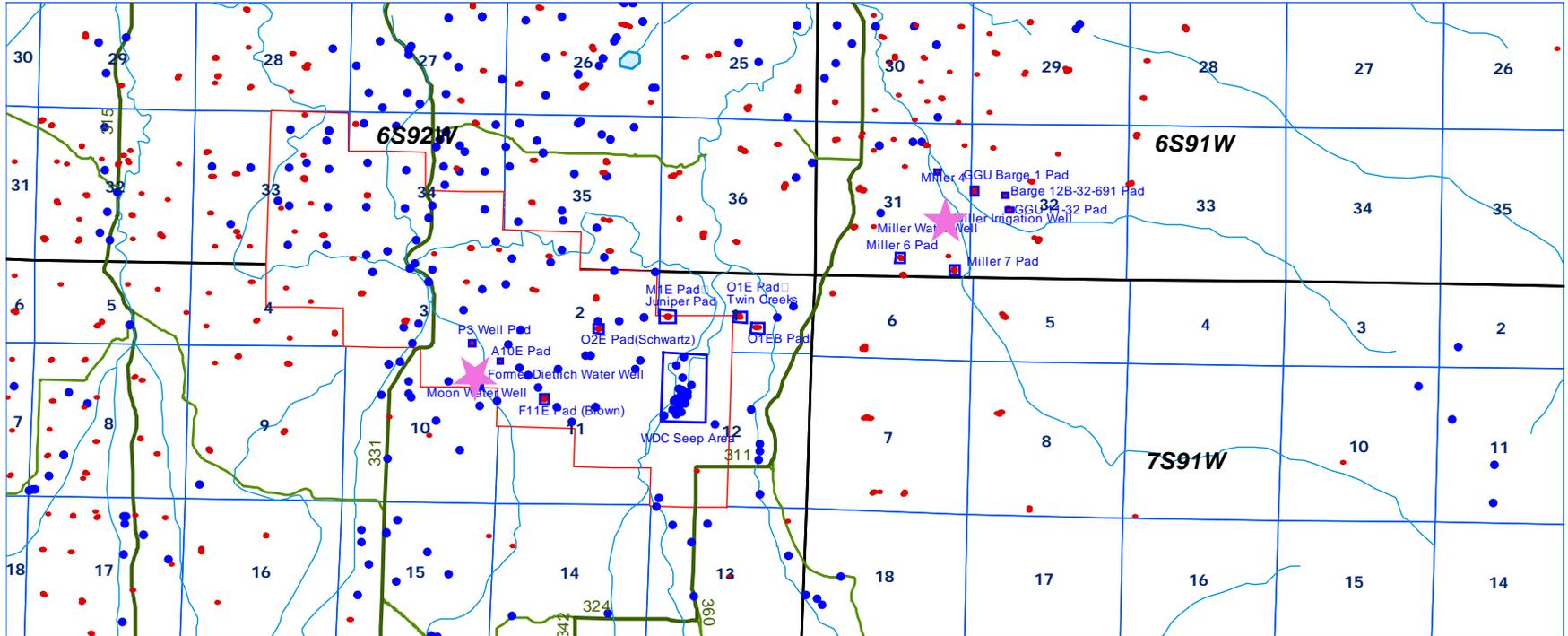


East Mamm Creek Area Investigation

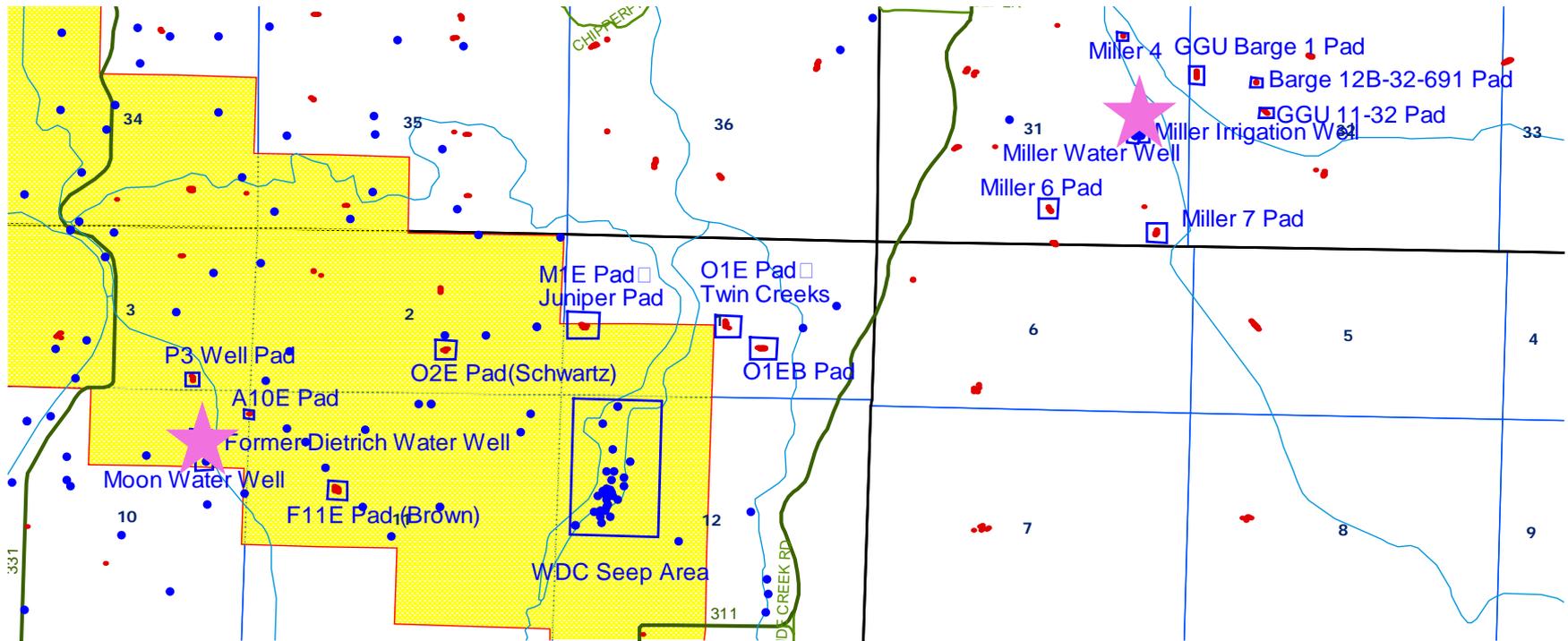
Presentation for
COGCC Commissioners Hearing
7/8/2010

