ANTERO RESOURCES

Battlement Mesa Natural Gas Development Plan

Meeting #7

Environmental Program – Air Quality and Water Resource Protection and Noise, Dust, Weed, Light, and Visual Mitigation

October 7, 2009

BMOGC Meeting Series – Brief Overview

- July 1st – Introductory Meeting (define future mtgs and public involvement process)
- July 29th - Pad Locations, Facilities, and Setbacks
- August 5th - Surface Use Agreement
- August 19th - Drilling Schedule and Pace
- September 2nd - Traffic Plan
- September 16th – Drilling, Completion, and Water Management Plan
- **October 7th – Environmental Program**
- October 21st – Emergency Response Plan and Pad Security Plan
- November 4th – Post Drilling and Completion Operations and Interim Reclamation

(All meetings are open to the public and times are posted in *Grand Valley Echo* and on battlementmesacolorado.com website)

Today's Meeting Purpose

- **Review Major Aspects of Environmental Program**
  - Air Quality and Odor Mitigation
  - Surface Water Resource Protection
    - Spill Prevention
    - Stormwater/Erosion Control
  - Mitigation Strategies
    - Noise
    - Dust
    - Light
    - Weeds
    - Visual/Aesthetics
- **Question and Answer Session**

Air Quality Modeling Study – Brief Overview

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- **What are the major potential emission sources involved in natural gas development?**

Temporary

- Truck Traffic and Construction of Pads and Pipelines – fugitive dust
  - Controls = reduce traffic (water pipeline), gravelling pads and dust suppression via water/soiltac
- Drilling Rig Generators – diesel fumes and exhaust emissions
  - Controls = electric grid power-substitute for diesel generators, low NOX engines where grid unavailable
- Drilling Reserve Pits
  - Controls = pitless drilling
- Fraccing Operations – diesel fumes and exhaust emissions, flowback tanks
  - Controls = Green completion skids and covered flowback tanks

Long Term

- Production Tanks – VOC emissions from condensate flashing (> 90% of potential)
  - Controls = Combustor flare controls and automatic igniters
- Separators and Wellheads – fugitive VOC emissions from valves and flanges
  - Controls = Low bleed valves and routine maintenance of connection integrity
- Water Handling Facility – VOC and bacterial odors
  - Controls = Eliminate through use of covered pit design and vapor collection/combustion

Air Quality Modeling Study – Brief Overview

- **What did Antero model and why?**
  - The community expressed concerns about air quality
    - Expansion of voluntary Antero programs
  - Antero modeled VOC emissions from production tanks because:
    - Continuous source of emissions over the productive life of a natural gas well
    - Uncontrolled emissions can be relatively significant compared to the other emission sources
  - Purpose of modeling study
    - To identify and evaluate the potential air quality impacts at nearby residences from production tanks at planned well pads

Air Quality Modeling Study – Brief Overview

- Potential Air Quality Impacts
  - EPA approved air model (AERMOD) used to estimate air quality impacts
  - Air Quality Impacts = Predicted benzene concentrations around well pads
  - EPA model used Rifle Airport meteorological data and worst case production tank emission rates
- Modeled Benzene Concentrations
  - Compared to EPA Health Based Standards and
  - Colorado Air Monitoring Data
- Conclusion – Modeled Worst Case Benzene Concentrations at Nearby Residences Are Significantly Below EPA Health Based Standard

Modeling Inputs – Worst Case Emissions Scenario

- Assumptions
  - No tank emission controls
  - Up to 20 wells on a completed pad (2x Antero actual dev. plans)
  - 11 proposed pads
  - 1.78 bbls condensate per MMscf (Grand Valley and Parachute Field)
  - Each well makes 2 MMscf/day
  - Each pad was modeled assuming 75 bbls/day condensate
- Antero Tank Emission Factor
  - EPA Approved Model (E&P Tanks 2.0) - Used to determine condensate tank VOC/benzene emission rates
  - Uncontrolled Benzene emissions ~ 0.36 tpy from each well pad
  - Uncontrolled Emission Factor = 0.026 lbs benzene/bbl condensate

Modeling Inputs – Worst Case Emissions Scenario (cont.)

