The New Science Centre 2011 Project

Case Study: Design Optimization of an Active Sub Slab Depressurization System to Mitigate Vapour Intrusion of Methane Gas from Former City of Calgary Landfill

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AMEC Environment & Infrastructure

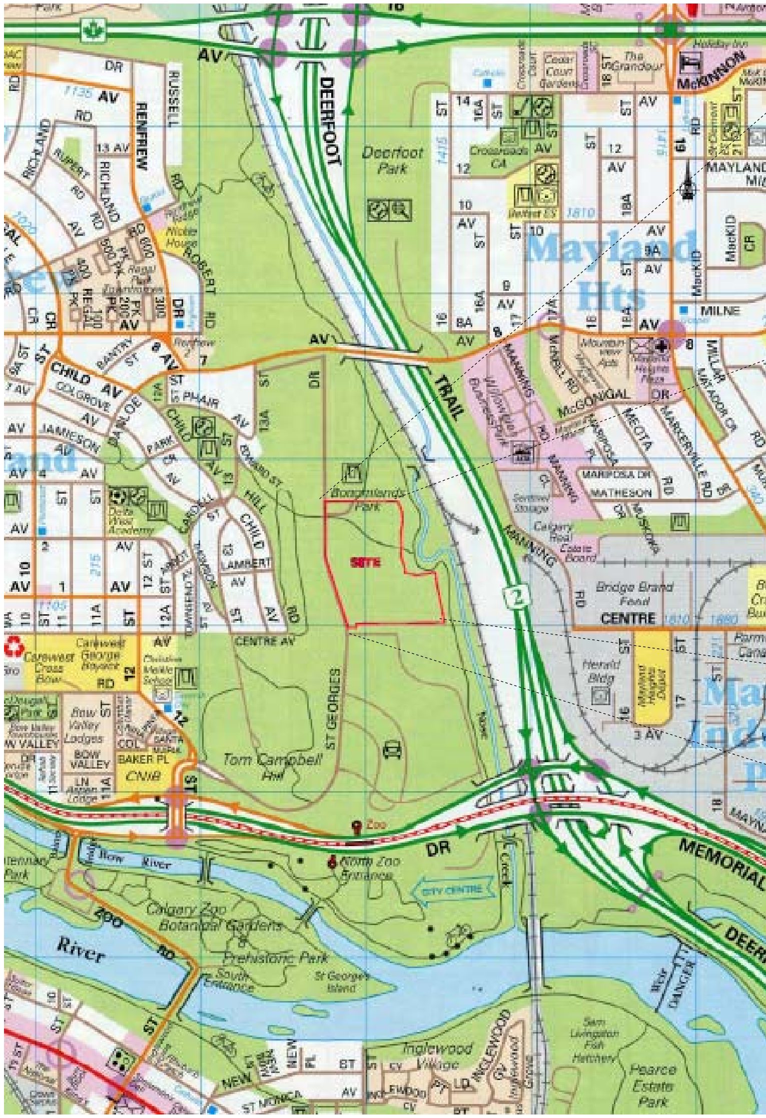
Outline

- Proposed Development
- Project Background
- Environmental Management Controls
- Vapour Intrusion
- Methane Properties
- Methane Mitigation Controls
- Secondary Methane Mitigation Controls
- Results
- Performance Monitoring
- LEED in Brownfield development

Proposed Development – New Science Centre

- 153 000 ft^2 new science centre to replace former science centre that was in operation for 44 years
- Built on a structural slab foundation
- Three story complex with attached dome theatre
- First new state-of-the-art science centre in Canada in the 21^{st} Century
- Municipal, Provincial and National hub for innovation
- Opening October 29^{th}, 2011

Project Background – Site Description



Project Background –
Historical Environmental Investigations

AMEC involved since the early 1990s:

- Bird and wildlife surveys
- Surface water quality assessment
- Extensive drilling/sampling to assess soil and GW conditions
- Human Health and Ecological Risk Assessment
- Preparation of a RAP to use site as a Urban Park
- Engineering report in support of application for variance of landfill setback
- Environmental Management Plan (EMP) in support of DP

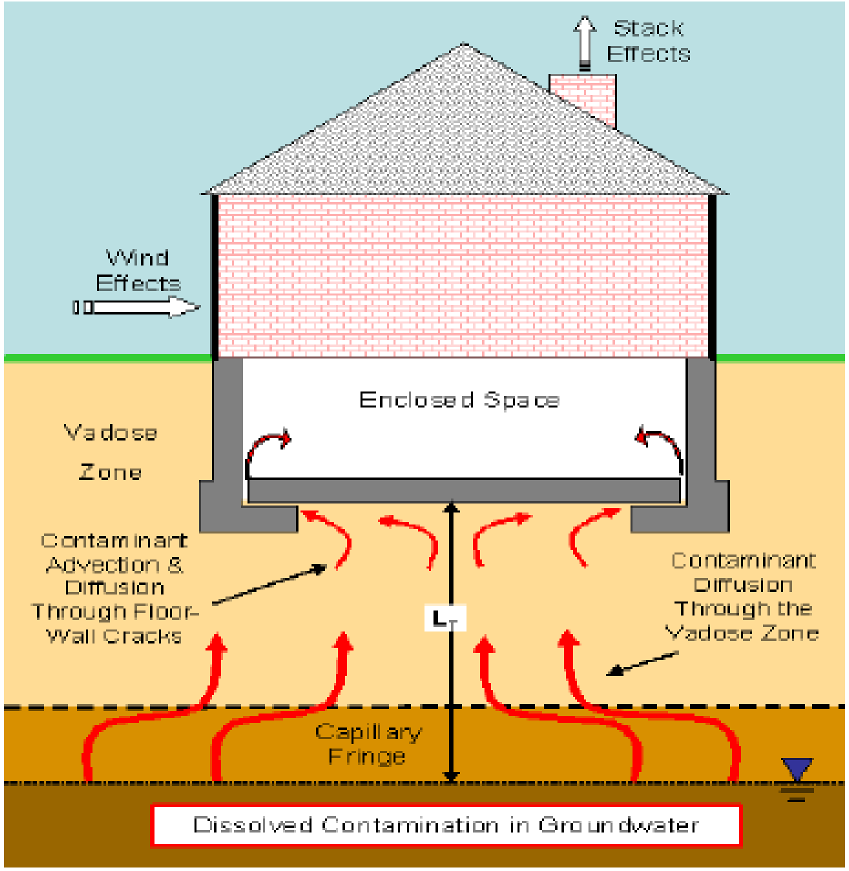
Project Background –
Key Environmental Concerns

Environmental Management Controls

- Removal of waste piles prior to construction
- Characterization, segregation and offsite removal of waste debris encountered during construction
- Importation of fill to raise surface elevation ~ 2m to mitigate impacts of being located in a flood fringe
- Collection of surface water to avoid direct runoff into the adjacent Nose Creek
- **Implementation of mitigation measures to address VI potential into site building from underlying C&D wastes and adjacent MSW**

What is Vapour Intrusion?