Prepared by Linda Spry O'Rourke, Mark Weems
and Kevin King

East Mamm Creek Area



East Mamm Creek Area



- Moon Water Well is located
- ▶ Near the southern border of East Mamm Creek Notice to Operators Area (NTO)
 - ▶ Within the Mamm Creek Field Area NTO
 - ▶ NENE Section 10 T7S R92W

- Miller Water Well is located
- ▶ Within the Mamm Creek Field Area NTO area
 - ▶ NESE Section 31 T6S R91W

Well Names through Time

- ▶ Domestic water well on Dietrich property in 2004 now referred to as “Former Dietrich Water Well”
- ▶ Encana also refers to it as “Moon 1 well” now, but “**Former Dietrich water well**” terminology is used in this presentation for consistency with 2004 investigation
- ▶ The replacement well, originally referred to as “Dietrich 2 well”, now named “Moon 2 water well”, is referred to as the “**Moon water well**” in this presentation

Well Names through Time con't

- ▶ Domestic water well on Miller property, referred to as “Miller water well”
 - ▶ Irrigation water well on Miller property referred to as “Miller irrigation well”
- 

▶ Moon Water Well Investigation

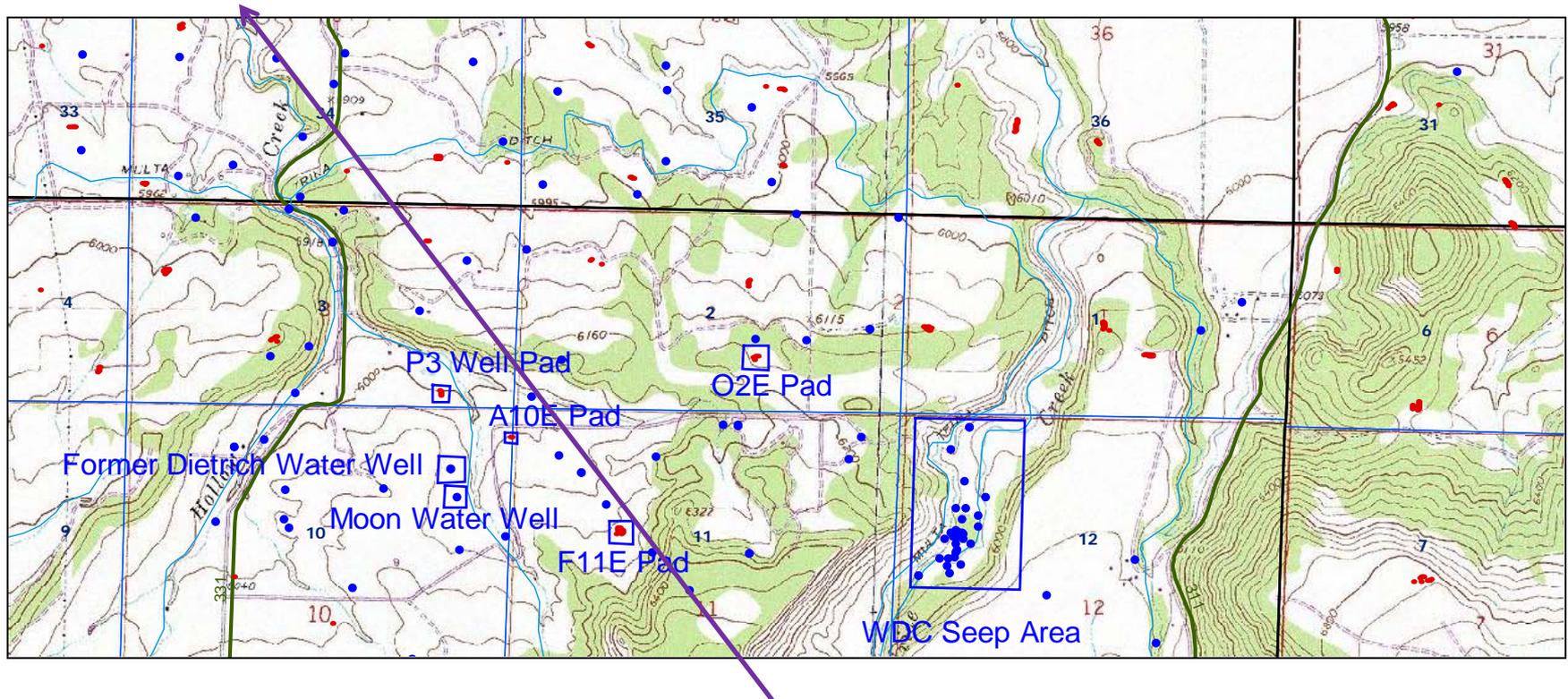
Moon Water Well Impact Identification and Voluntary Mitigation Actions

- ▶ February 16, 2010
 - NENE Section 10 T7S R92W
 - Encana self-reported a methane increase in Moon water well samples collected from a spigot located prior to the water storage tank to the COGCC
 - Moon water well not used for drinking water, but does provide household and livestock water
 - No BTEX compounds identified in Moon water well samples

