Large Scale Soil Vapour Migration Controls at an Active Calgary Landfill

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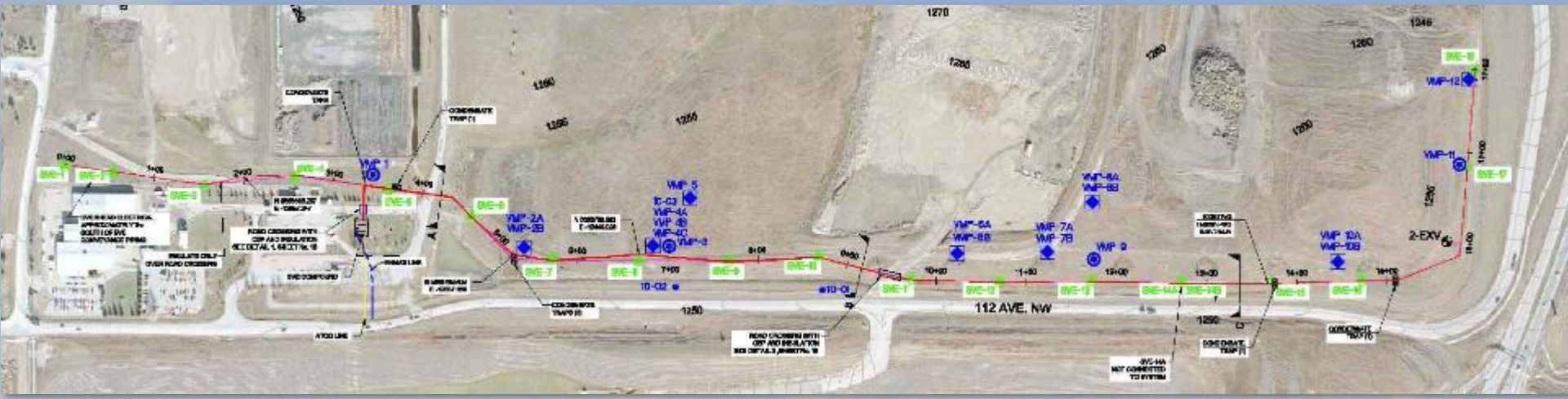

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Outline

- Project Overview
  - Background, project objectives and scope
- Design
  - Review of design and challenges
- Construction
  - Review of construction and challenges
- Commissioning & Operations
  - Review of operational experiences and challenges
- Conclusions & Lessons Learned

Project Background

- Spyhill Landfill operated from 1968 to present
  - Stage 1 operated from 1968 to 1992
- Initially outside the city, development has encroached
  - Residential to the south and northeast, commercial to the east and northeast, and industrial to the west and northwest
- Routine monitoring identified sub-surface VOCs
  - No off-site risk was found, but precautions were planned
- Past disposal practices met standards of the day, though not current standards
  - Waste segregation was limited
  - Stage 1 is largely unlined and capping is not engineered