- Soil gas migration from subsurface to overlying and/or adjacent buildings
- Common Sources
  - Methane
  - Radon
  - VOC's
- Transport
- Preferential Pathways

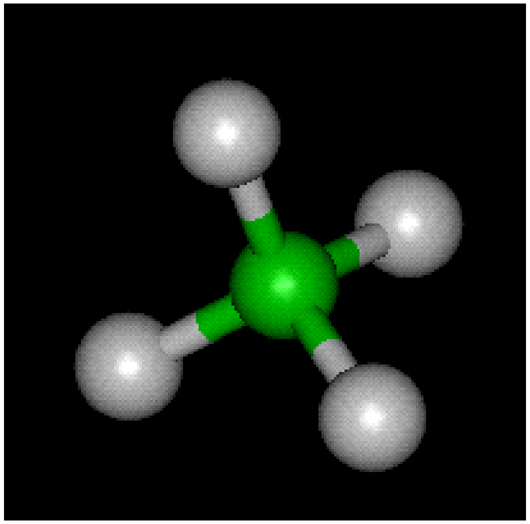


Provided by ITRC, January 2007

Vapour Intrusion– Landfill Gas

Methane Properties

- CH_4
- Simplest hydrocarbon (alkane)
- Gas at room temperature
- Less dense (lighter) than air
- Forms explosive mixtures with air (5 – 15% Gas)
- Colourless
- Odourless
- Relatively insoluble in water
- Simple asphyxiant



Methane Mitigation Controls – Design Objective

To reduce the potential for methane gas to accumulate to harmful levels inside site facilities

Methane Mitigation Controls – Design Challenges

- Structural Slab
  - Sub slab settlement
- Building size/configuration
- Shallow groundwater
  - moisture
- Visibility
  - interior aesthetics
  - exterior - Hwy 2/C-train route, urban park, residential
- Acoustics
  - adjacent residential neighborhood
  - Internal vibrations/noise levels
- Energy efficiency
- Minimal maintenance
  - completely automated

Methane Mitigation Controls – Design Selection

- Primary Mitigation Technology Selected:
  - Active sub slab depressurization (SSD) selected
- Optimization features:
  - Variable Frequency Drive
  - Inline combustible gas sensor
  - Acoustical Isolation
  - Contingency moisture knockout
- Secondary Mitigation Controls
  - Inbuilding monitoring system
  - Utility blocks/vents

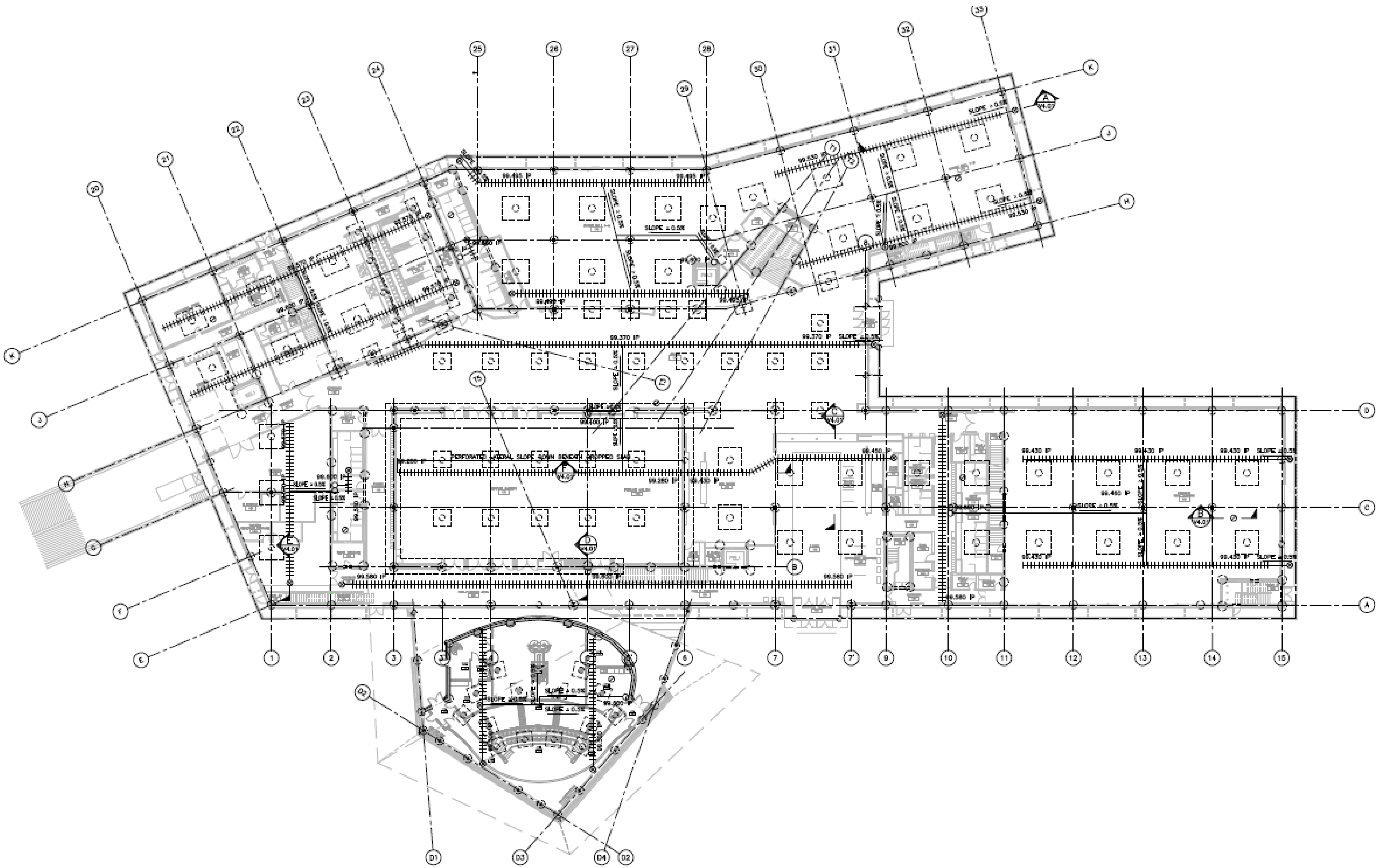
Methane Mitigation Controls – SSD

- Key System Components
  - Powered extraction unit
  - General synthetic barriers not required
  - Permeable layer beneath floor slab (e.g. gravel)
  - Perforated piping network completed with risers for venting of soil gas
  - Hangers to suspend collection piping