Moon Water Well Impact Identification and Voluntary Mitigation Actions

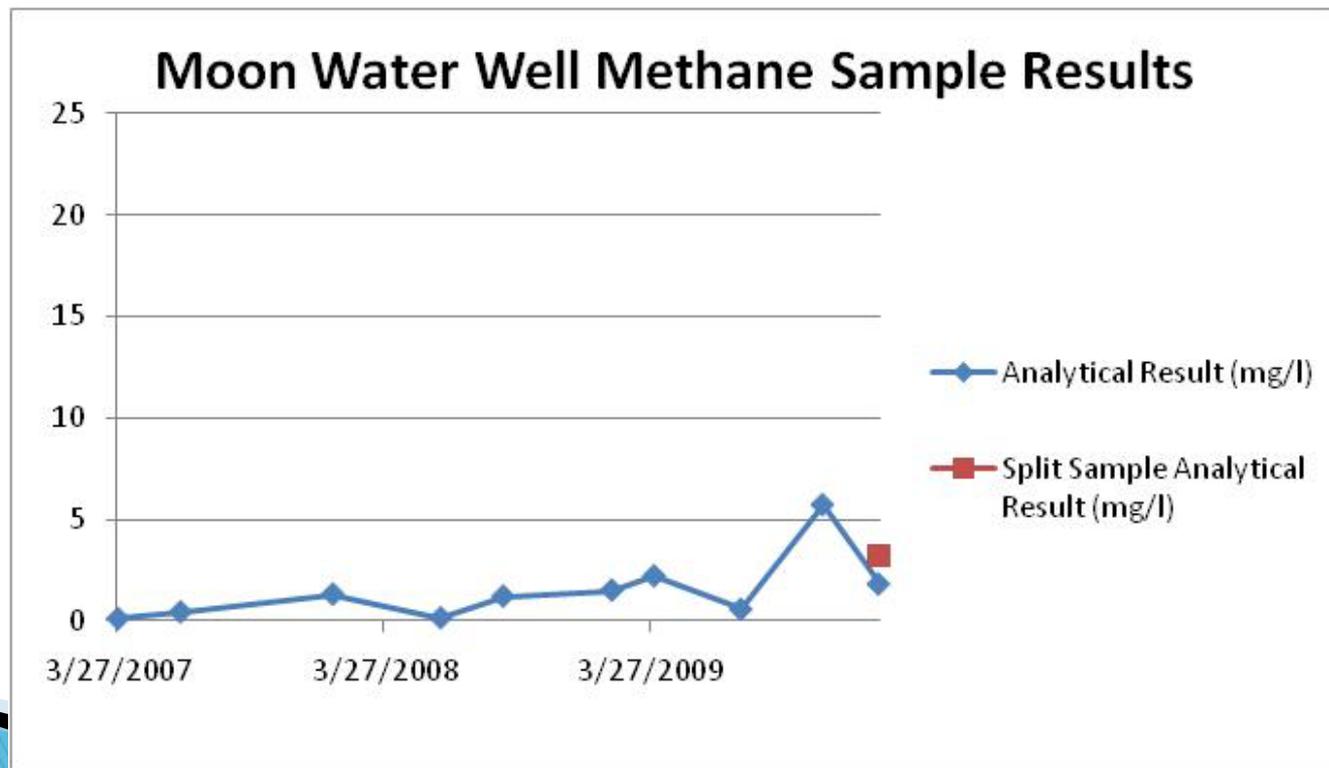
- ▶ February 16, 2010, continued
 - Encana presented mitigation steps currently being conducted:
 - Sampling frequency would increase from quarterly to monthly until April or longer if needed to monitor the situation more closely.
 - Installation of a gas detector at the Moon residence.
 - Increased the vent diameter on the Moon water storage tank.

Topographic Map of Area Surrounding Moon Water well with Approximate Axis of Divide Creek Anticline