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- Why Model Worst Case Uncontrolled Emission Scenario?
  - Actual production tank well pad emissions controlled by flare with potential to be fitted with auto igniter
  - Actual modeled emissions (controlled) will be significantly less than worst case modeled emissions (uncontrolled)
  - If worst case modeled benzene concentrations are below EPA health based standards then actual benzene impacts will be significantly less

Modeling Inputs – Meteorology

- Used a Rifle Airport 5-yr meteorological dataset
- Rifle Airport dataset provided by Colorado Department of Public Health & Environment (CDPHE)
- Rifle Airport - Wind direction/speed data
  - Most representative of Battlement Mesa meteorological conditions
  - Prevailing wind direction are from west and south (see Rifle Airport Wind Rose Slide)
- Rifle Airport - Terrain influences
  - Similar to Battlement Mesa
  - Both locations immediately south of river and I-70
  - Rifle Airport at 5,500 ft, Battlement Mesa at 5,100 to 5,500 ft

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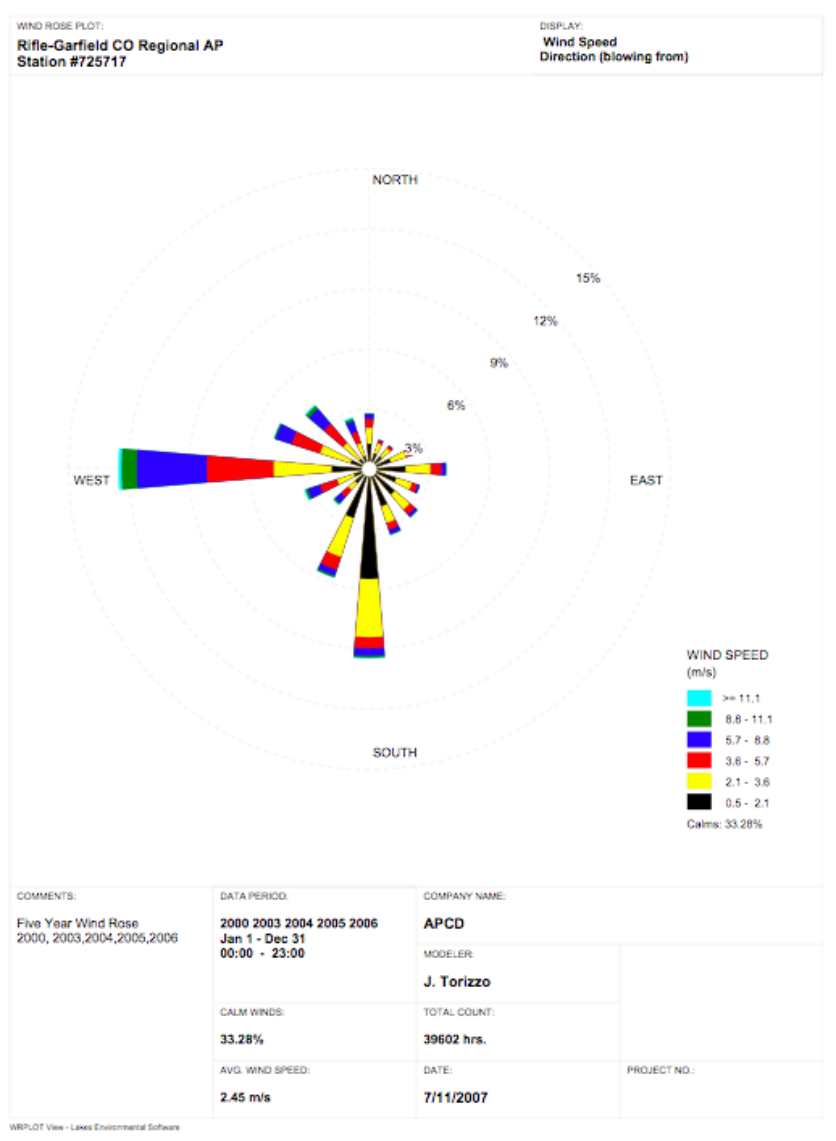
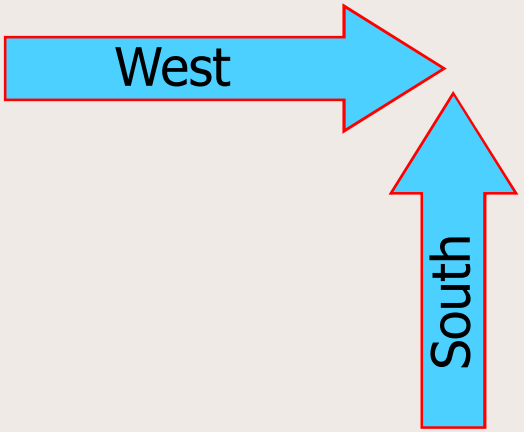
- Closet meteorological dataset is Williams' Parachute Creek Gas Plant (PCGP), however it was not used because:
  - Located in Grand Valley oriented NW to SE
  - PCGP Wind Rose shows prevailing winds parallel to Grand Valley
  - Dataset limited to 1-yr