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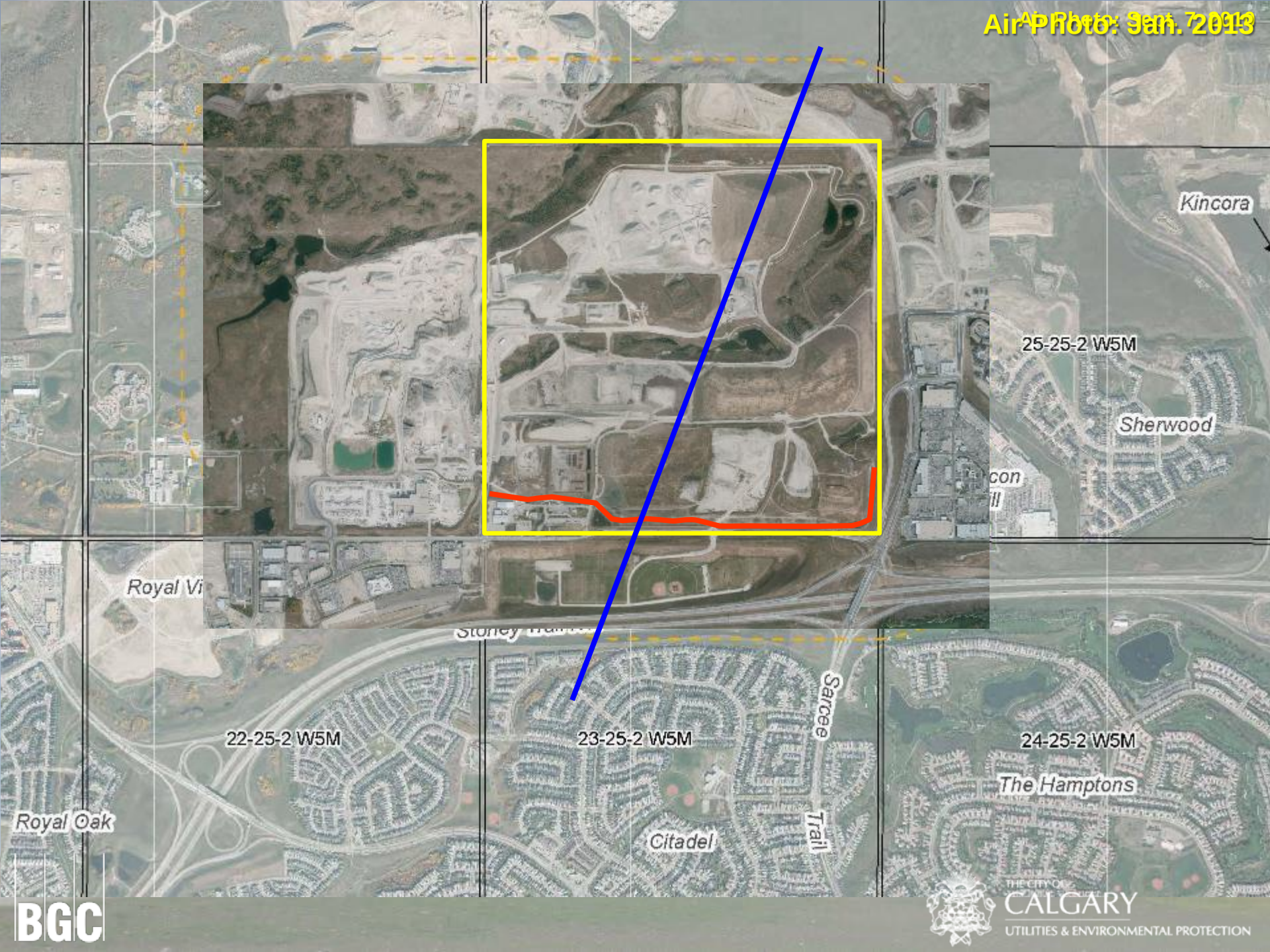
Air Photo: Jan. 2013
Kincora
25-25-2 W5M
Sherwood
Royal Vi
22-25-2 W5M
23-25-2 W5M
24-25-2 W5M
Sarcee
The Hamptons
Royal Oak
Citadel
Trail
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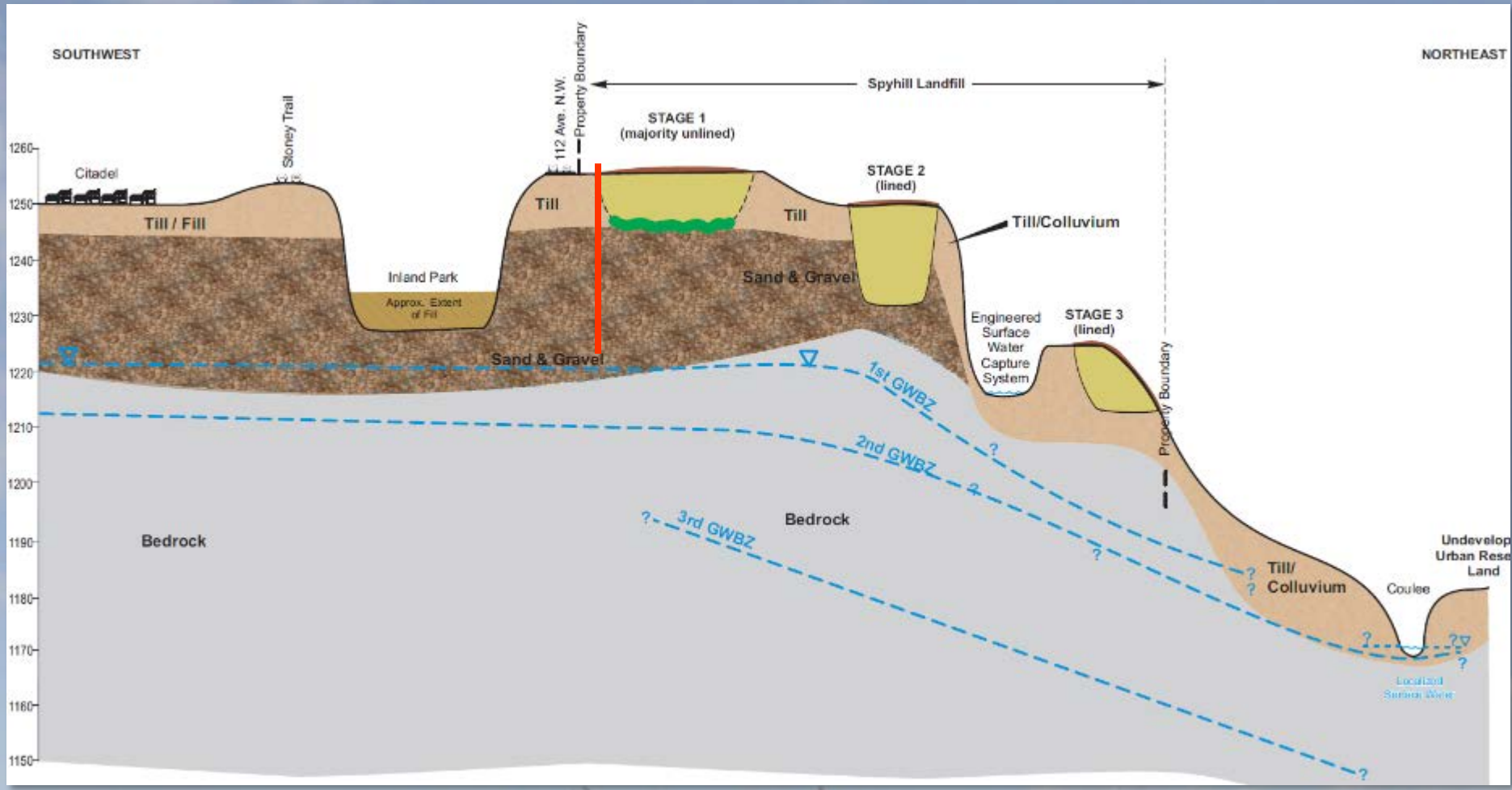
Site Geology

