Hydrogen Sulfide Remediation at King George County Landfill

January 18, 2012

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Waste Management

Delmarva Area

Gas Operations Manager

WASTE MANAGEMENT

SAVING THE PLANET ONE LANDFILL AT A TIME

Agenda

- Site Overview / History
- H2S Detection and Determination of Extent
- Gas Collection and Control System Upgrades
- Intermediate Cap
- Evaluation of H2S removal systems
- Installation of Temporary/Intermediate H2S Scavenger System for LGTE Plant and Flares
- Way Ahead
- Questions

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Site Overview

- 295 acres
- 190 acres filled
- 14 acres capped
- 11.4 M tons filled
- 1.2M tons in 2010
- 5K tons/day

(2,500 tons/day rail)

<u>Gas:</u>

- Current: 7K Scfm
- LGTE: 4 turbines
- 12.4 Mw

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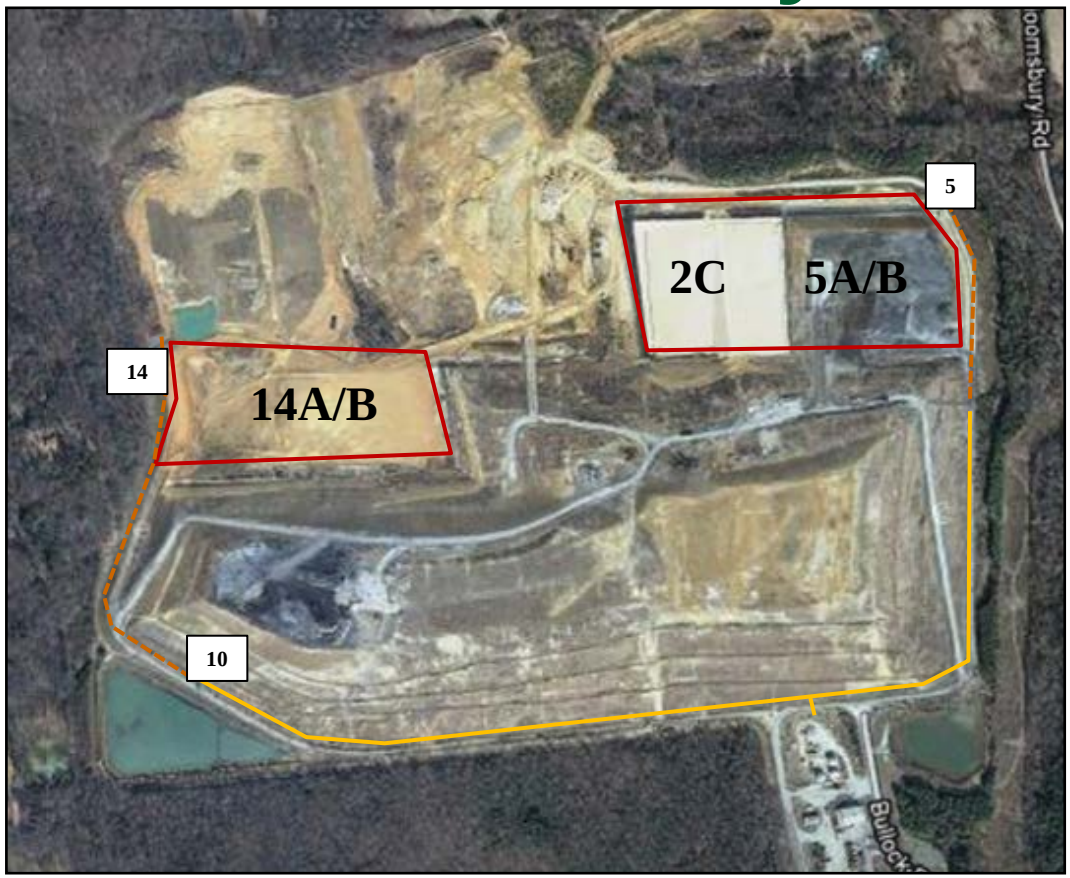
Site History



Landfill Open 1996

Waste 5A/B & 2C 2008

Nor/Ida & Snow 2009

Odor Complaints Jan 10

GCCS Upgrades Jan-Aug 10

LGTE Startup May 10

ID H2S as issue Jun 10

H2S Testing Oct 10

Construction Nov 10

LGTE Treatment Dec 10

Flare Treatment Dec 10

Cap Construction Feb 10

Cap Complete

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H2S Detection and Determination of Extent

Compliance Drivers

- Title V permit:
  - 240 Ton/Yr SO2 (770 ppm H2S @ 8000 Scfm)
  - No off site odors
- LFGTE Stationary Source Permit. :
  - 0.15lb/MMBtu SO2 (435 ppm H2S)
  - Stain tube test for H2S for 30 days upon startup

  Results 1200-1400 ppm(2007 test 235 ppm)
  - Stack Performance Test within 90 days