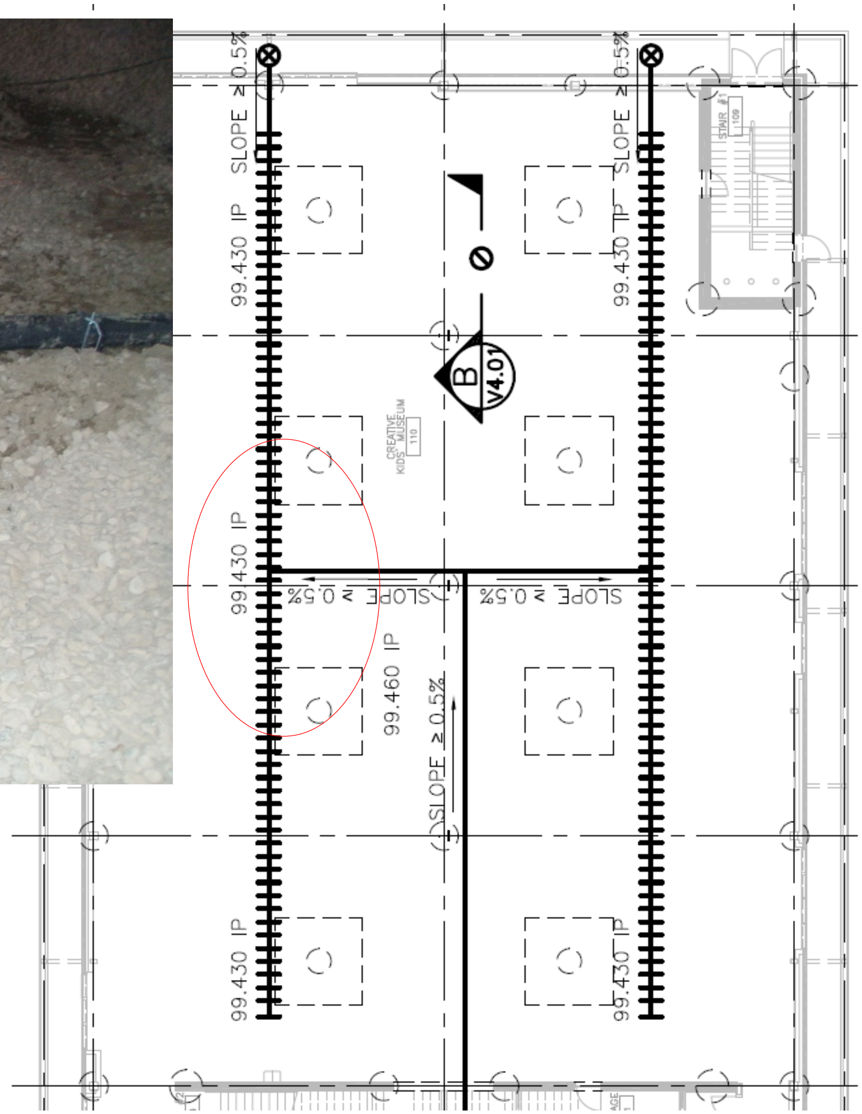
- Design parameters
  - Flow = 3000 CFM
  - Vacuum = 50 in. H_20
  - Sub slab vacuum range = 0.01 to 0.1 In.H_20