Southwest

Northeast



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SVE Project Objective & Scope

- Objective: To capture VOCs from below the landfill migrating off-site to the south
- SVE wells: approx. 50m radius of influence anticipated
  - At extraction rate of 40 scfm
- Nineteen (19) extraction wells
  - Screened across the vadose zone (unsat. sands & gravels)
- SVE wells distributed among 4 independent headers
- ~1.8 km system length (incl. 3.5 km of header piping)

Design

- Challenges:
  - Varying geology along length of SVE route and vertically within sands and gravels
  - Varying waste quality and (consequent) soil vapour quality across system
  - Coordination with active landfill requirements
  - Explosive gas handling considerations

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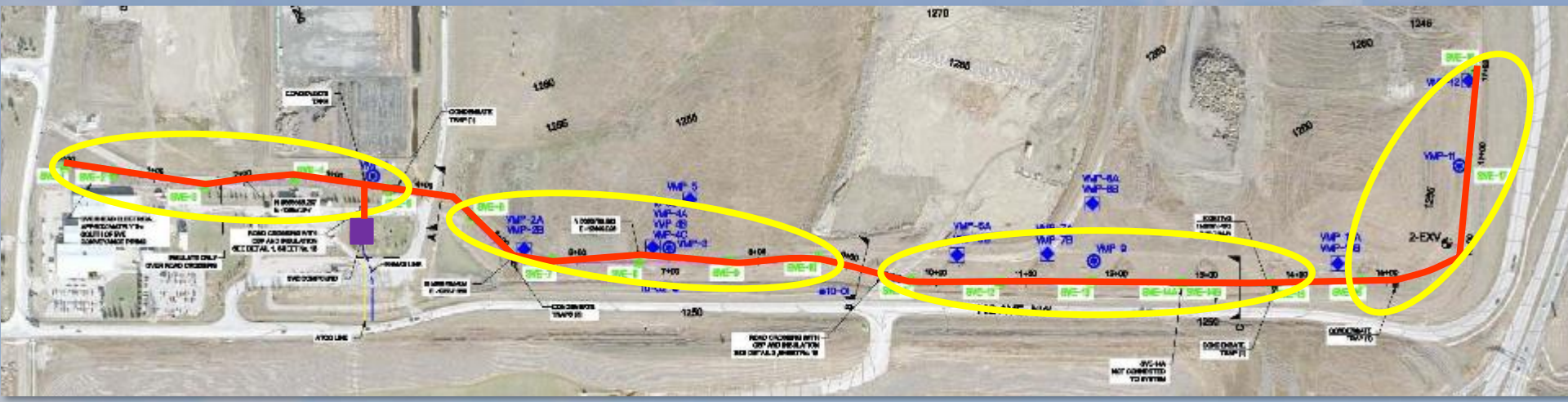
SVE Well Layout Profile