  Results average .319lb/MMBtu

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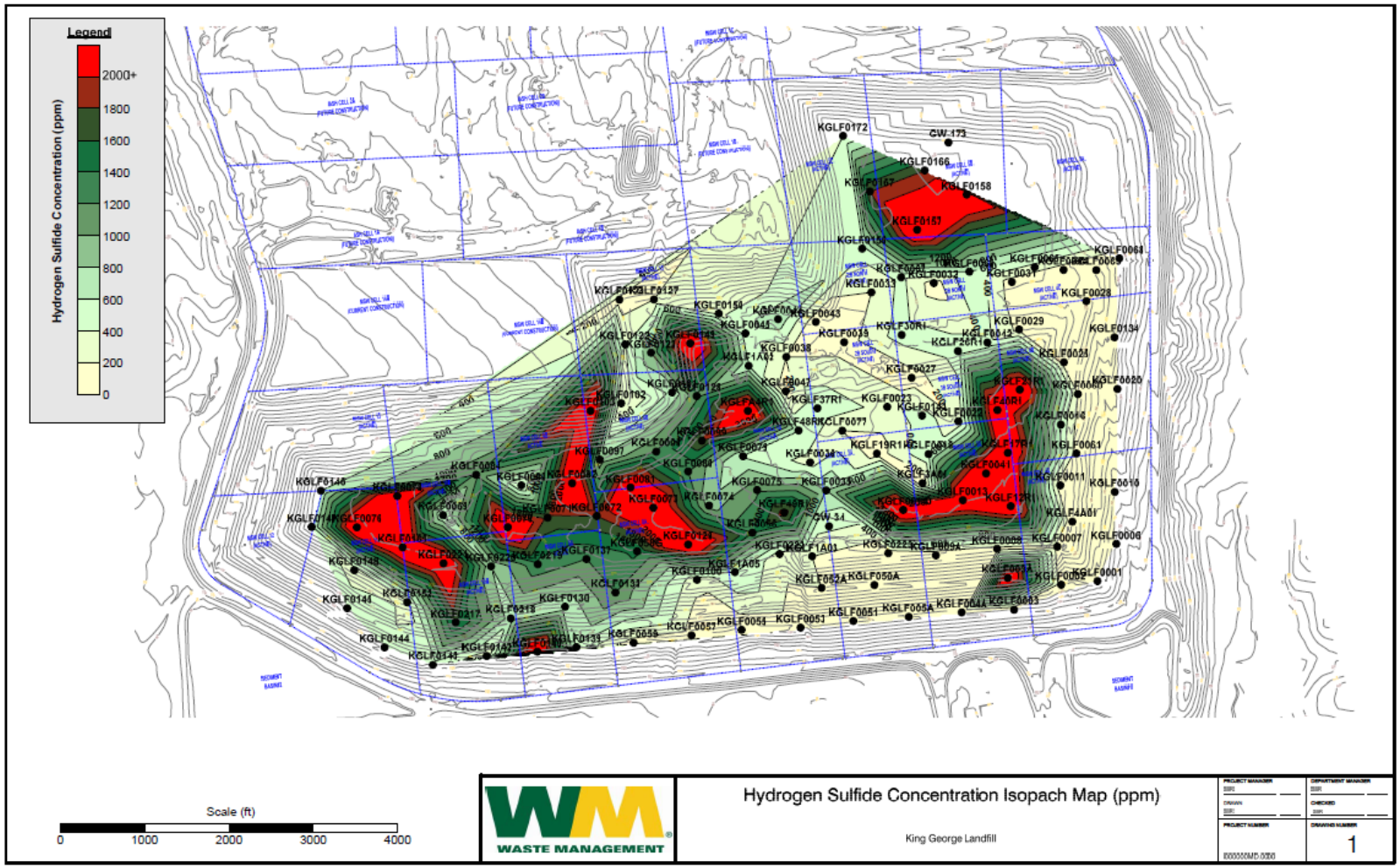
H2S Field Detection Methodology

- Stain tube testing at flare, plant and key areas of landfill (Cell 5A/B 2C)
- Tedlar bags at flare, plant and key areas of landfill
- 100% stain tube test of all collectors
- Tedlar bags of high concentration collectors (+2000ppm)
- 3 X daily monitoring of flare and LGTE plant

