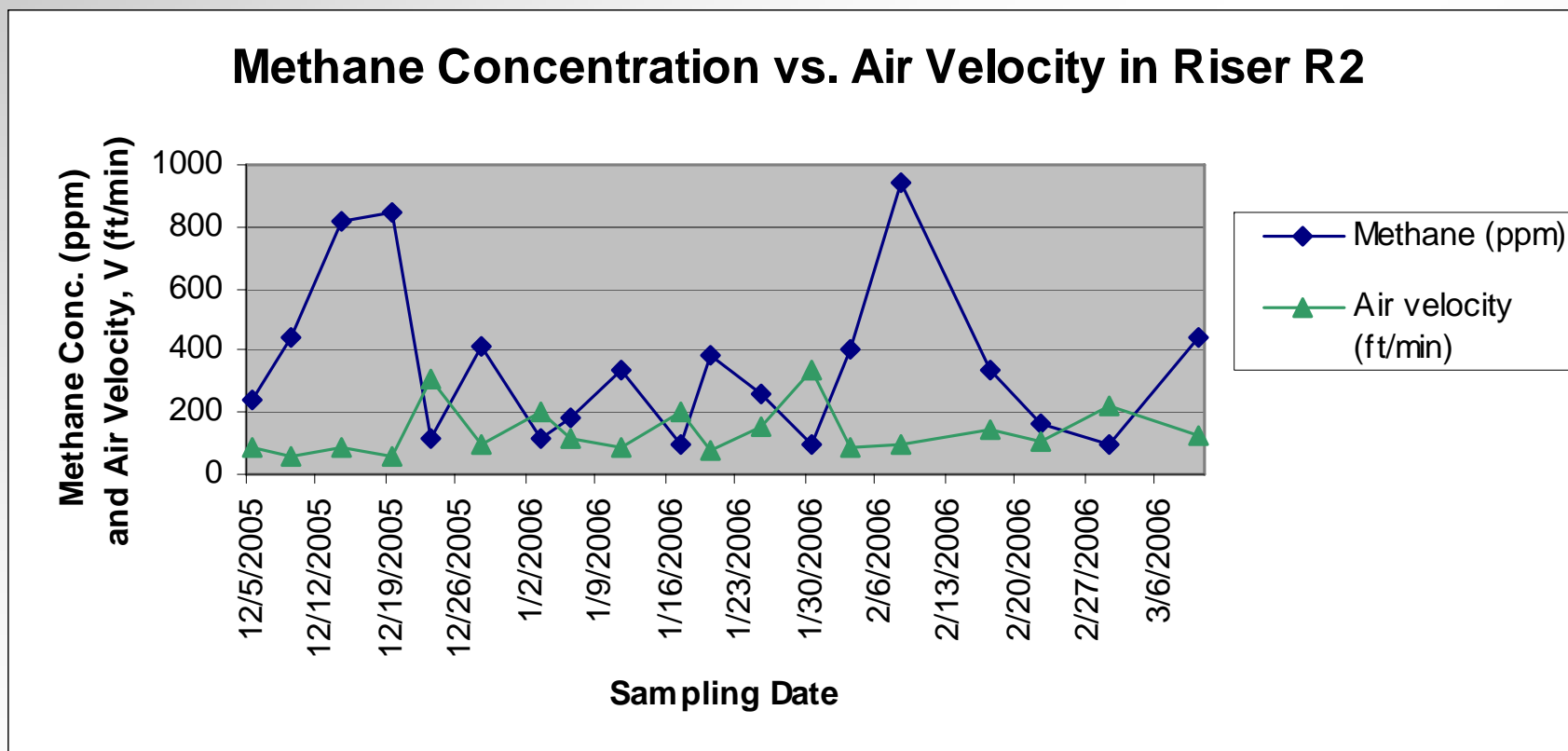
- There is negative air pressure within the system at all times, even on calm days (wind turbine is not spinning).

# Perimeter Grade Beam Inlet Vent Air Flow



- Perimeter grade beam inlet vents allow fresh atmospheric air to be pulled into the gravel layer and enhance vapor movement towards and up the risers (convective flow).

# Methane Concentration vs. Air Velocity in Riser



- During relatively calm periods (airflow is less than 100 ft/min) for an extended period of time, sub-slab methane concentrations rise, and when windy conditions return, methane concentrations decrease rapidly.

# VMS Monitoring Program: Conclusions

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- VMS allows facility development in advance of final/complete site cleanup.
- “Maintenance-free” with minimal O&M costs.
- Effective in reducing sub-slab vapor concentrations.
  - Combination of convection and wind effects maintain air movement and negative air pressure in the system at all times, even on calm days.
  - Perimeter grade beam vents enhance vapor movement through gravel layer towards and up the risers (convective flow).
- Performance monitoring confirmed VMS function without indoor air testing.