- Equivalent pipe length method used to size piping

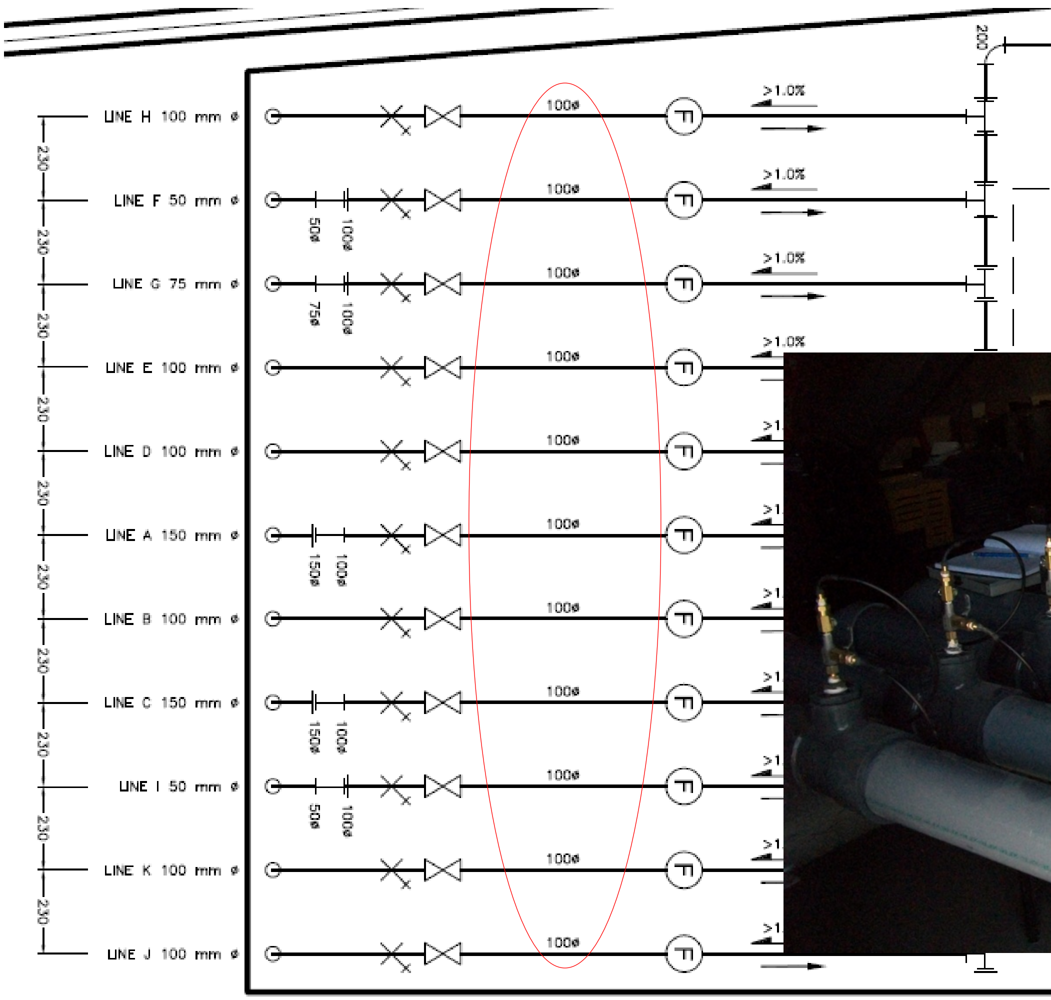
SSD – Sub Slab Piping Layout



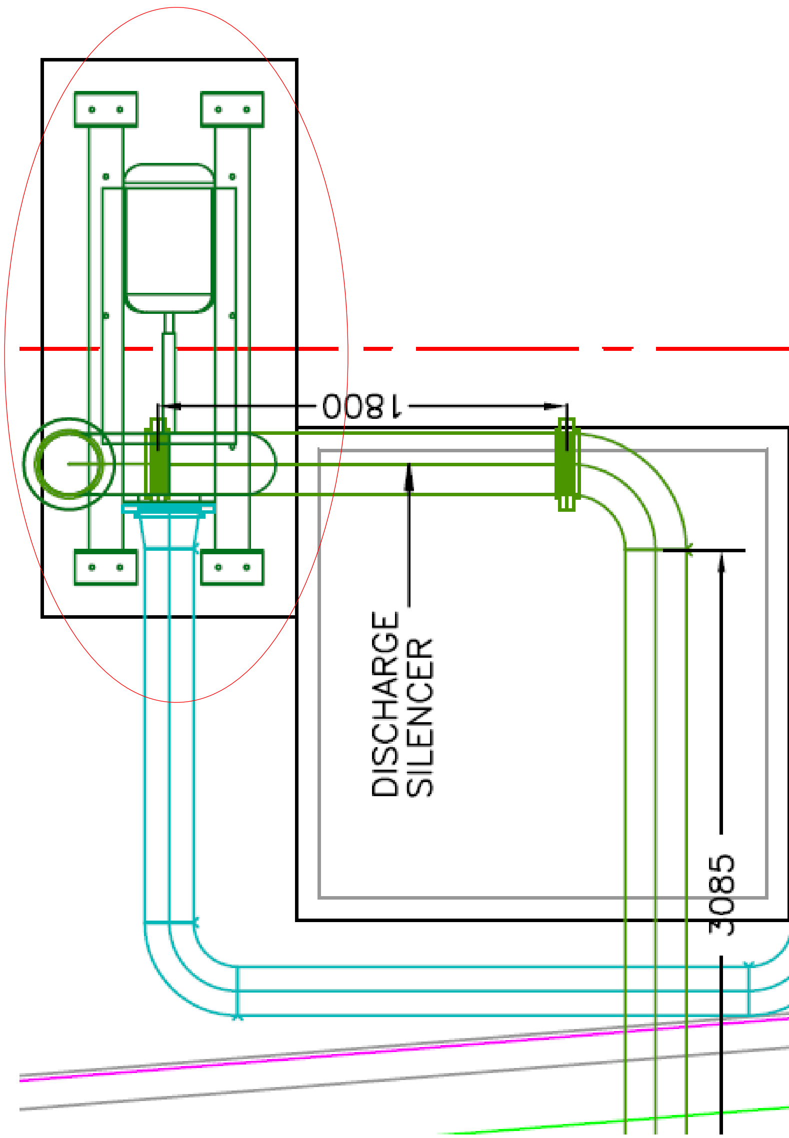
SSD – Perforated/Solid Collection Piping

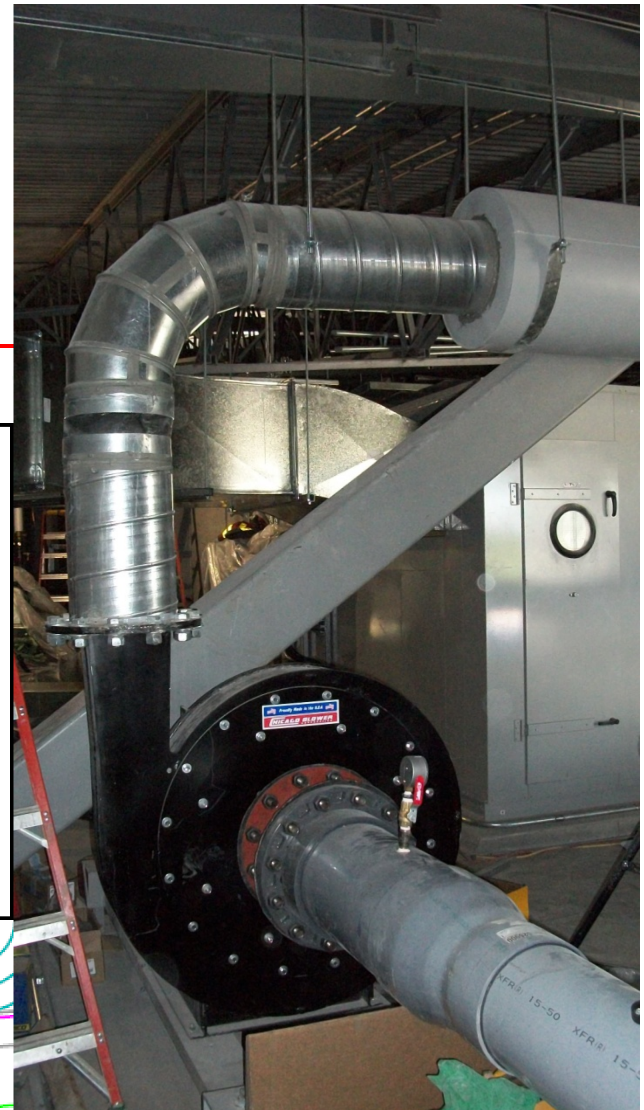


SSD – Header System



SSD – Extraction Fan





SSD - Variable Frequency Drive/Inline Combustible Gas Sensor

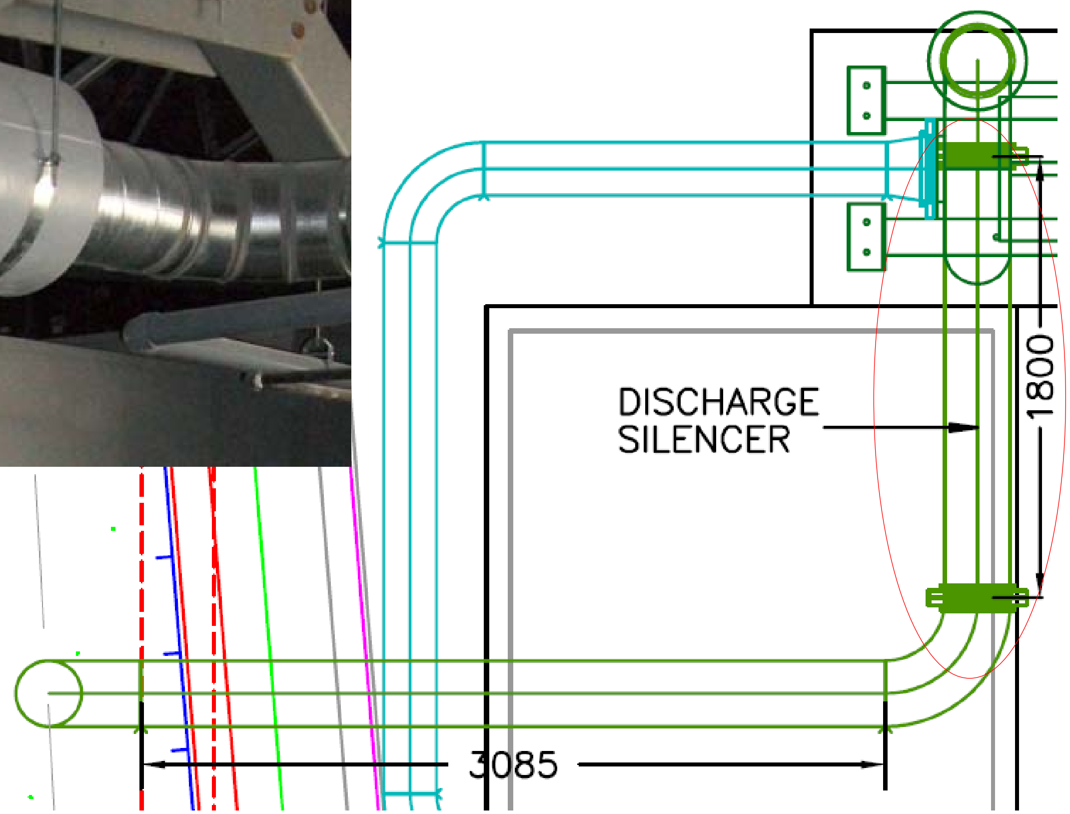
Extraction fan speed is controlled by a VFD and inline combustible gas sensor

- Low Speed = 50% capacity or 1500 cfm
- High Speed = 100% capacity or 3000 cfm

Fan Sequence of Operation

- If inline methane concentrations remain below 15% LEL fan runs continuously at Low Speed.
- If inline methane concentrations exceed the 15% LEL set point, fan is increased to High Speed; fan remains at high speed until concentrations fall back below the set point.