H2S Field Test Results



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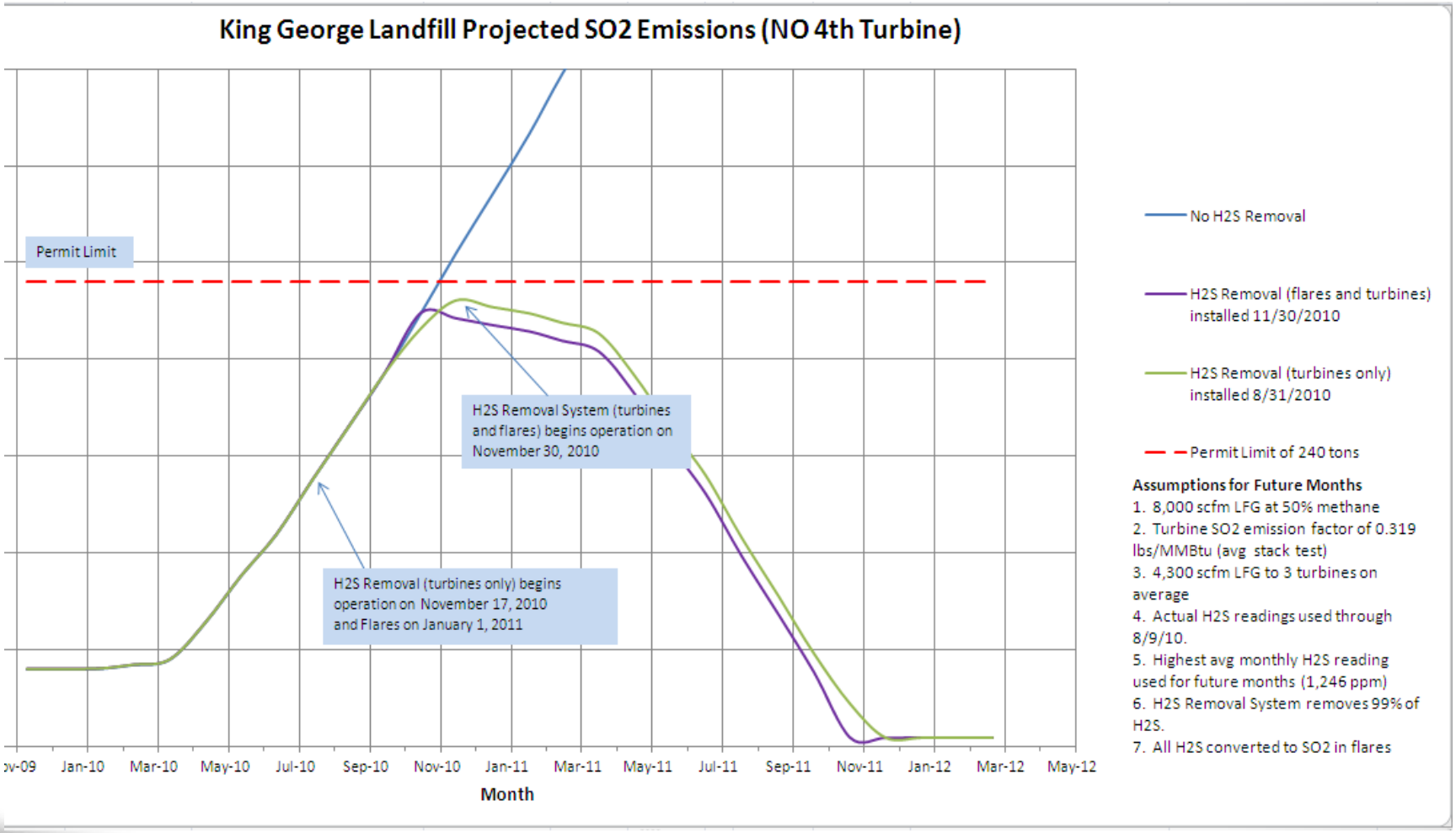
Projected SO2 Emissions Tons/Yr

12 Month Rolling Average



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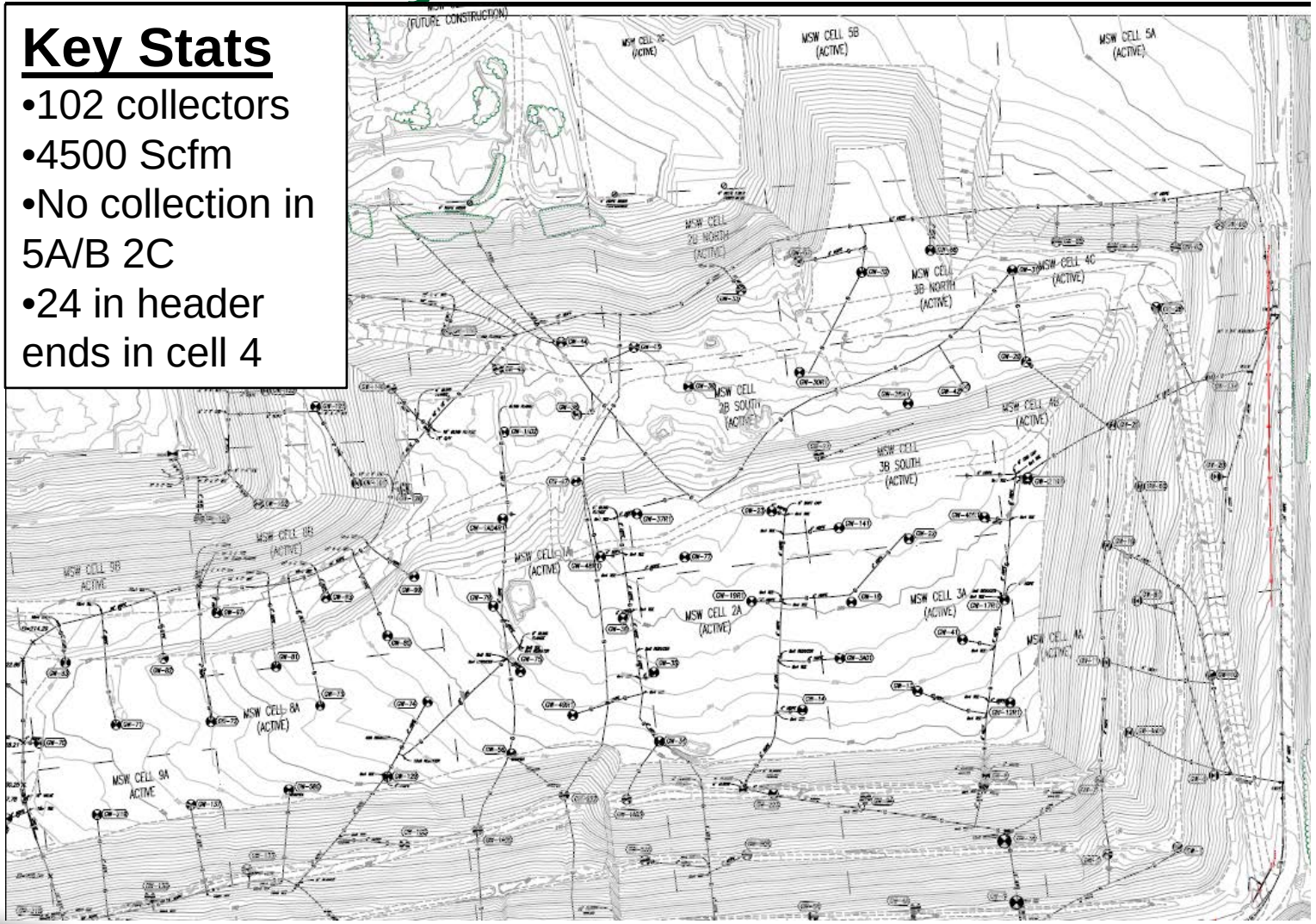
GCCS System as of Jan 2010

