Methane Seepage: Measuring the Flux, Recovering Lost Resources, and Protecting the Environment*

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Abstract

Since the mid-1990's, the seepage of methane has added complexity to how production companies are required to operate in Colorado. Residents near methane seepage are demanding that governments understand this reservoir seepage; how methane impacts human health and the environment; what impacts the loss has on unrecovered mineral resources; and the effects on global climate change. Recent rule changes in Colorado have been promulgated in an attempt to address these concerns.

Monitoring methane seepage in La Plata County, Colorado, has been performed with an overriding goal of quantifying the temporal changes in the magnitude and extent of the flux. The objectives of the monitoring program are: to understand how seepage affects vegetation, coal fires, and explosion hazards; evaluate losses in production; identify preferential pathways; verify seepage model predictions; and evaluate contributions to greenhouse gas emissions.

Recent application of methane flux equipment has aided in better quantifying seepage rates. With more than 10 years of data, methane seepage, primarily from 5 discreet areas, along a 23-mile stretch of the San Juan Basin north rim, is estimated at approximately 6,000 MCFD.

Quantifying methane seepage has focused efforts toward implementation of mitigation measures by county governments, the COGCC, the Southern Ute Indian Tribe, and CBM operators. Mitigation is currently being performed or evaluated through surface and subsurface capture and changes to county building codes. Development of mitigation approaches is evolving and may include strategic CBM production (infill or near the outcrop), potential carbon credit incentives, and local conversion to electricity.

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JOHN PETERSON-PRESENTED TO RMS-AAPG JUNE 16, 2010

Pine River – San Juan Basin

Purgatoire River – Raton Basin

North Fork Texas Creek – San Juan Basin

Weston – Raton Basin

Bondad – San Juan Basin

Image source - CBS4 KCNC

Weld County – DJ Basin

EFFECTS OF SEEPAGE

- Accumulation of explosive vapors
- Dead vegetation through O_2 displacement in the root zone
- Water well / shallow aquifer impacts
- Inefficient reservoir production
- Greenhouse gas emissions
- Property value impacts
- H_2S gas generation