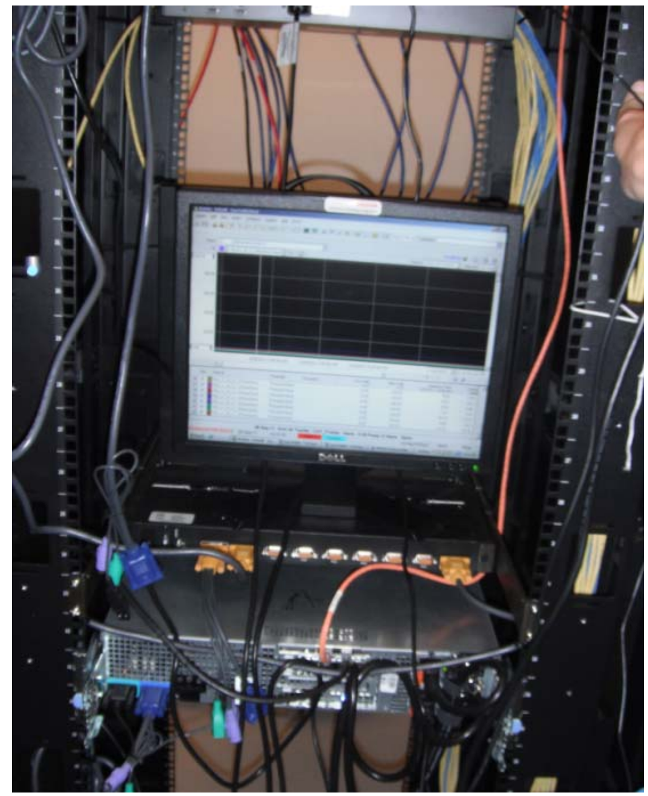
SSD - Exhaust Acoustical Isolation



Secondary Mitigation Controls - Inbuilding Monitoring System

Two Stage In-building Alarm System tied to BMS

- Alarm # 1 > 5% LEL (2 500 PPM):
  - activation of HVAC system
  - automated notification to property manager
- Alarm # 2 > 25% LEL (12 500ppm):
  - evacuation via activation of fire alarm system
  - activation of blue strobes located at employee entrance
  - METHANE specific signal sent to Fire Department message
  - automated notification to property manager
- Sensor locations based on:
  - manufacturers area of coverage
  - building configuration and confined spaces



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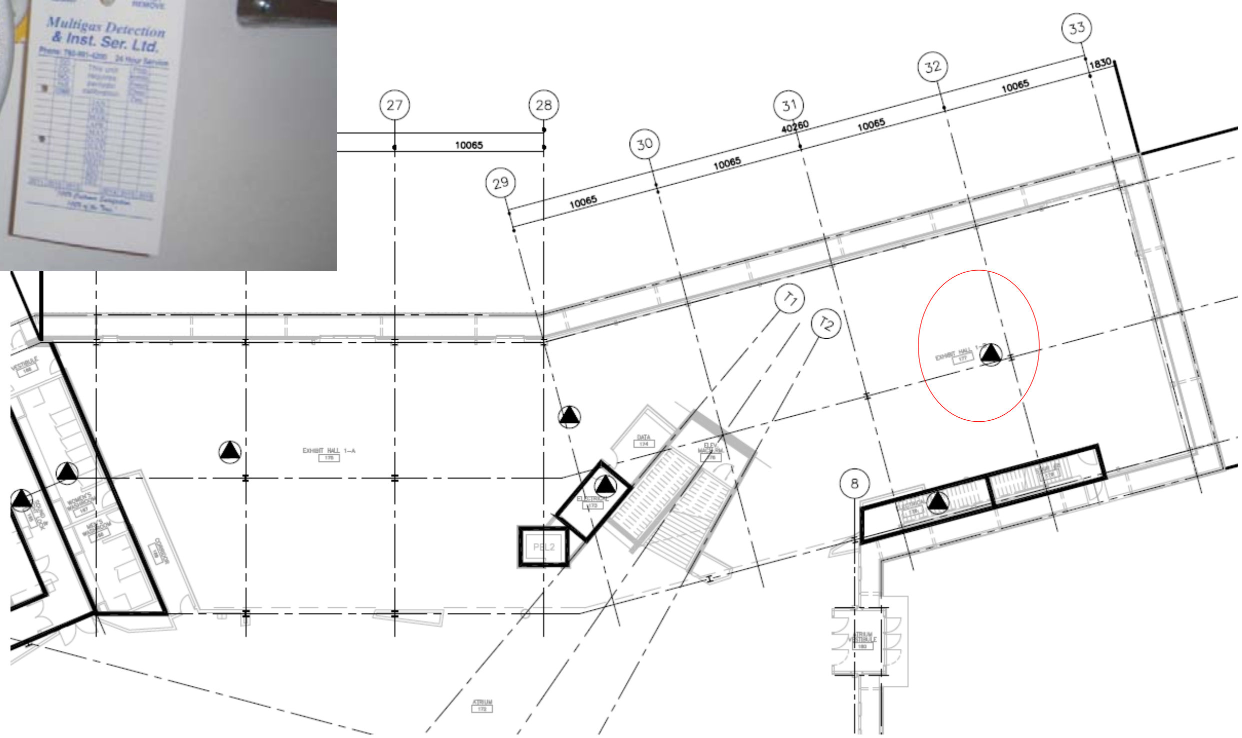
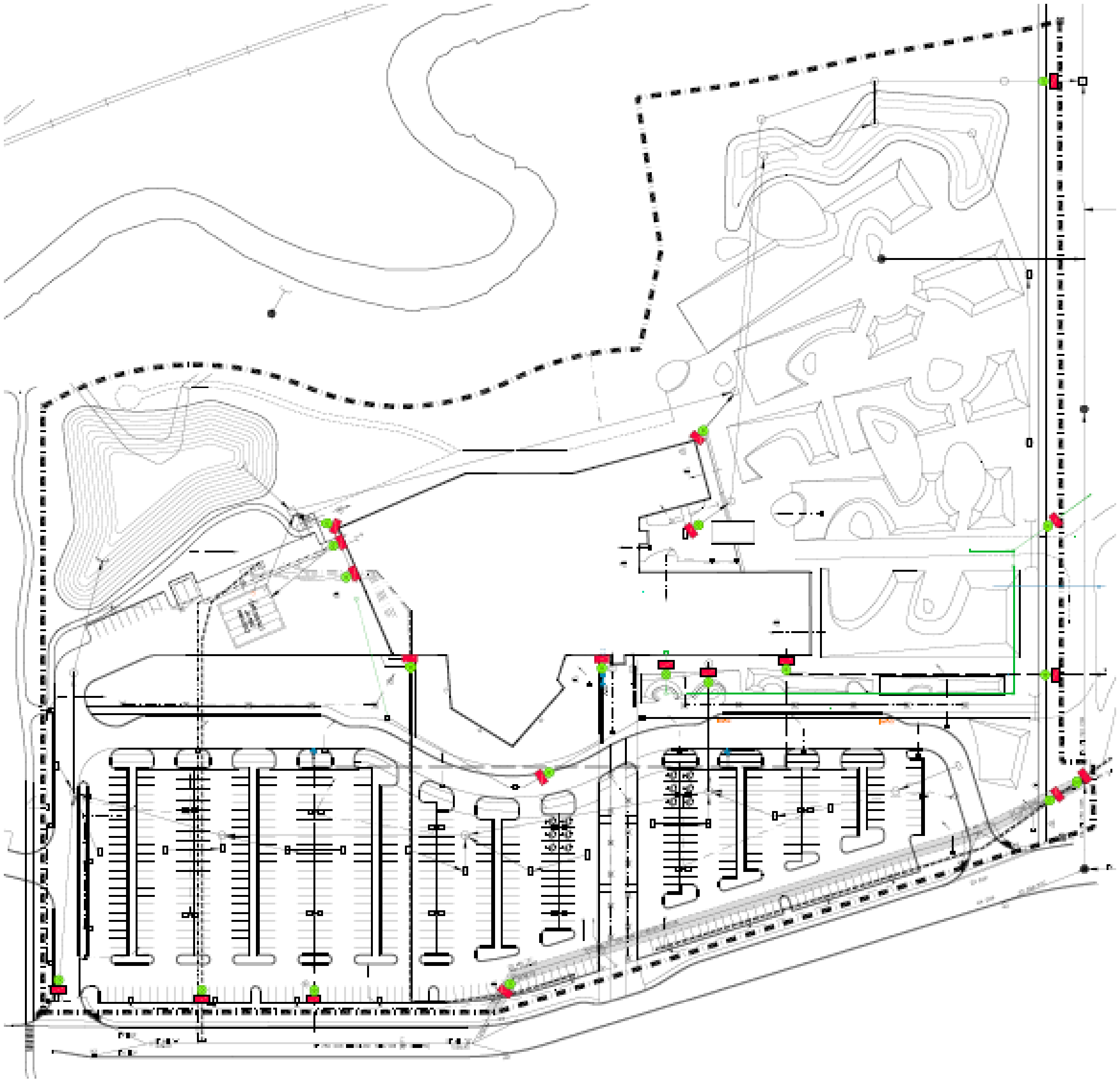