Key Stats

- 102 collectors
- 4500 Scfm
- No collection in 5A/B 2C
- 24 in header ends in cell 4



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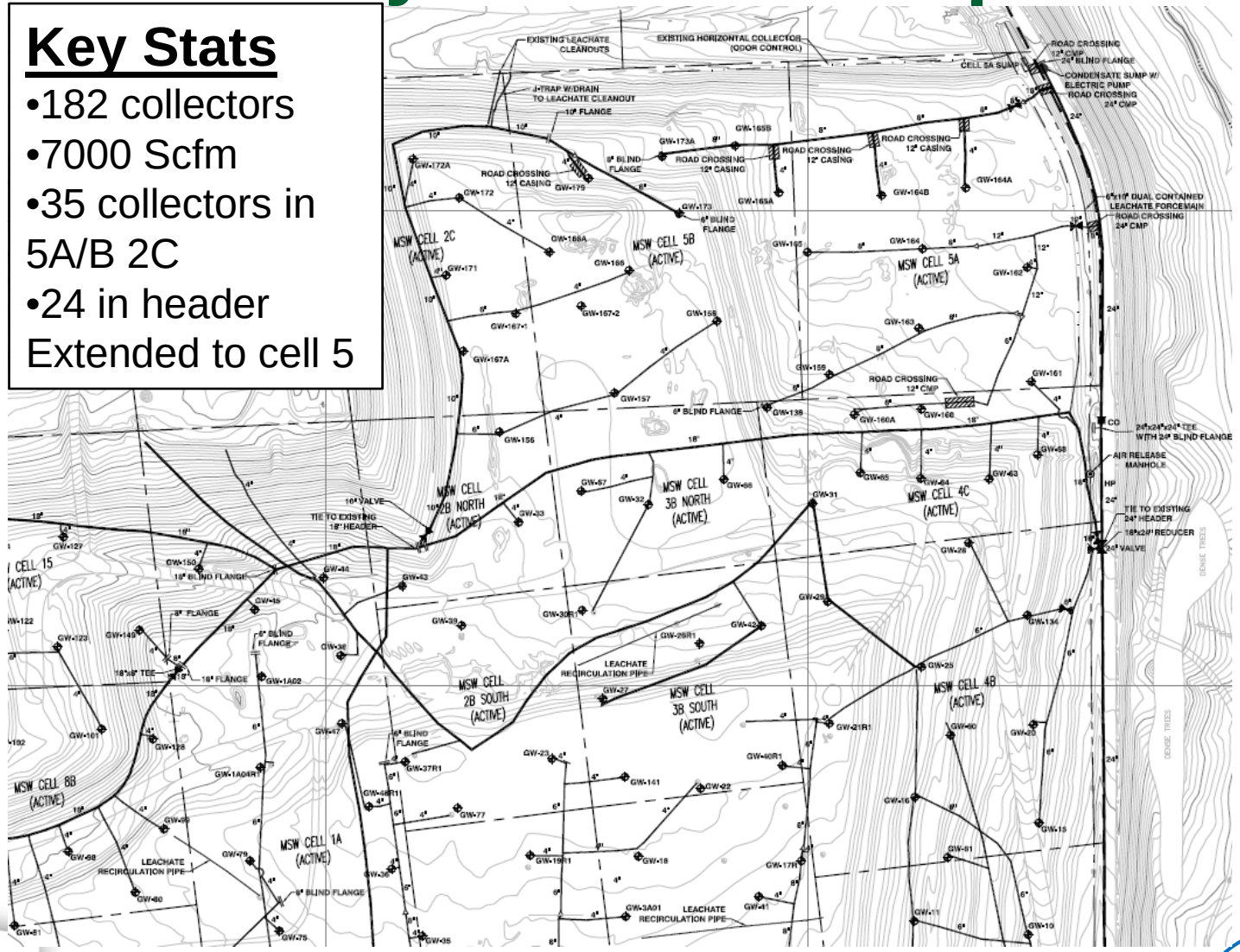
GCCS System as of Sep 2010

Key Stats

- 182 collectors
- 7000 Scfm
- 35 collectors in 5A/B 2C
- 24 in header Extended to cell 5