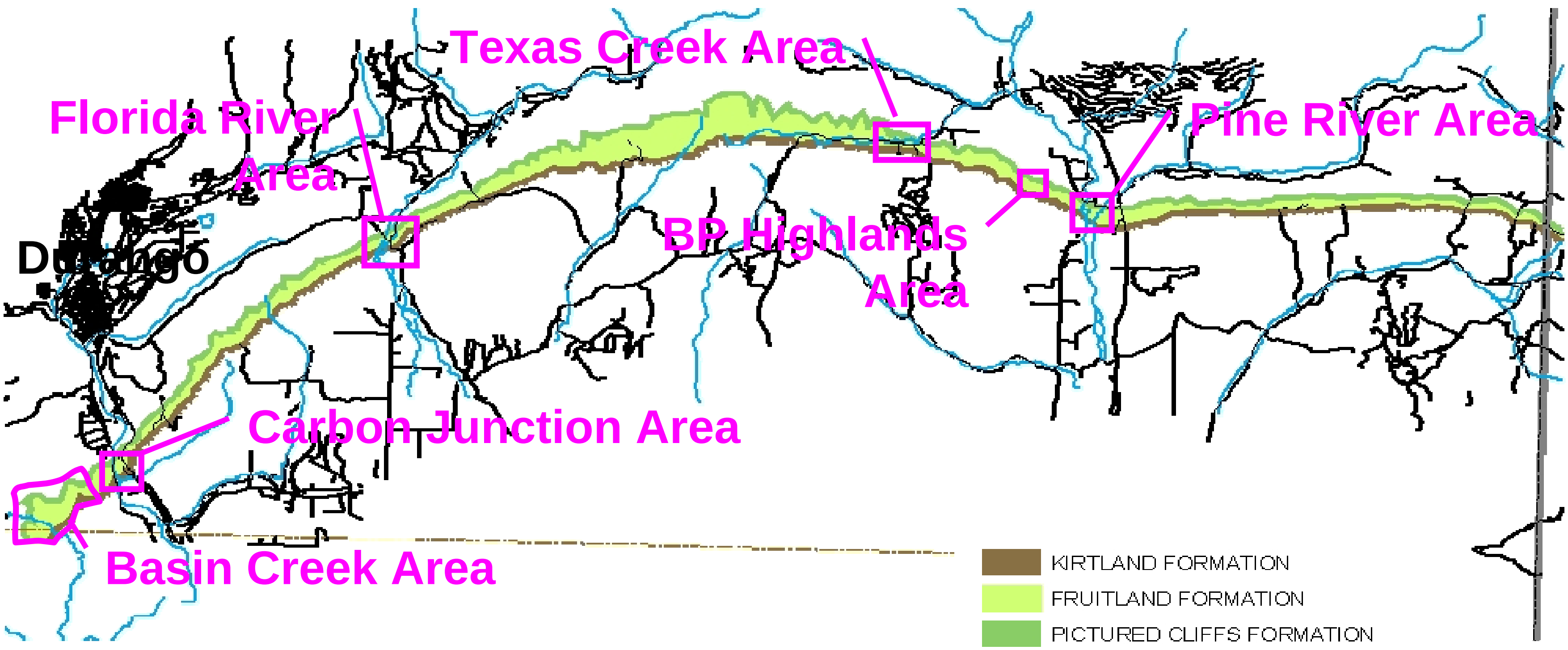
SAN JUAN BASIN BACKGROUND

Source: BP.com

- **Covers 6,700 mi^2 of land area.**
- **Second largest natural gas reserve in U.S.**
- **Since the 1980's, the Fruitland Formation (Kf) has been the major source of CBM--1.32 TCF produced in 2008 (USEIA, 2009).**

HISTORICAL SEEPAGE

- Seepage has occurred for nearly 100 years.
- Seepage most active along the northern rim in La Plata County.
- Most commonly found where drainages transect the Fruitland Formation outcrop.



REGULATORY FRAMEWORK

- ~1997 - 3M (Mapping, Modeling, Monitoring) established to understand and evaluate seepage
- April 2000 – COGCC Issues Order 112-156 & 112-157
  - Establishes Buffer Zone for No Drilling
  - Requires Outcrop Monitoring
  - Requires Water Well Baseline and Post Drilling Sampling
- 2006 – 4M (Mapping, Modeling, Monitoring, Mitigation) established to continue work of 3M but also evaluate mitigation alternatives

REGULATORY FRAMEWORK

- April 2009 – COGCC Amends rules to include Rule 608 for all CBM development statewide
  - Outcrop Monitoring
  - Natural Spring Surveys
  - Abandoned Well Surveys
  - Water Well Sampling
  - Bradenhead Testing
  - Static Pressure Monitoring