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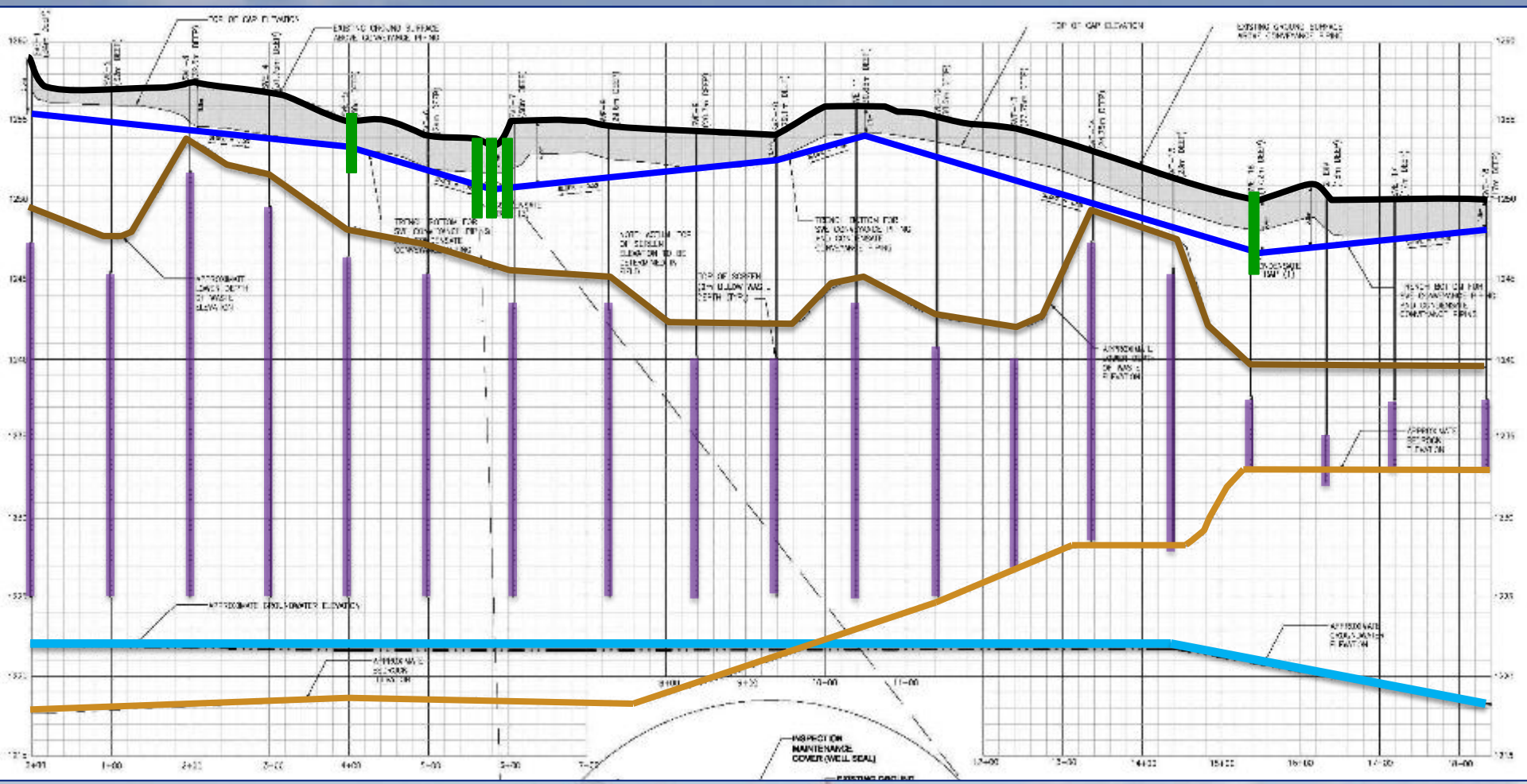
SVE Well Layout Profile

West

East



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Extraction & Treatment System

Extraction System

- 760 scfm design flow rate
  - 40 scfm X 19 extraction wells
  - Redundant blowers

Treatment System

- Chemicals of potential concern (COPC)
  - Chlorinated solvents, freons, hydrocarbons
  - 99% destruction efficiency target (98% for CH4)
  - Ground flare (oxidation system) selected for treatment
    - Fueled by extracted methane and supplemental natural gas