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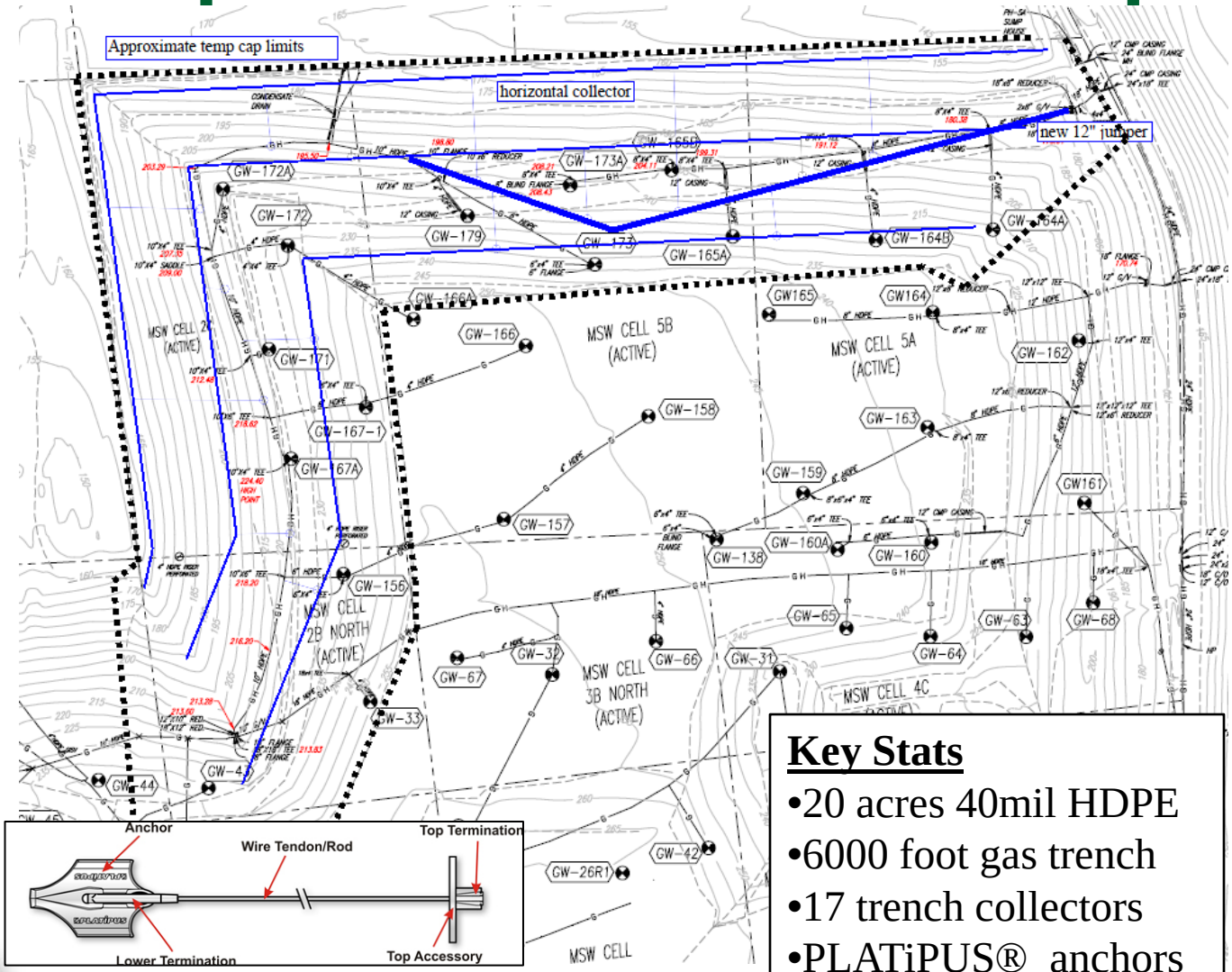
Exposed Intermediate Cap



Key Stats

- 20 acres 40mil HDPE
- 6000 foot gas trench
- 17 trench collectors
- PLATiPUS® anchors

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Interim Cap

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Evaluation of H2S Removal Systems

- **Design Criteria**
  - LFG flow rate: 8000 Scfm interim, 12000 Scfm life of site
  - Input H2S levels: 1200 ppm
  - Output H2S level: <1 ppm
  - Implementation: as soon as practical. Only solutions with short implementation times were considered for the interim treatment solution
- **Technology Available**
  - Activated carbon
  - Liquid scavenger chemicals (Q2, Benzeco Scientific)
  - Solid scavenger chemicals (SulfaTreat®)
  - Bio-process (THIOPAQ®)

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Solid Scavenger System

- Ceramic base impregnated with Iron Oxide. (Fe_2O_3)
- Saturated LFG with H_2S flows through solid media, converted to Iron Pyrite. (FeS_2)