MONITORING METHODS

<u>Probes</u>

Shallow subsurface, fixed-point, concentration, flow

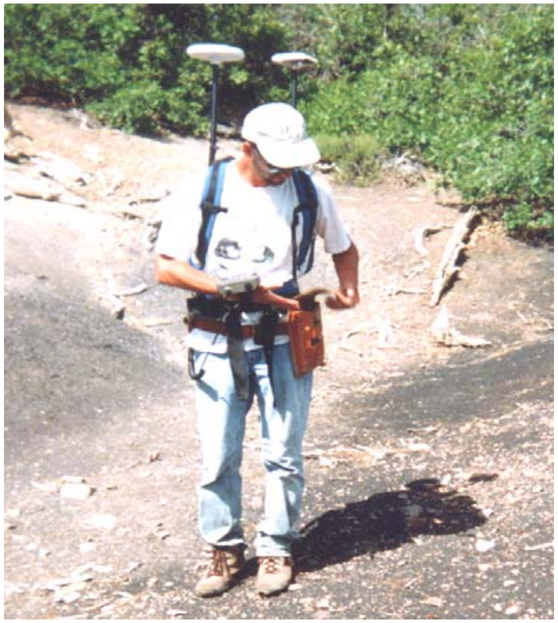
<u>Flux Chambers</u>

Surface, fixed-point, flow

<u>Monitoring Wells</u>

Subsurface (reservoir), fixed-point, gas/water pressures

MONITORING METHODS

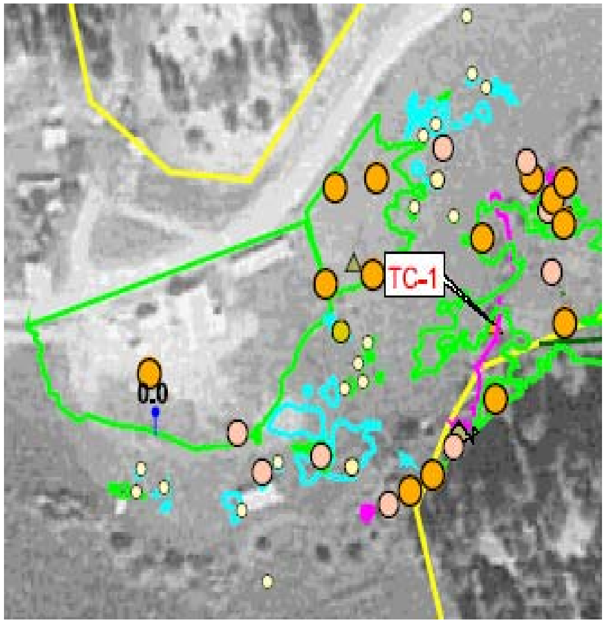


<u>Pedestrian Surveys</u>

Surface, variable-point, concentration

<u>Subsurface Temp Probes</u>

Subsurface, variable-point, concentration, flow



<u>Detailed Mapping</u>

Subsurface, variable-point, concentration

MONITORING METHODS

IR Imaging & Field Verification

Subsurface, variable-point, concentration