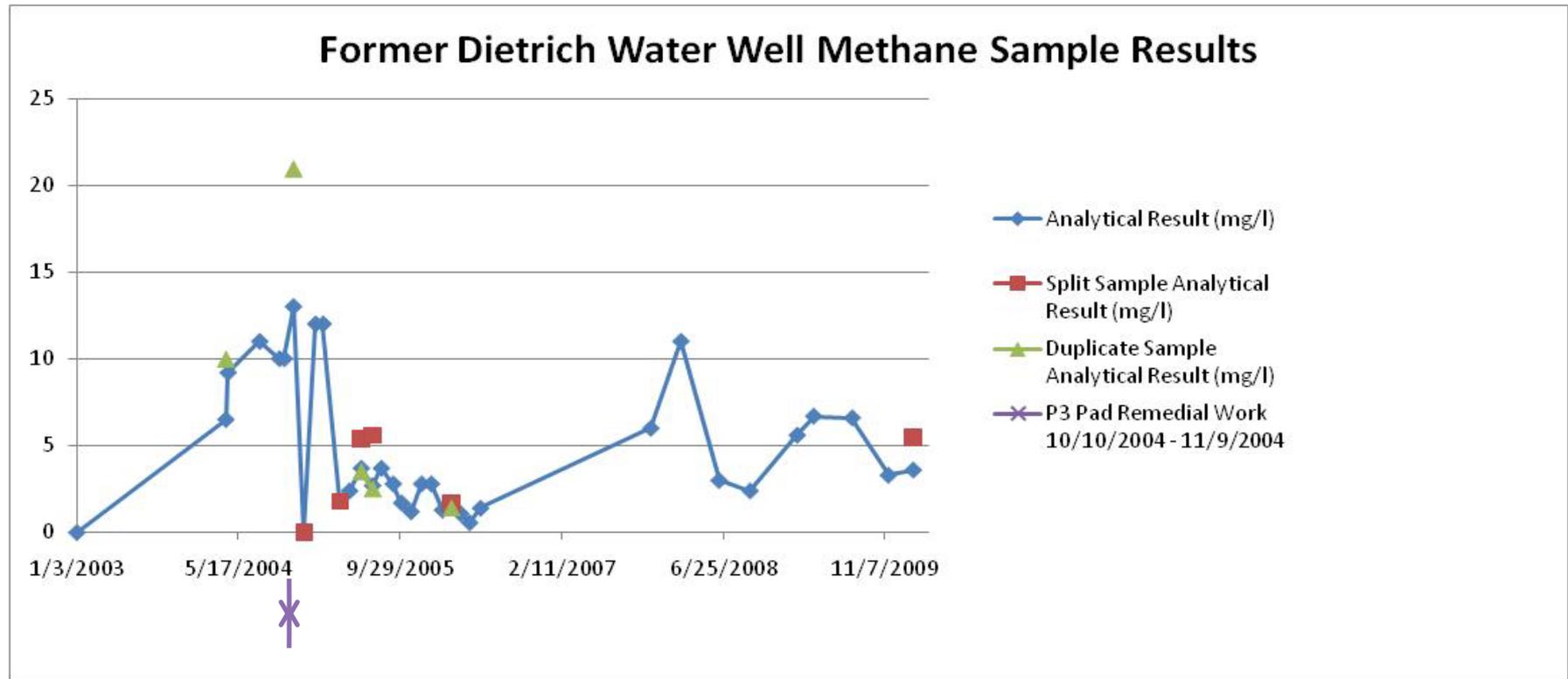


Methane History in Moon Water Well Samples

- ▶ Methane level fluctuations historically in the well water; there is bacterial contribution
- ▶ Small uptick reported to COGCC by Encana



Methane History in Former Dietrich Water Well Samples



Moon Water Well Data Evaluation

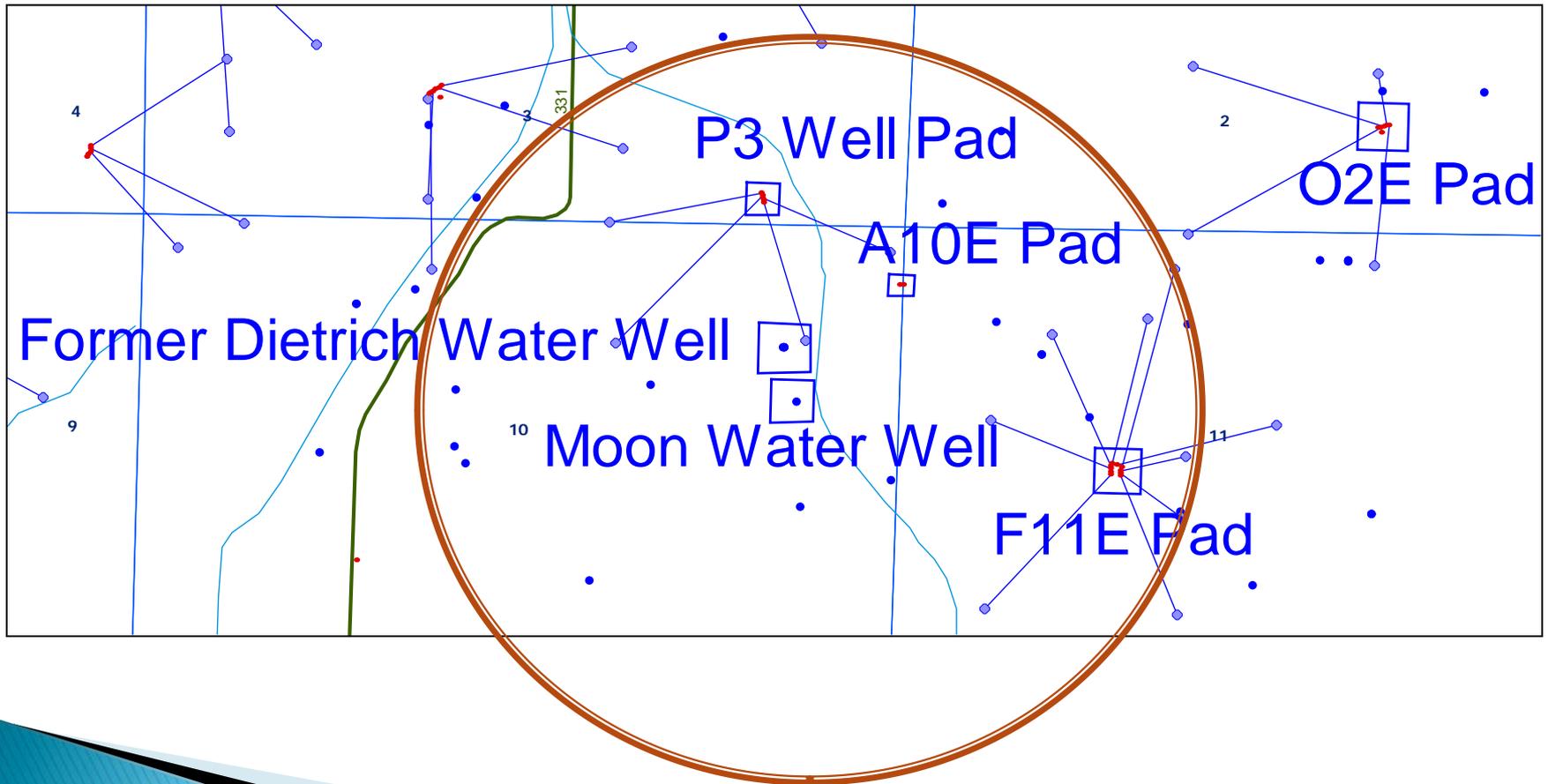
- ▶ February 24, 2010
 - Encana provided compositional and isotopic data summary of gas samples collected from Moon and Dietrich water wells to COGCC.
- ▶ February 25 – March 19, 2010
 - COGCC staff evaluated historical analytical data provided by Encana.
 - COGCC staff identified thermogenic gas impact to Moon water well.