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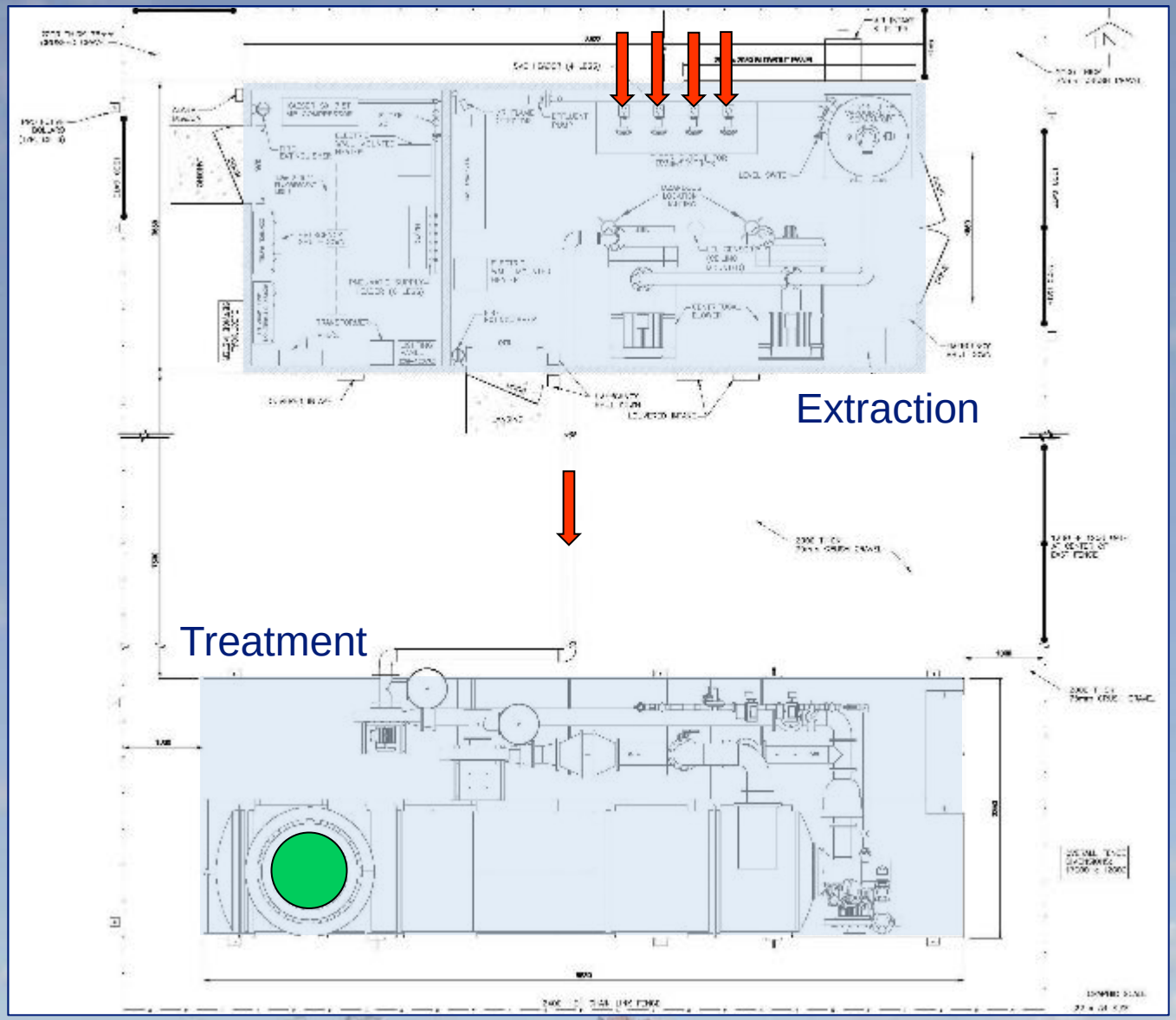
SVE System Compound