Secondary Mitigation Controls – Utility Blocks/Vents



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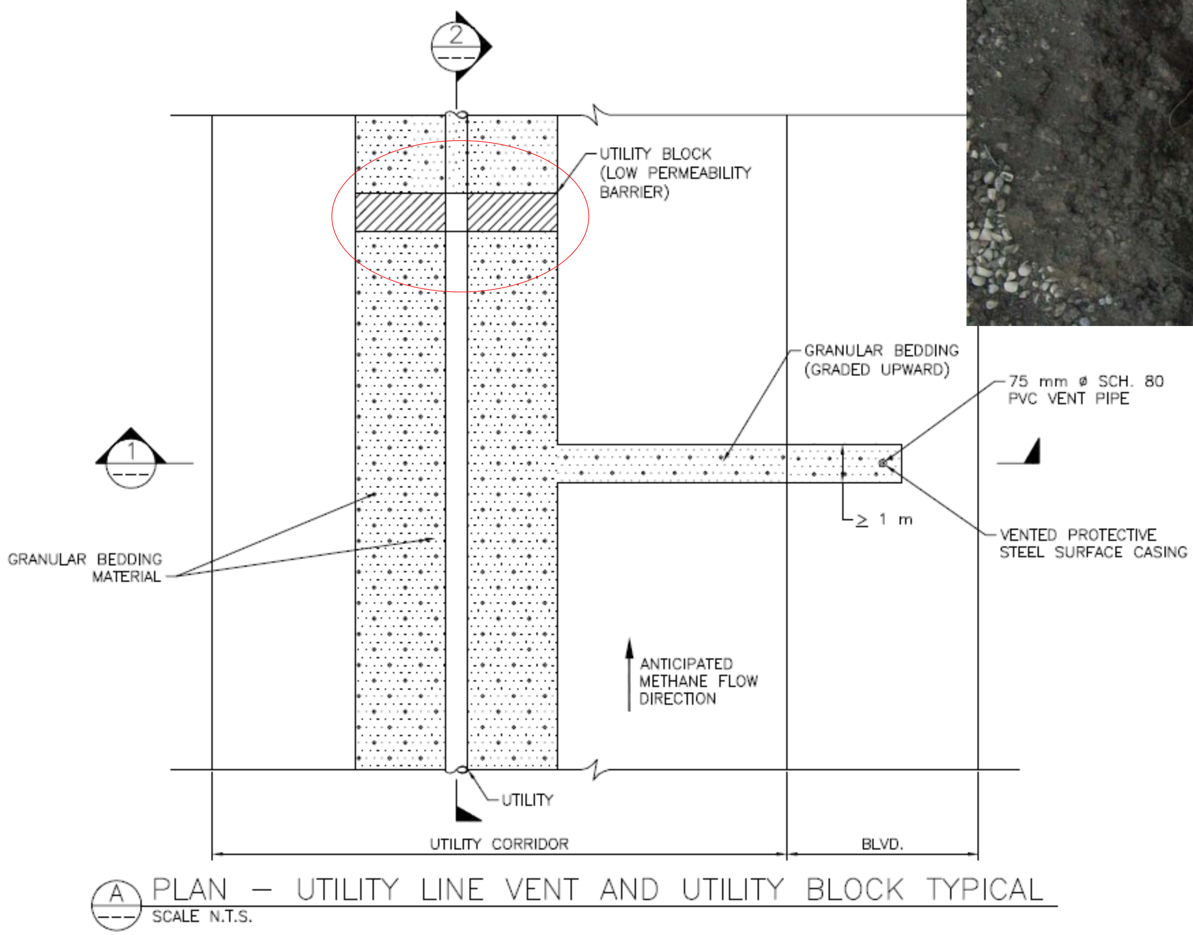
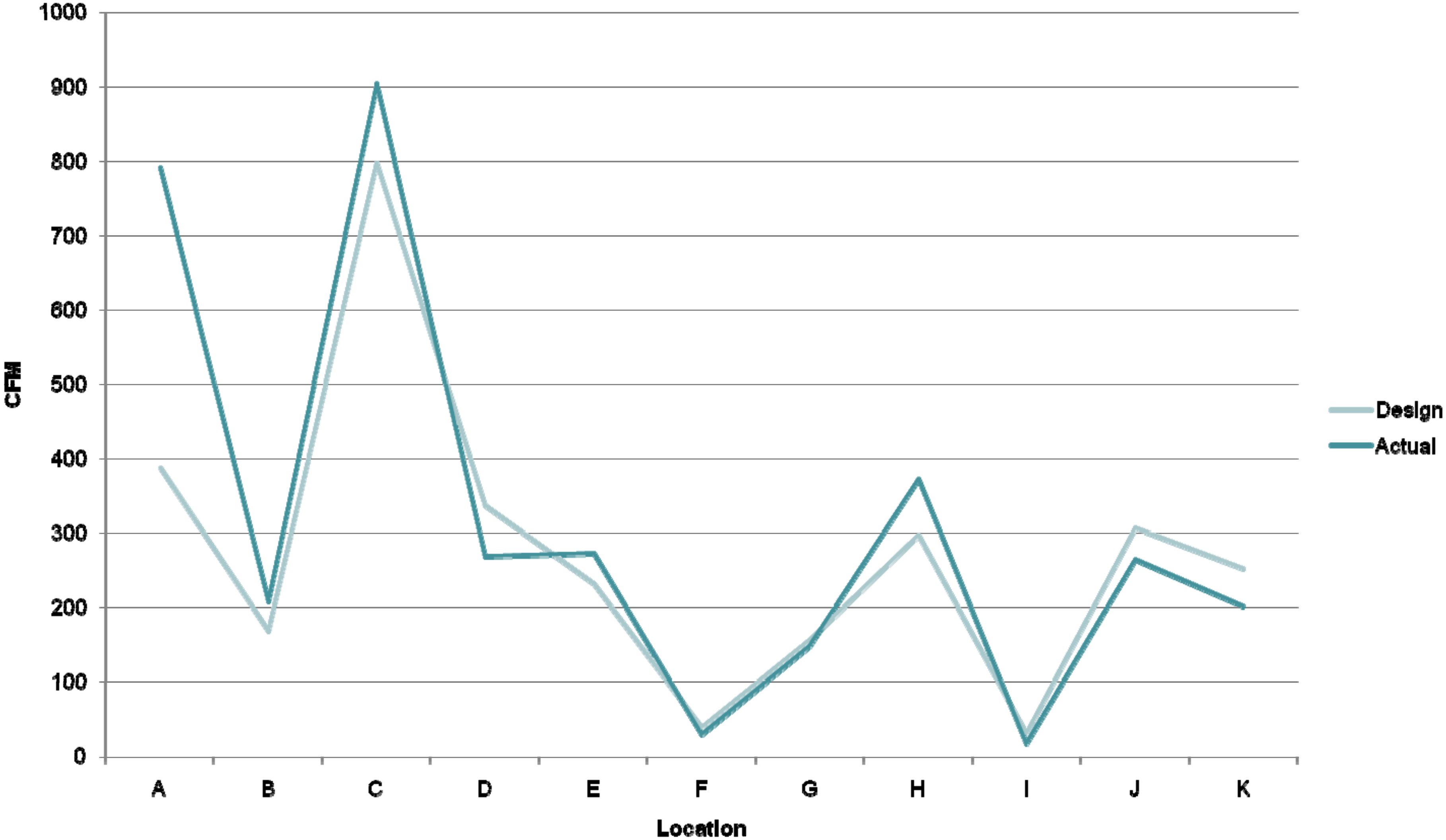
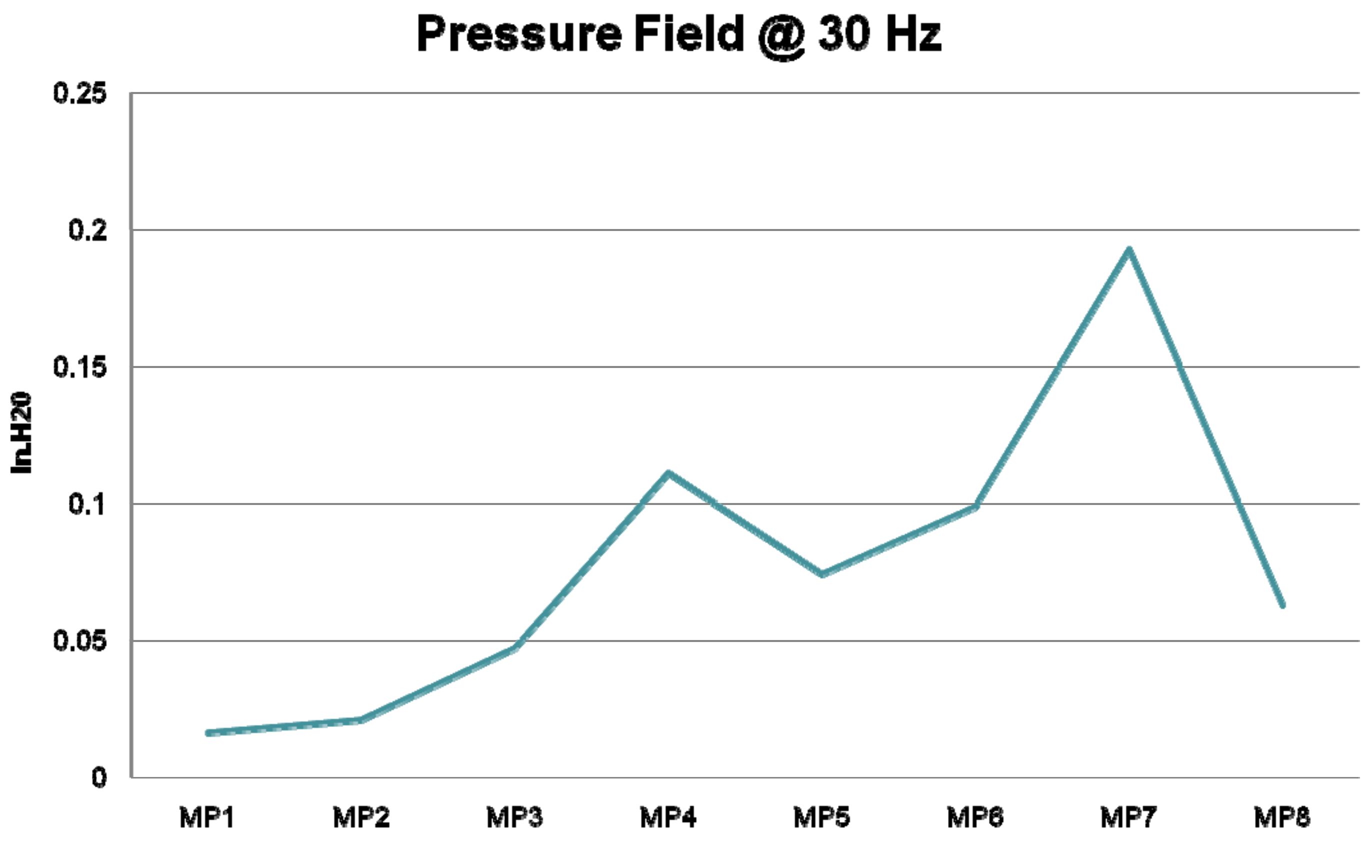