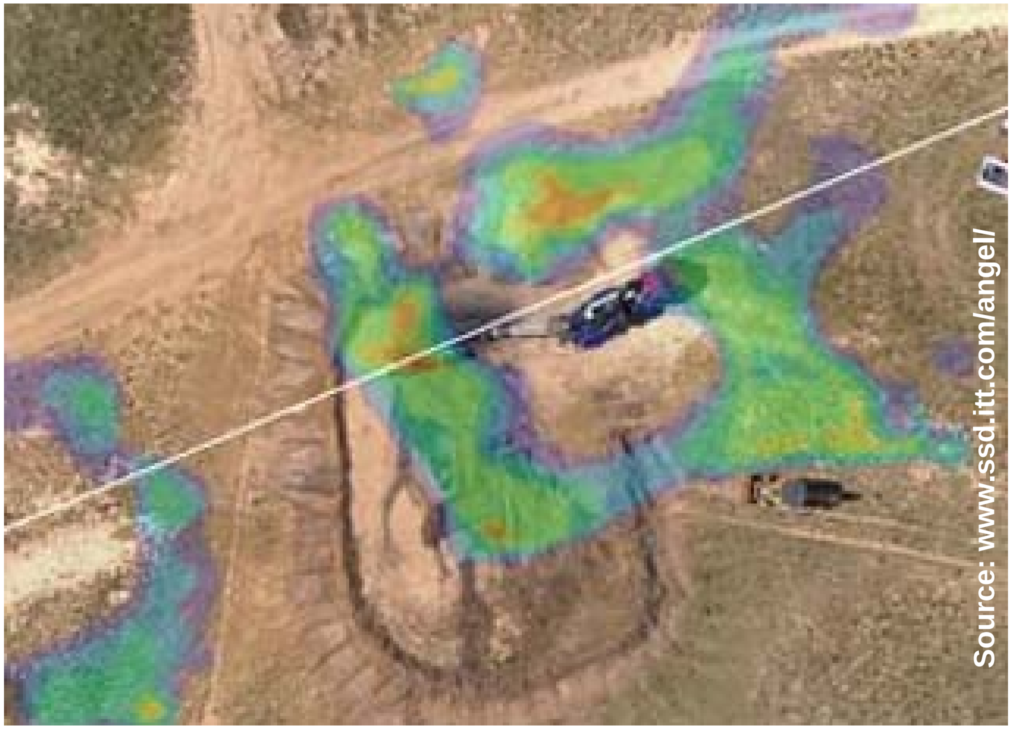
Spring Surveys

Surface water, fixed-point, concentration, flow

Road Surveys

Ambient air, variable-point, concentration, wind direction

MONITORING METHODS



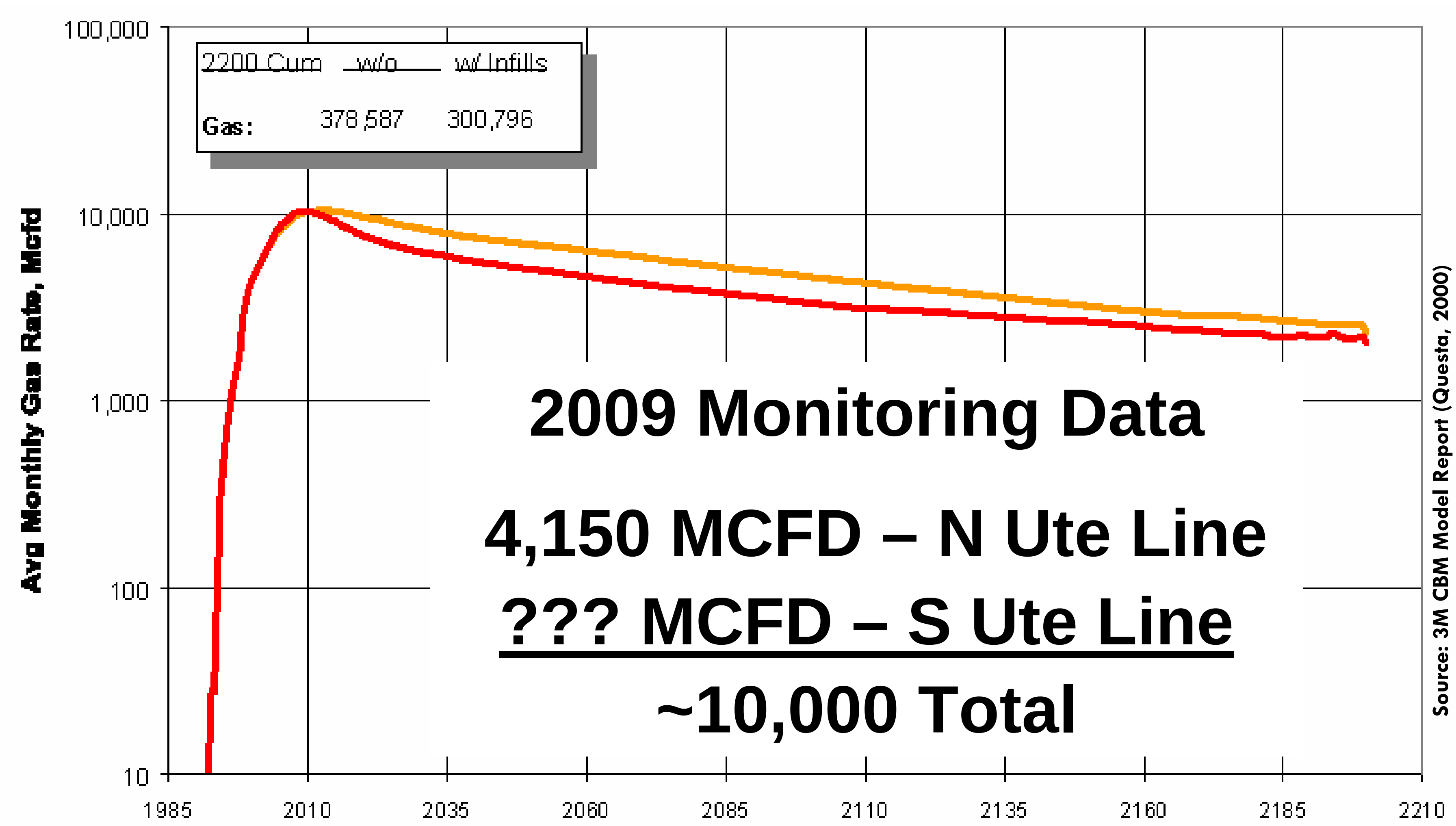
Aerial Natural Gas Emission Lidar (ANGEL)

Full land surface coverage, concentration

Portable Flux Meter

Surface, fixed-point grid, mass flux

METHANE FLUX VALUES – SJB



2009 Monitoring Data

4,150 MCFD – N Ute Line

<u>??? MCFD – S Ute Line</u>

~10,000 Total

MITIGATION

Protecting public safety, groundwater, greenhouse gas emissions, and recovering lost resources prompts the need for mitigation of methane seepage.