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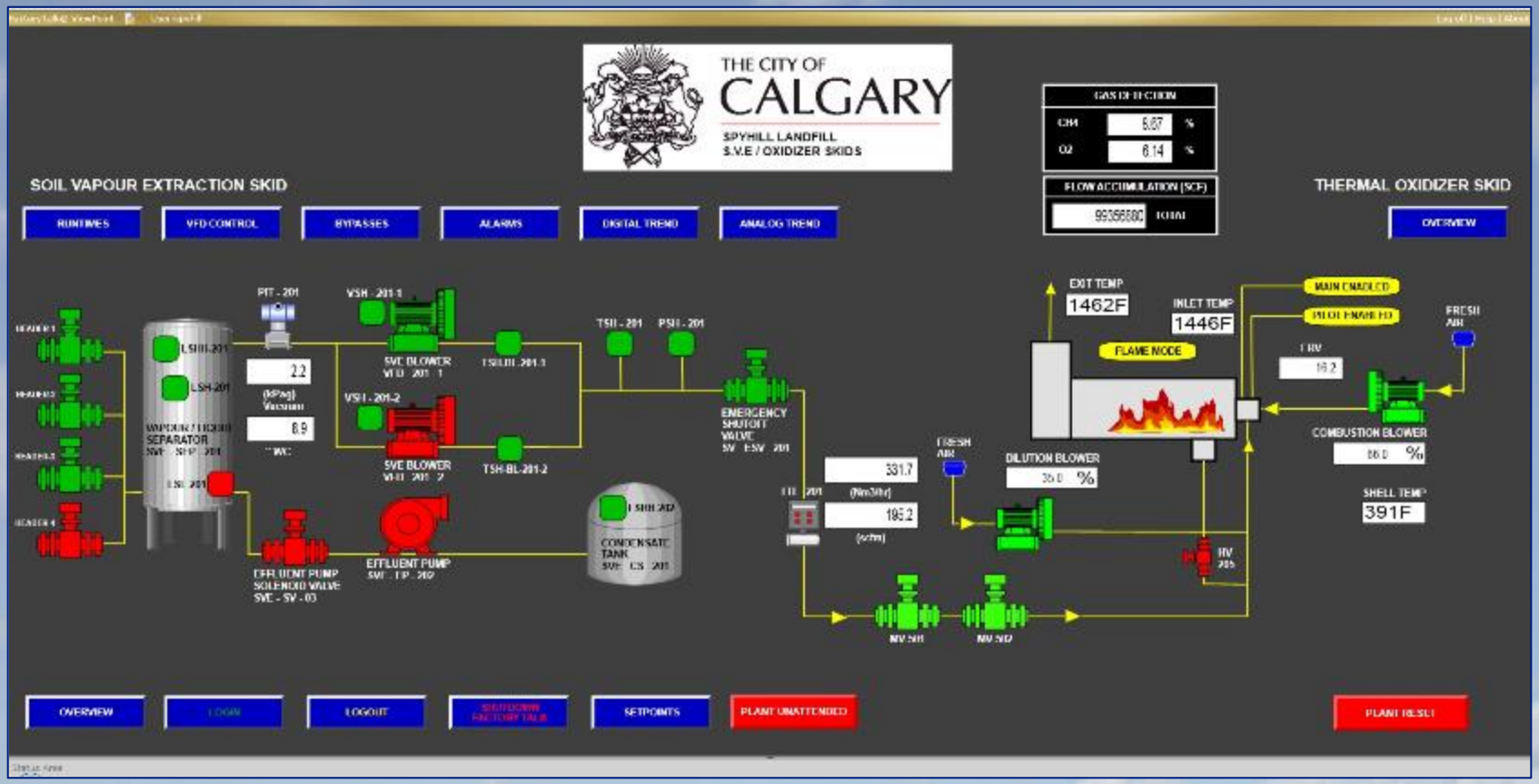
SVE Remote Operation



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Construction

- Challenges
  - Drilling conditions were very challenging
    - Drilling through waste has certain requirements
    - Drilling in sands & gravels has differing requirements
    - Rig selection very important (to accommodate both)
    - System revolves around quality of well installations
  - Construction in waste... always fun!
    - H&S – methane and potential H2S and VOCs
    - Odour management
    - Leachate infiltration – disposal and construction issues
    - Trench slope stability
  - Supply chain – long lead items
    - Check long leads items early and often... don't believe the initial delivery timing