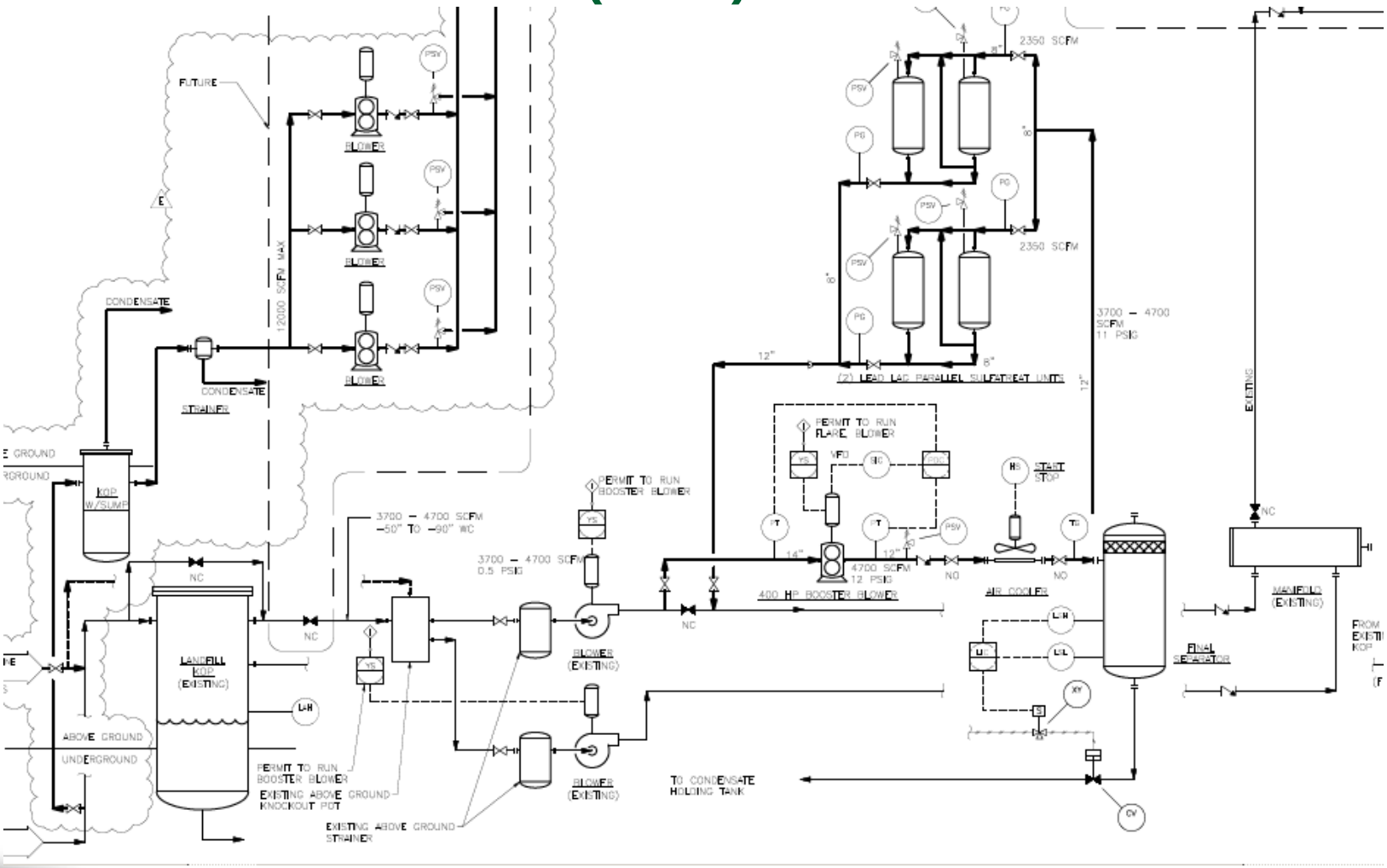
$$4H_2S + Fe_2O_3 \longrightarrow 2FeS_2 + 3H_20 + H_2$$

- Lead lag system: 3 vessels (turbine) 4 vessels (flare)
- Change out done at 20ppm H_2S outlet of lag
- Lead changed out, lag becomes lead, standby becomes lag

Solid Scavenger

- **Pros**
  - Proven in LFG application
  - Short implementation: used vessels available
  - Relatively low capital cost
  - Simple operation / controls
  - Vessels can be reused when H_2S levels drop
- **Cons**
  - High pressure drop, upgrade compressor required
  - Media replacement costs
  - Disposal of spent media (landfill)

Solid Scavenger System
(Flare)



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Solid Scavenger System

Flare treatment

Plant treatment

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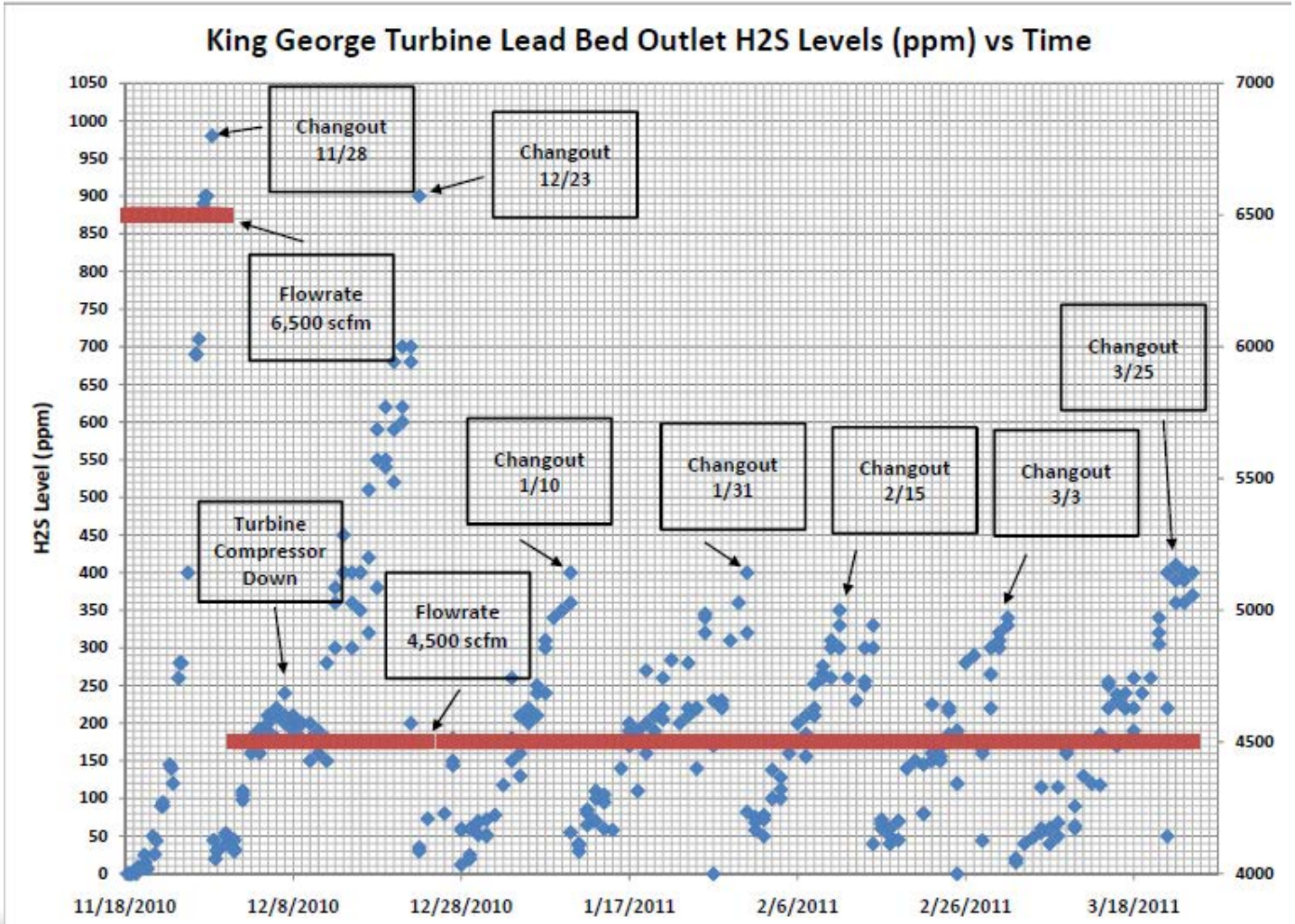
H2S Monitoring/Change Out