Moon Water Well Data Evaluation continued

- ▶ COGCC staff evaluated 17 oil and gas wells within ½ mile of the Moon domestic water well for anomalies indicative of problems.
 - Completion, cement bond, temperature logs
 - Bradenhead history

API	Well	Location	Approx. Dis. to Moon 2 Well	Spud Date	RTC Date	Bredenhead psi	TOC
	TOG Reported	Perforation Interval	Surf. Csg. Shoe	Gradient @ Shoe	Additional Notes (Kicks Reported)		

Gas Wells within ½ Mile of Moon Water Well



Encana – Voluntary Investigation

▶ March 19, 2010

- COGCC requested that Encana initiate a voluntary investigation into the source of the thermogenic gas
 - Submit bradenhead readings collected from all wells on P3 and F11E well pads to COGCC
 - Submit all compositional and isotopic bradenhead and production gas sample data to COGCC.
 - Suggested that Encana provide the Moons with water for human and livestock consumption, and household uses such as bathing/showering while investigation proceeded
 - Sample water system at the point of use after the storage tank
 - Supply engineering and drilling documents as requested
 - List of bradenhead testing already conducted
 - Conduct a soil gas survey including the area between former Dietrich well and the Moon water well

Overall Investigation Progress

- ▶ Encana has been
 - Open and forthcoming with information and data
 - Proactively taking steps to mitigate impacts
 - Providing status updates to COGCC regularly or when a situation changes
 - Willing to implement COGCC's requests in a timely fashion
 - Expanded on the scope of work COGCC requested for the initial soil gas survey
- 

COGCC Moon Water Well Investigation Summary

- ▶ Soil gas survey indicated:
 - Additional work required at P3 pad wells
 - All P3 pad wells were drilled/completed** before the East Mamm Creek NTO went into effect
 - P3 pad soil gas was detected
 - Arbaney #3-16C drilled 4/30/2003
 - Magic #10-1 drilled 1/23/2004
 - Magic #10-1A drilled 2/16/2004
 - Magic #10-2 drilled 3/3/2004
 - Arbaney #3-15C drilled 3/15/2003
- ** verbal correction to slide during presentation: all wells were drilled in 2003-2004 but several of the wells were completed after the NTO went into effect in 2006

COGCC Moon Water Well Investigation

Summary con't

- ▶ Completion changes required by the Mamm Creek Notice to Operators (NTO) and the East Mamm Creek Area within the NTO, have been effective:
 - All but one of the F11E pad wells were drilled/completed after East Mamm Creek NTO went into effect
 - F11E pad, soil gas was not detected
 - Brown #11-2C drilled 1/20/2004
 - Encana #11-13B2 drilled 9/3/2008
 - Encana #11-4D drilled 9/15/2008
 - Encana #11-4C drilled 9/24/2008
 - Encana #11-5 drilled 10/6/2008
 - Encana #11-12A drilled 10/13/2008
 - Encana #11-3D drilled 11/29/2008
 - Encana #11-6A drilled 12/12/2008
 - Encana #11-6 drilled 12/29/2008
 - Encana Federal #11-11A drilled 1/5/2009

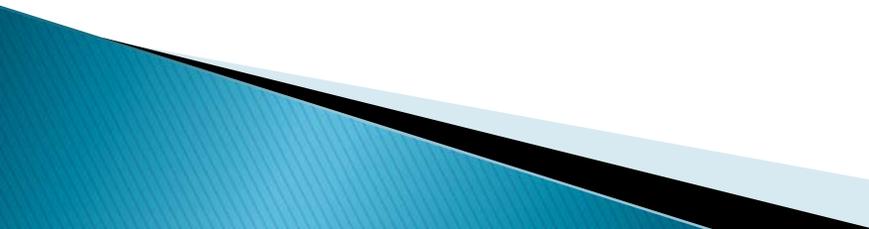
COGCC Moon Water Well Investigation Conclusions

- ▶ **Environmental:** Appears that bradenhead gas was released from the Arbaney 3-15C gas well (P3 pad) in November 2009. That bradenhead gas appears to be the source of the Moon water well impact. COGCC will require Encana to continue monitoring this area.
- ▶ **Engineering:** Moon water well impact appears to be a residual problem due to pre-East Mamm Creek NTO completion methods

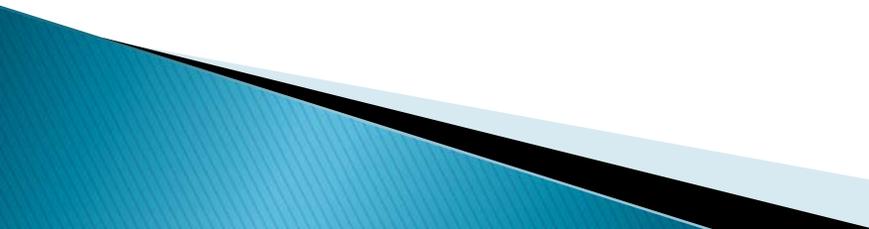
Next Phase Requested of Encana

- ▶ **Mechanical Integrity Tests P3 Pad**
 - ▶ Magic 10-1; 10-1A; 10-2
 - ▶ Arbaney 3-16C (testing cement squeezes)
 - ▶ Arbaney 3-15C