SVE Well Installations

Drilling SVE Wells
Nov/Dec 2010 & Apr 2011

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SVE Trench Aug – Nov 2011

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SVE Header Installation

Aug – Nov 2011

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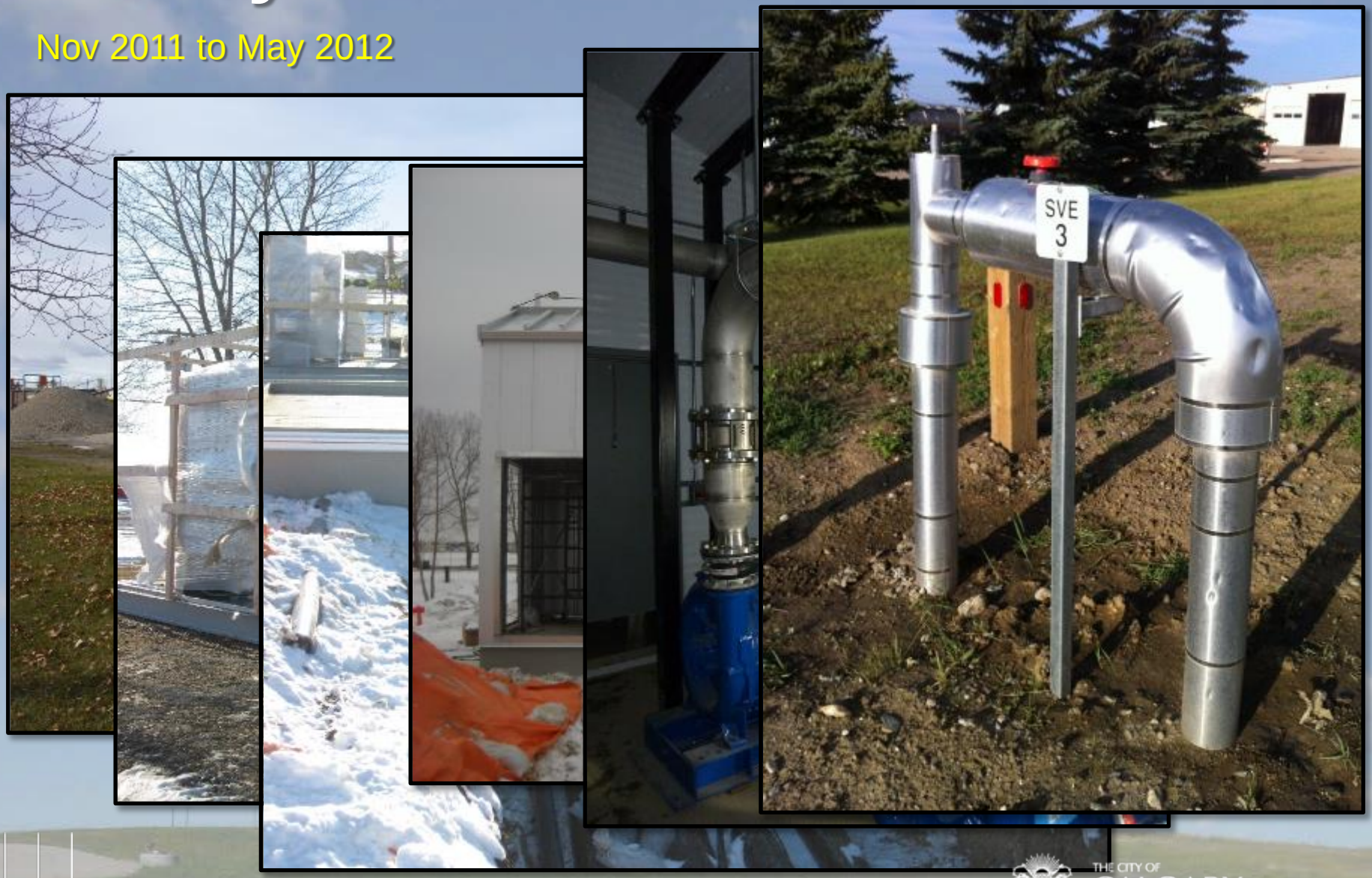
SVE System Fabrication

Nov 2011 to May 2012



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Commissioning

- Construction completion – May 2012
  - Delays due to long lead time on valves and instrumentation
- Commissioning and shakedown – May to Aug 2012
  - Programming refinements
  - Gas quality drift
- Begin long term operation – Aug 2012
  - Sustained operation
  - Performance assessment ongoing to identify capture
  - Need to optimize flow to deal with low methane
  - Need to shift to thermal oxidation mode

Operations

- Challenges
  - Extracted vapour quality variance (lower CH4, higher O2)
  - Gas handling through explosive range
  - High sensitivity of extracted gas to barometric pressure
  - Capture assessment involves very small pressure differential
  - Environmental and thermal stresses on system
  - Significant ground settlement along conveyance piping
- Operational effort much higher than anticipated
  - Greater labour effort, higher utility consumption