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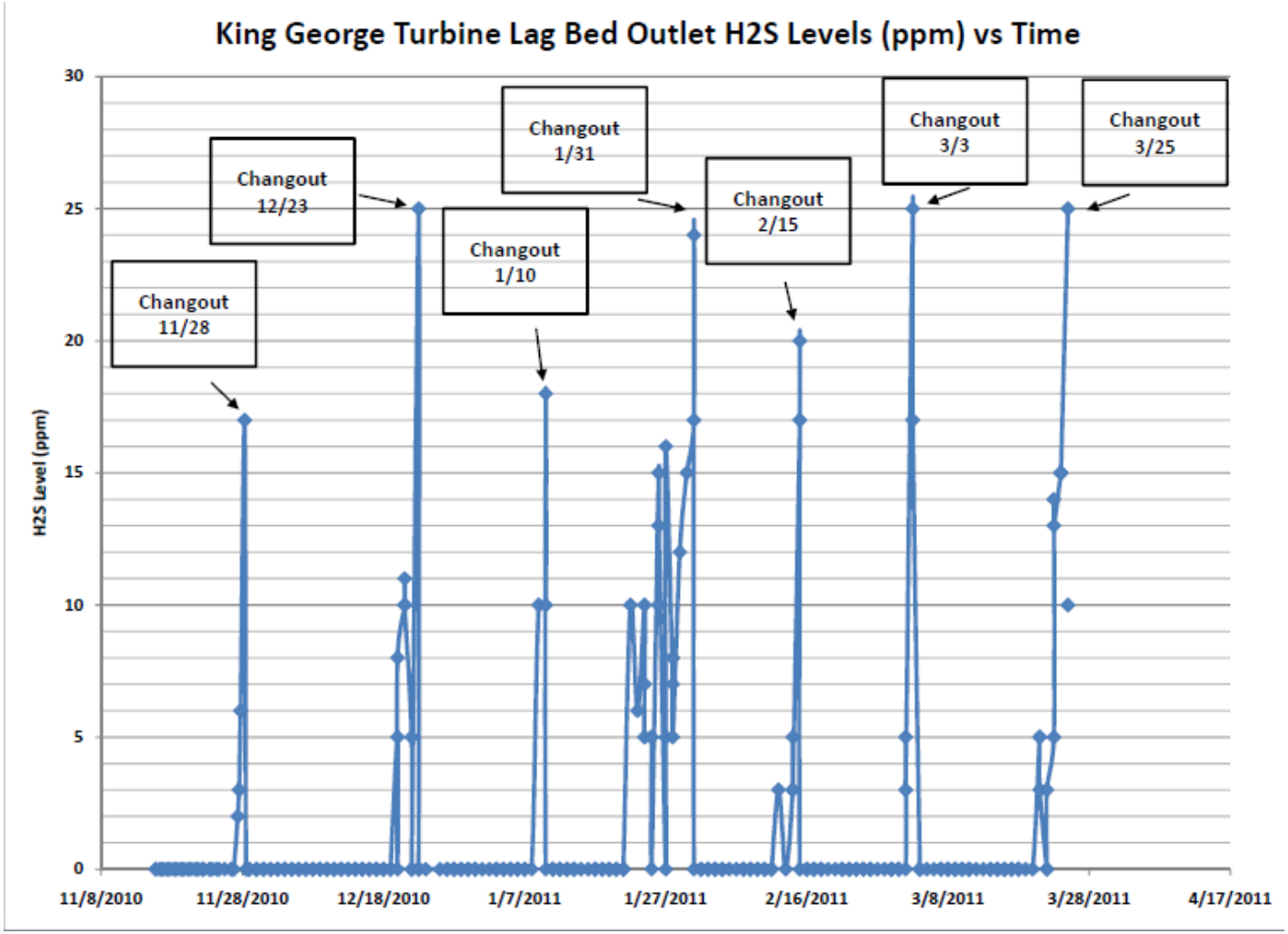
H2S Monitoring/Change Out



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SAVING THE PLANET ONE LANDFILL AT A TIME

THIOPAQ®

- Biological process for removal of H2S from gas streams
- Gas is contacted with an aqueous soda solution
- H2S is absorbed by the soda
- H2S is removed from the soda by biological conversion to elemental sulfur using air
- Regenerated soda is returned to the absorber