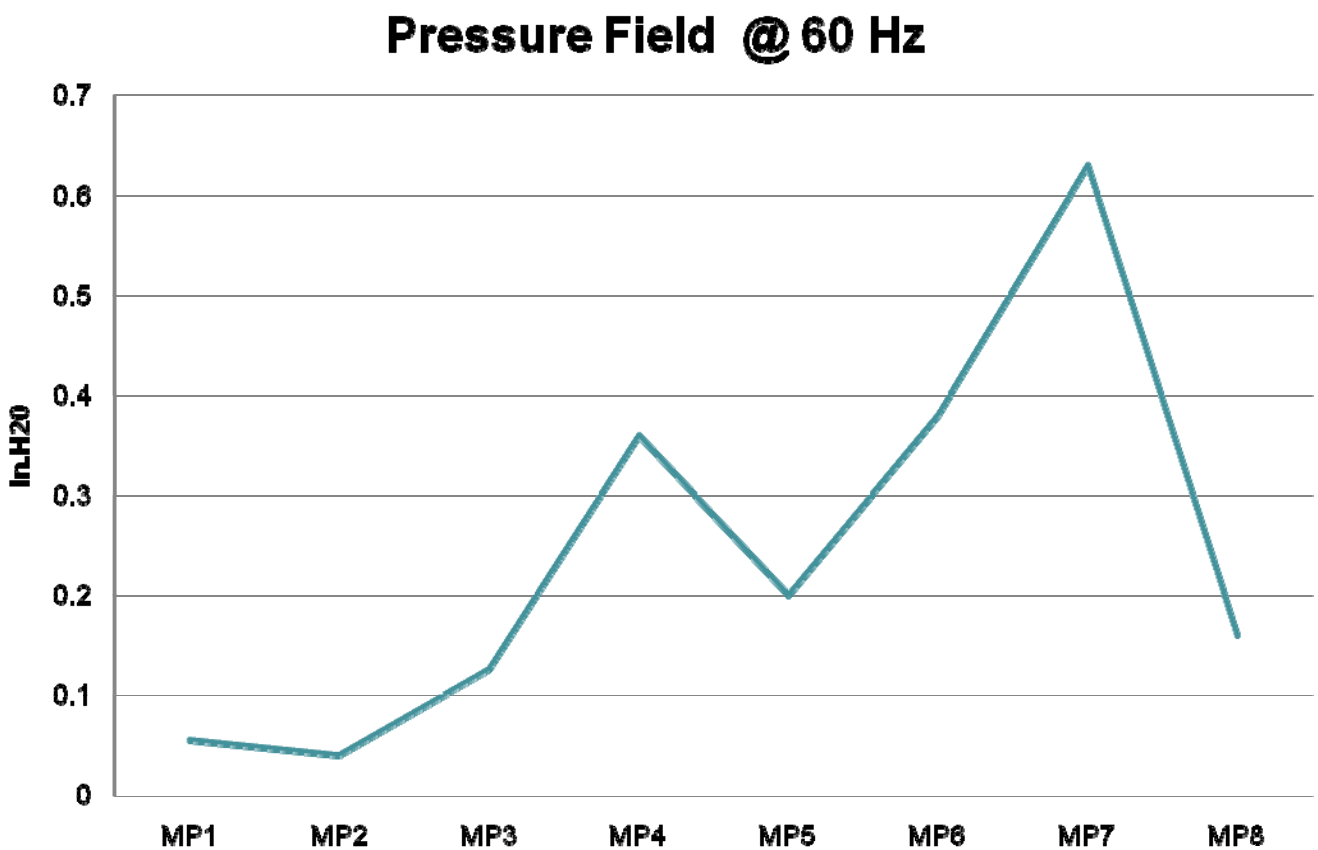
Results: Design vs. Actual Flow Rates



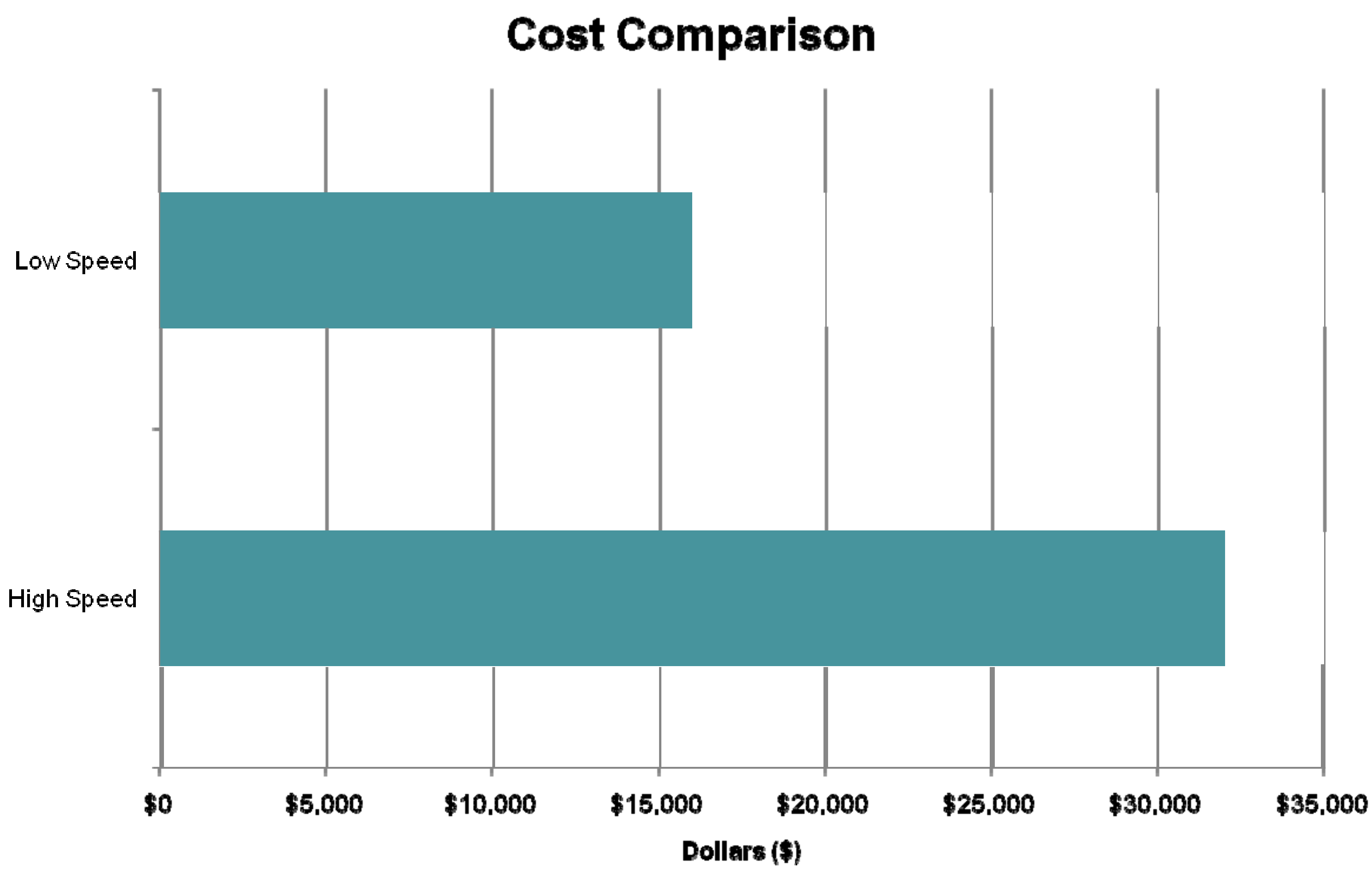
Results: Sub Slab Pressure 30 Hz



Results: Sub Slab Pressure 60 Hz



Energy Optimization



Post Construction SSD System Refinement

- Refinement efforts undertaken to allow for modification to pressure fields and fan speed/size
- Refinement based on attaining as even as possible vacuum beneath floor slab via:
  - Adjustment of fan speed and types
  - Adjustment of valves at header to control flow
- Sub-slab Vacuum monitored through access ports connected to low vacuum sensitivity gauges

LEED in Brownfield Development

- New Science Centre applicant for LEED certification
- Sustainable Site, Credit 3 – Redevelopment of Contaminated Sites

Questions?

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