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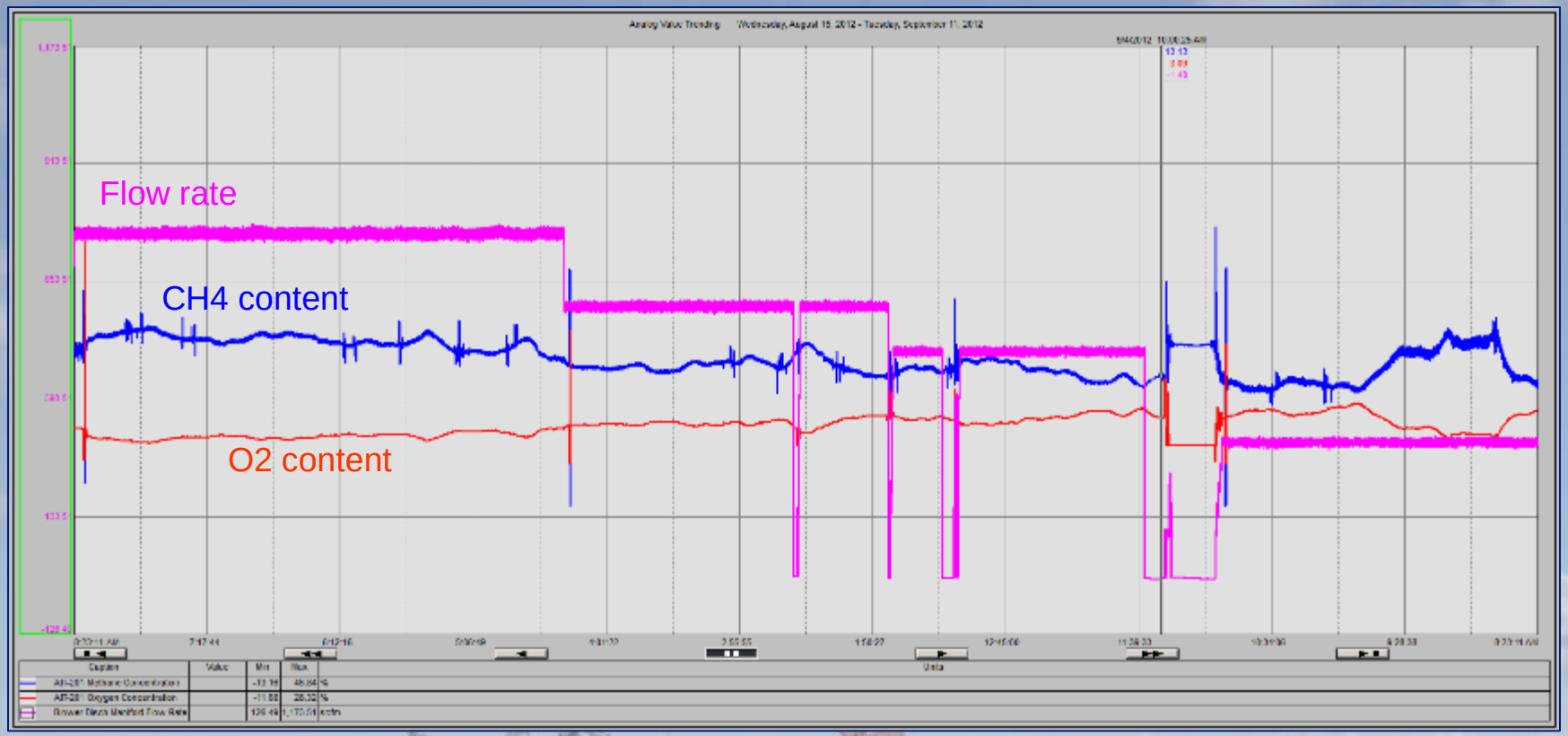
Gas Quality Trend

- Gas quality – Aug. 2012: 23% CH4, 0.5% O2
- Gas quality – Mar. 2013: 10% CH4, 6% O2



Conclusions

- System is operational and capable of drawing vapours from sands and gravels across the 1.8km system
  - Performance evaluation (capture assessment) is still ongoing
- System is unobtrusive and able to operate within the active landfill
- Treatment system is effective in treating the extracted soil vapours
  - Initial DRE testing indicates targets are being met
- System is robust, has run consistently through four seasons (+) and has weathered many unscheduled shutdowns

Lessons Learned

- Managing uncertainty in site conditions is challenging
  - Sensitivity analysis in the design stage
  - Build flexibility into design
  - Undertake staged implementation
  - ***Observational Method***
- Increases in operational effectiveness and efficiency are anticipated in long term operation

Moving Forward

- Current system to be upgraded to optimize performance
  - Core system components are robust and effective
    - Well field, extraction plant, treatment system
  - Operation through the explosive range is needed to efficiently achieve VOC capture objectives
  - Labour and utility consumption efficiencies are achievable

Thank You !

- Questions?

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