 - ▶ **Investigate the Possibility of Pressure Transient Analysis**
 - ▶ Arbaney 3-15C

 - ▶ **Develop a plan to remediate P3 pad wells**
- 

Step-out Verification Actions Being Discussed with Encana

- ▶ Sample domestic water wells in the vicinity to verify that no other wells are being impacted.
 - ▶ Conduct Soil Gas Survey at the O2E (Schwartz well) pad to verify no similar problems exist
 - ▶ Evaluate bradenhead gas at O2E pad and recent gas data from West Divide Creek Seep monitoring wells to evaluate the gas degradation status
- 

▶ Miller Water Wells Investigation

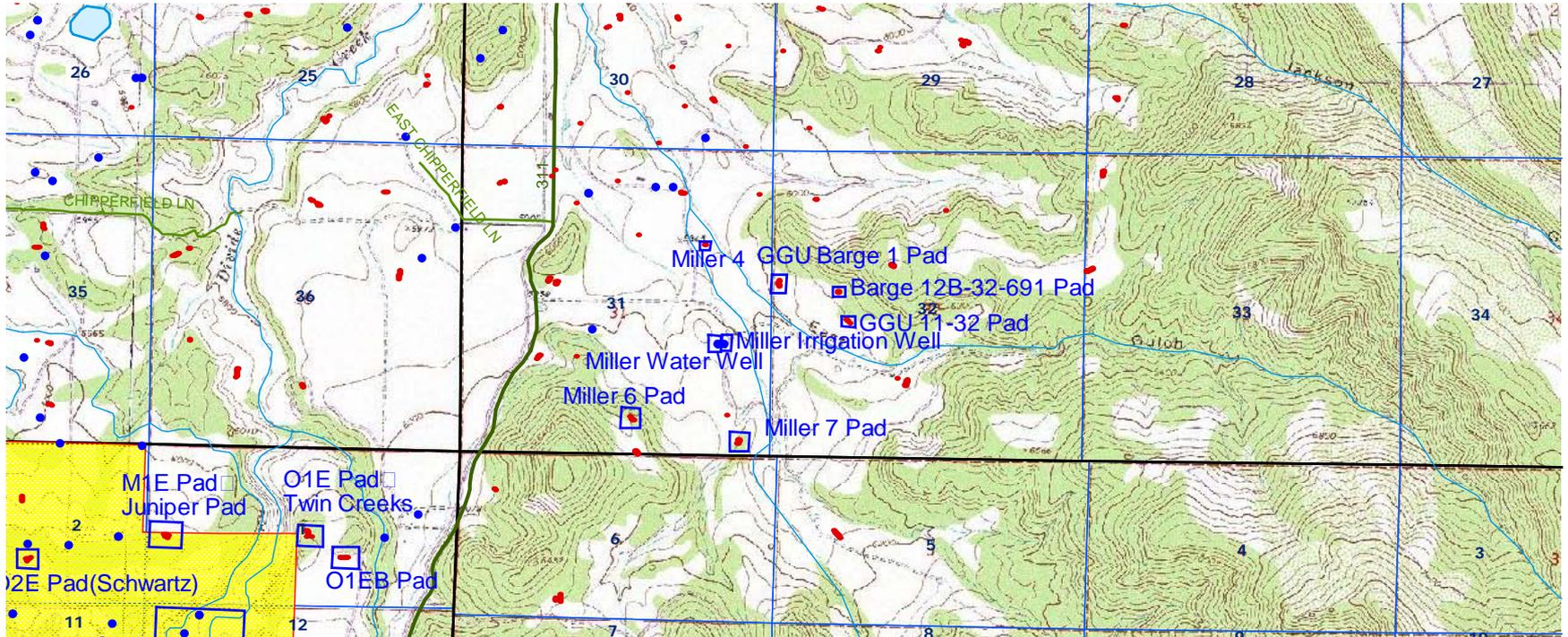
Miller Water Wells Impact Identification and Voluntary Mitigation Actions

- ▶ NESE Section 31 T6S R91W
- ▶ 12/2010 Mr. Miller asked BBC to sample his well
- ▶ 2/11/2010 BBC self-reported a thermogenic gas increase in Miller water well sample from 12/16/2009 to the COGCC
- ▶ Miller water well is used occasionally for drinking water and household use.
- ▶ No BTEX compounds identified in Miller water wells

Miller Water Wells Impact Identification and Voluntary Mitigation Actions

- ▶ 2/11/2010 con't
- ▶ BBC presented mitigation actions that were being conducted
 - BBC is monitoring the Miller water well on a monthly basis.
 - BBC offered to treat Miller water well for bacteria and replace Miller's carbon filters.
 - BBC offered to pay for or provide drinking water to Millers