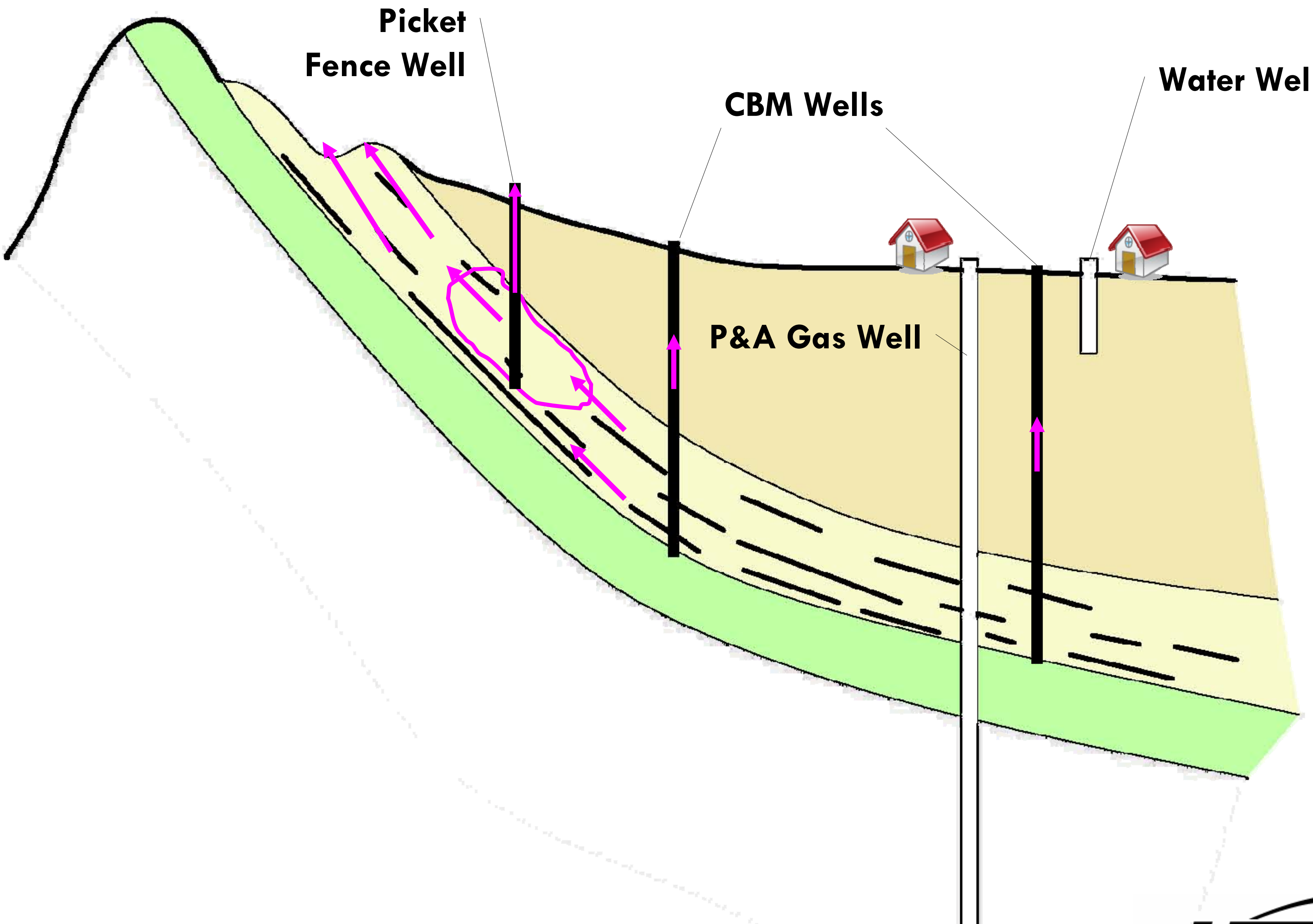
MITIGATION FOR SAFETY

- **P&A Well Surveys (ensure proper abandonment procedures)**
- **Bradenhead Testing (ensure proper completion procedures)**
- **County Building Codes**
- **Annual Surveying (monitoring)**
- **Water Treatment Systems**
- **Water Sampling**