THIOPAQ®

- **Pros**
  - Effective H_2S in large scale / life of site (12000 Scfm)
  - Regenerative
  - Waste product is organic elemental Sulfur which can be landfilled or used as organic fertilizer
  - Lower operational costs
  - Controls will improve gas system performance
- **Cons**
  - High capital costs
  - Relatively new process in landfill environment
  - One supplier for nutrient
  - Extensive design and construction

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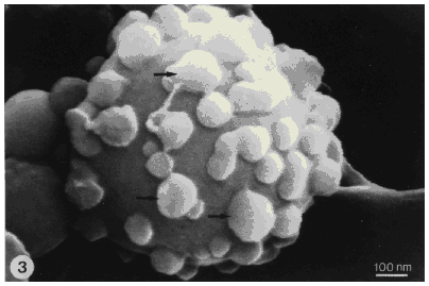
THIOPAQ® Process Chemistry



- **Absorption**

  $H_2S + OH^- \longleftrightarrow HS^- + H_2O$

- **Bio- Regeneration**

  $HS^- + \frac{1}{2}O_2 \longrightarrow S^o + OH^-$

- **Oxidation into sulfate (bleed) <5%**

  $HS^- + 2O_2 \longrightarrow SO_4^{2-} + H^+$

- **Bioreactor conditions**
  - pH 8-9
  - Temperature 60-100 F
  - O_2 controlled to limit sulfate production

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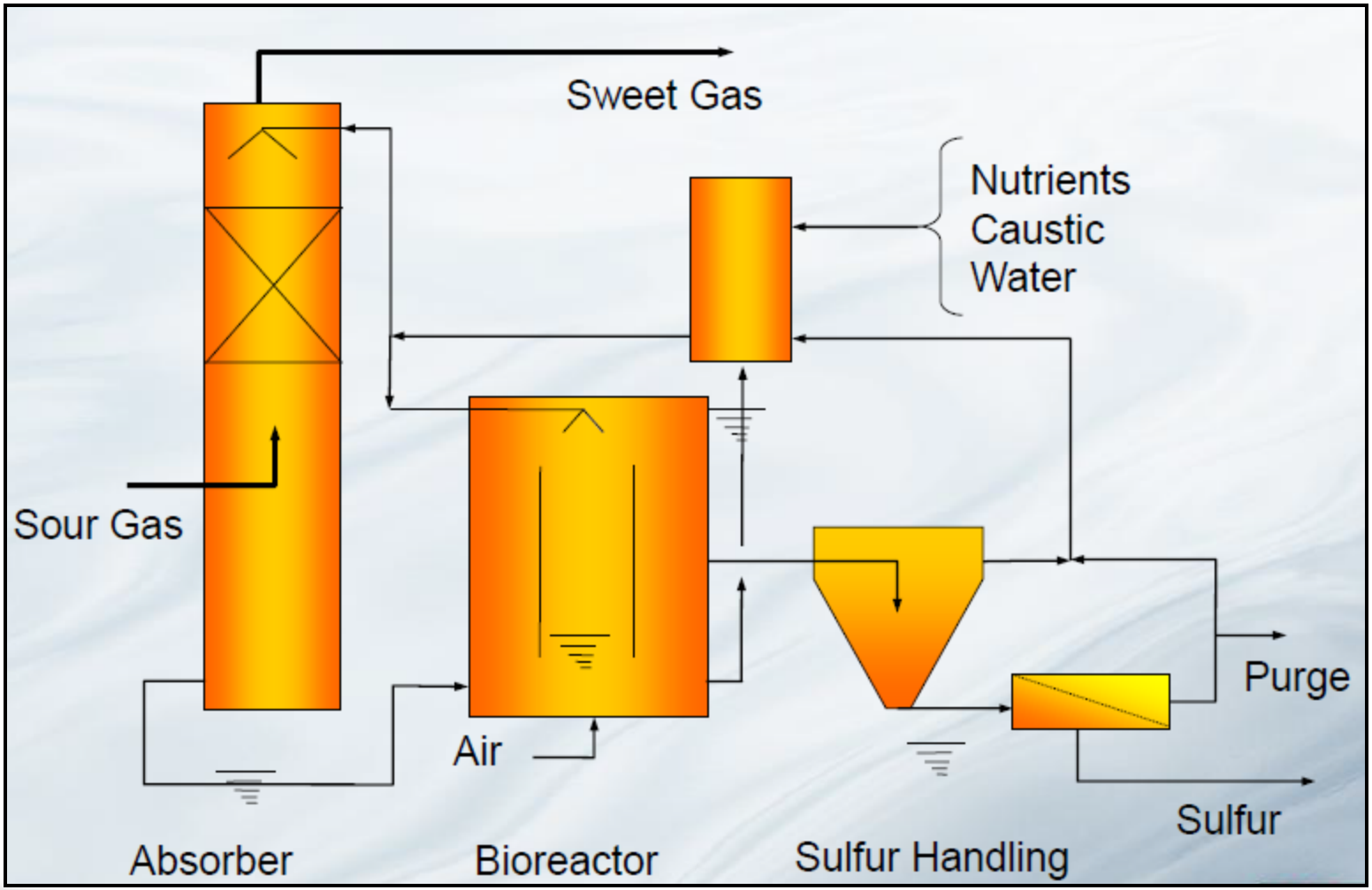
THIOPAQ® Process



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Way Ahead

- Installation of 4th turbine June 2011
- Construction/startup of Cameron THIOPAQ® biological sulfur removal system
- Continuing GCCS upgrades of header, well installations and collection in Cell 14A/B
- Continuing H_2S monitoring
- Interim cap cell 14 A/B

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Questions/Discussion