Topographic Map of Area Surrounding Miller Water Well



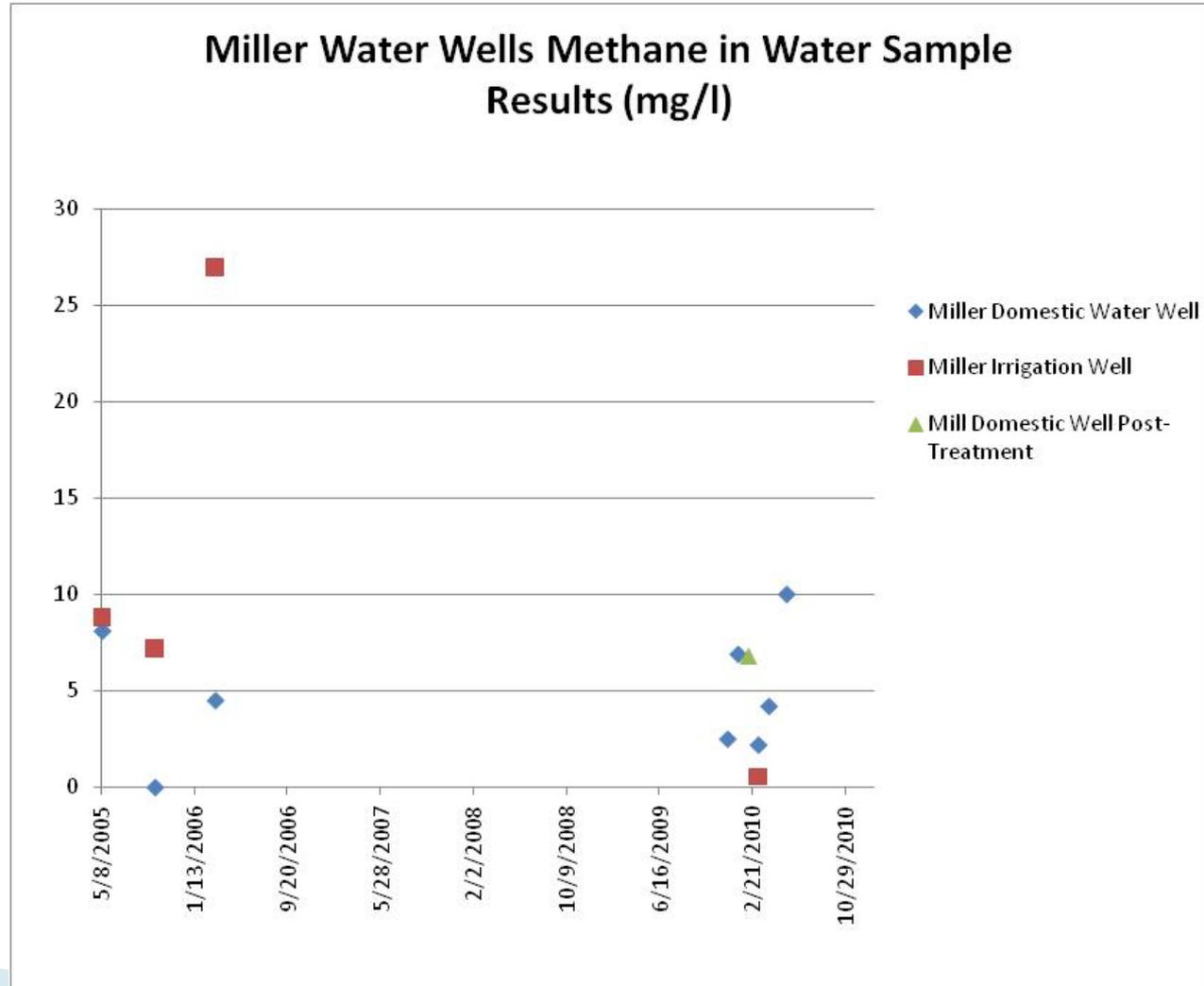
Methane History in Miller Well Samples

Miller Irrigation Well

5/10/2005	8.8
9/29/2005	7.2
3/10/2006	27.0
3/9/2010	0.55

Miller Water Well

5/10/2005	8.1
9/29/2005	ND
3/10/2006	4.5
12/16/2009	2.5
1/13/2010	6.9
3/9/2010	2.2
4/6/2010	4.2
5/24/2010	10.0



Miller Water Well Data Evaluation

- ▶ February 18, 2010
 - BBC provided compositional and isotopic data summary of gas samples collected from Miller water and irrigation wells to COGCC.
 - ▶ February 19 – March 2, 2010
 - COGCC staff evaluated historical analytical data provided by BBC.
 - COGCC staff verified thermogenic gas impact by the December 2009 Miller water well sample data.
- 