MITIGATION FOR RECOVERY

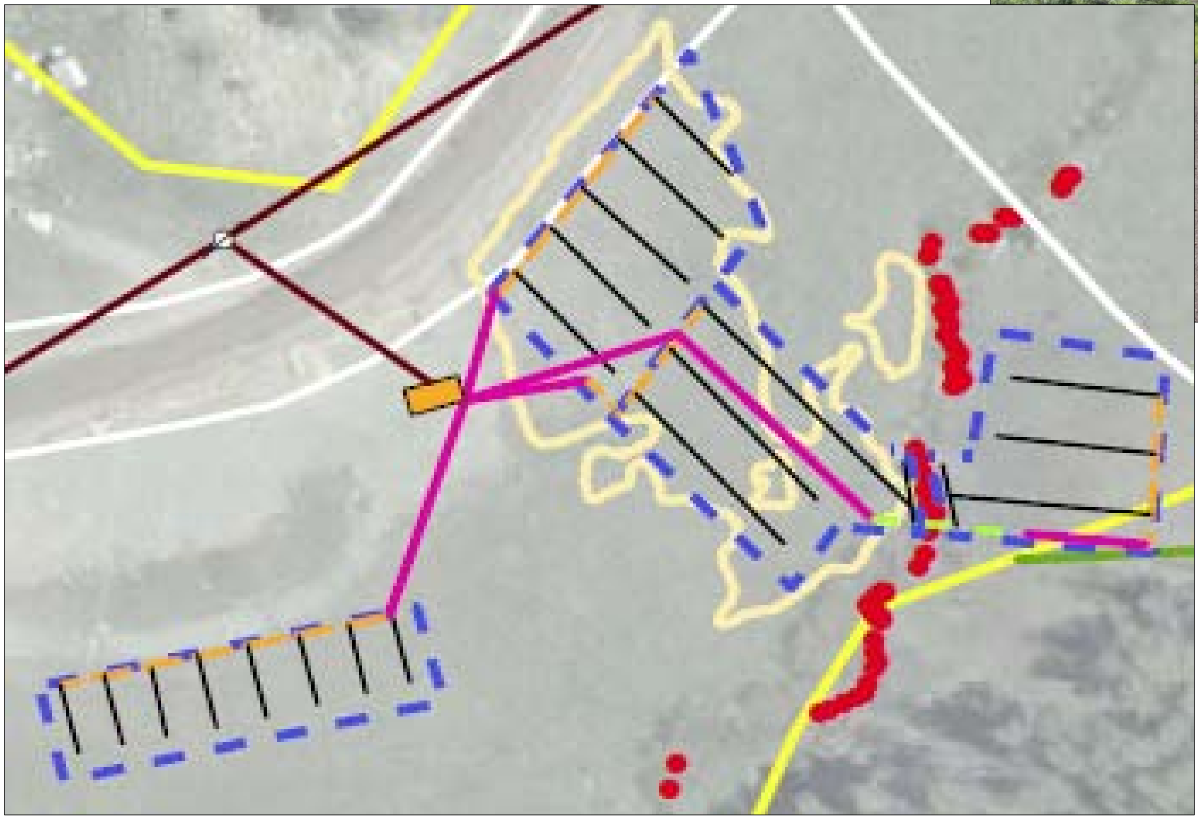
- Infill Drilling
- Strategic Drilling
- SUIT “Picket Fence Wells”
- OGCC “Green Fields”

“Picket Fence”



"Green Fields"

Install recovery pipes to capture gas, pull vacuum to enhance recovery, gas-fired generator creates electricity…



Surplus electricity delivered to power grid

CONCLUSIONS

- **Methane seepage impacts the public safety and welfare, the environment, and resource recovery.**
- **Quantifying seepage rates is critical to fully assessing the impacts.**
- **Mitigation will ultimately be the focus in addressing these impacts.**
- **Regulators are accounting for impacts from seepage to safety, groundwater protection, GHG emissions, and mineral recovery as they permit resource development.**
- **The costs associated with these issues may need to be considered in the economic analysis for development.**