Miller Water Well Investigation

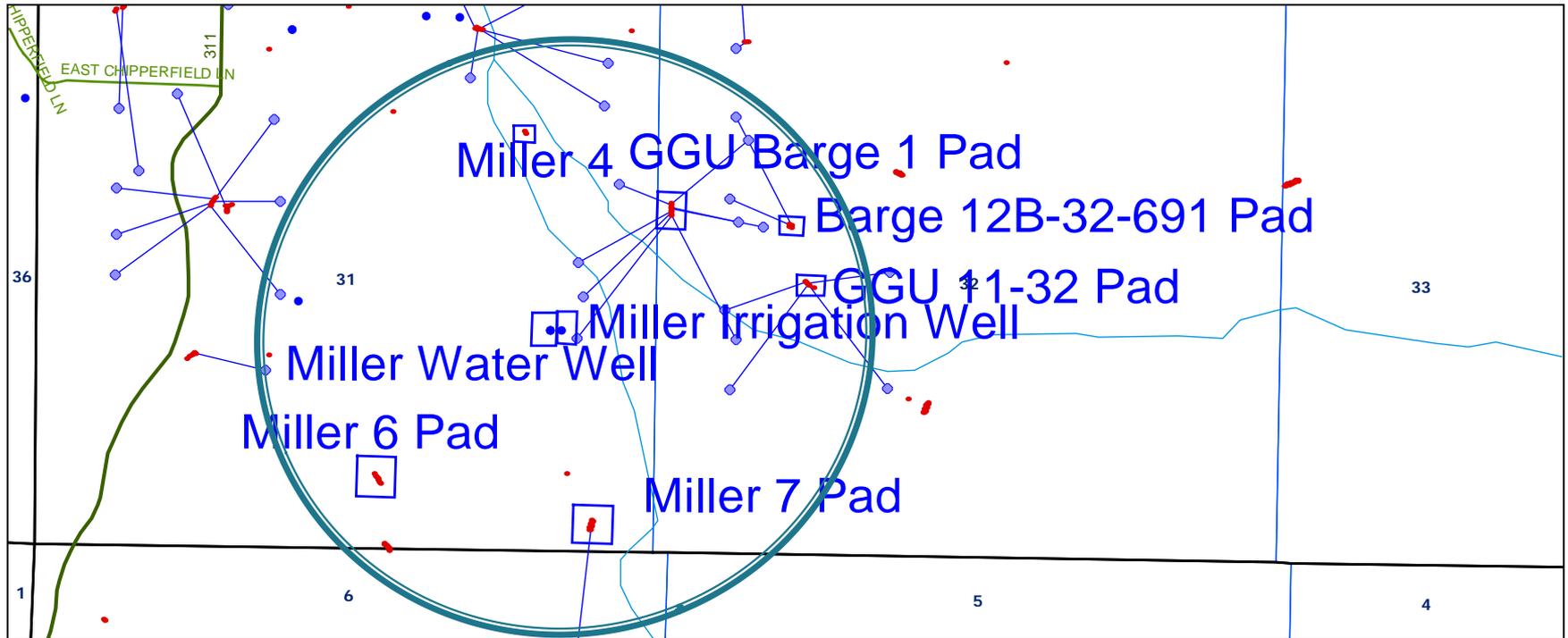
COGCC Data Evaluation

- ▶ 3/2/2010 COGCC staff meet to review data
 - COGCC staff evaluated a total of 55 oil and gas wells within ½ mile of the Miller water well for anomalies indicative of problems.
 - 3/8/2010 – COGCC requested bradenhead testing on 5 wells and that gas samples be collected from any wells with bradenhead pressure
 - COGCC requested all drilling/completion logs on Barge pad
 - COGCC requested that a soil gas survey be conducted

API	Well	Location	Approx. Dis. to Moon 2 Well	Spud Date	RTC Date	Bredenhead psi
	TOG Reported	Perforation Interval	Surf. Csg. Shoe	Gradient @ Shoe	Additional Notes (Kicks Reported)	

- ▶ 3/25/2010 Bradenhead testing completed by BBC
 - ▶ Four wells had zero pressure. One well had pressure and a gas sample was collected
- ▶ 4/22/2010 COGCC requested bradenhead testing on 7 additional wells
- ▶ 4/30/2010 Bradenhead testing completed by BBC
 - ▶ Six wells had zero pressure. One well had pressure and a gas sample was collected

Gas Wells within ½ Mile of Miller Water Wells



BBC – Voluntary Investigation

- ▶ 5/19/2010 – 6/11/2010
 - COGCC received well completion files
 - Received GGU Barge pad well drilling reports
- ▶ 6/15/2010 – 7/6/2010
 - BBC completed evaluation of soil gas subcontractor proposals, submitted general scope of work for a soil gas survey to COGCC for approval
 - Approval was granted
 - BBC continues to work with Millers to schedule a time to have contractor treat domestic well for bacteria.
 - BBC is in the process of conducting additional investigation activities

- ▶ COGCC's
 - ▶ East Mamm Creek
Area Investigation
- 

COGCC East Mamm Creek Area Investigation

▶ Fall 2008

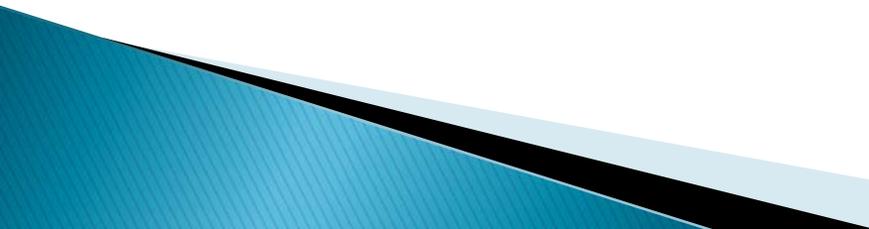
- ▶ COGCC staff evaluated 16 oil and gas wells on the O2E (Schwartz) and M1E (Juniper) pads near West Divide Creek Seep for anomalies indicative of problems in response to landowner concerns .

▶ Fall 2008

- ▶ COGCC staff collected water and gas samples from West Divide Creek based on landowner concerns
- ▶ No new gas well anomalies identified
- ▶ No new thermogenic impacts to surface water in West Divide Creek identified

COGCC East Mamm Creek Area Investigation

▶ Next Phase

- May expand East Mamm Creek boundaries pending further assessments and new developments
 - Consider collecting more surface casing interval data from new gas wells (various logs, cores)
 - Take a fresh look at published geologic information, engineering requirements and existing gas well data
 - Review data for trends
- 

COGCC East Mamm Creek Area Investigation

- ▶ **East Mamm Creek Area investigation approach**
 - COGCC is collaboratively evaluating data
 - staff with knowledge of project history
 - staff with fresh eyes asking questions
 - operators
- ▶ **East Mamm Creek Area actions**
 - July 8, 2010 – Notice to Operators
 - Bradenhead testing procedures & requirements
 - Retain 3rd party petroleum engineering consultant to review all data and make recommendations
 - Retain 3rd party consultant to evaluate bradenhead and production gas data gathered in conjunction with venting requests
 - Assess recommendations and conclusions drawn by operators and consultants.

COGCC East Mamm Creek Area Investigation

▶ Next Steps

- Evaluate Encana's domestic water well sampling data when it is available
 - Evaluate BBC Miller soil gas survey data when it is available
 - Evaluate BBC Miller water well investigation results relative to East Mamm Creek Area and Moon water well investigation results for trends and relationships, if any
 - Evaluate the need for mechanical integrity tests on gas wells near Miller water well, based on soil gas results
 - Evaluate the need for domestic water well sampling in the vicinity of the Miller water well
- 