Modeling Inputs – Rifle Airport Wind Rose



Dominate Wind Directions



Air Quality Modeling – Predicting Impacts from Well Pad Production Tanks

- Modeled potential offsite impacts at "Receptors" out to 1,500 feet in all directions from each well pad location
- Receptor = residence, golf course clubhouse, schools, etc.
- Impacts = Modeled 24-hr Benzene Concentrations
- Identified location of Potential Maximum 24-hr impacts relative to each pad location
- Modeled Results – See Area Specific Well Pad Impact Maps
  - Area specific maps include setback distances
    - 350 ft - COGCC Setback in high density areas
    - 500ft - Antero Internal Setback
    - 1,000 ft

Benzene Air Quality Data - Monitored

- Compared modeled worst case uncontrolled 24-hr benzene concentrations to monitoring data in Denver, Grand Junction and Piceance Basin.
- Average monitored 24-hr benzene concentrations
  - Denver = 2.5 to 3.2 $\mu g/m^3$ (data collection follows EPA monitoring protocols)
  - Grand Junction = 1.6 $\mu g/m^3$ (data collection follows EPA monitoring protocols)
  - Parachute = 3 $\mu g/m^3$ (likely less than 3 $\mu g/m^3$ because benzene "non-detects" not counted – Garfield County monitoring data)
- Benzene monitoring data for Colorado are presented in following table

Monitoring Data – Benzene Background

Benzene Monitoring Results in Colorado

- 24-hr Measured Concentrations

Location	24-hr Conc. (ug/m^3)	
	Average	Maximum
[1]Denver - Urban Site 1	3.2	7.4
[1]Denver - Urban Site 2	2.5	7.2
[1]Denver - Urban Site 3	2.8	7.0
[2]Grand Junction (Powell)	1.6	4.2
Glenwood - Courthouse	1.2	3.5
New Castle - Library	2.0	15.0
Rifle - Henry Bldg	2.9	6.9
Parachute	3.0	5.1
Silt - Cox	1.0	1.9
Silt - Bell	2.0	7.4
Butterfly	2.0	7.7
Isley	1.2	3.0
West Landfill	4.4	7.5
Sebold	1.1	2.7
Haire	1.0	2.3

[1] Denver data from 2003 monitoring project

[2] Grand Junction 2006-2007 data (Powell site)

*** Garfield County date from 2005-2007 study**

Benzene Air Quality Data - Modeled

- Worst case modeled benzene concentrations were compared to:
  - EPA acceptable 24-hr exposure of 30 µg/m^3 = benzene health based standard (*U.S. EPA. Integrated Risk Information System (IRIS) on Benzene. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 2002)*
- Residential (receptor) locations are all below the EPA standard of 30 µg/m^3
- 9.2 µg/m^3 was the highest modeled 24-hr concentration (house north of N Pad). (maximum out of 365 X 5 yrs = 1825 days)
- Background benzene 24-hr concentration of 3 µg/m^3 in Parachute was added to modeled results for comparison to the health based 24-hr standard.
- Maximum Modeled benzene 24-hr concentrations for each well pad are presented in the next slide.

Benzene AERMOD Results – All Pads

Antero Resources - All Proposed Production Pads

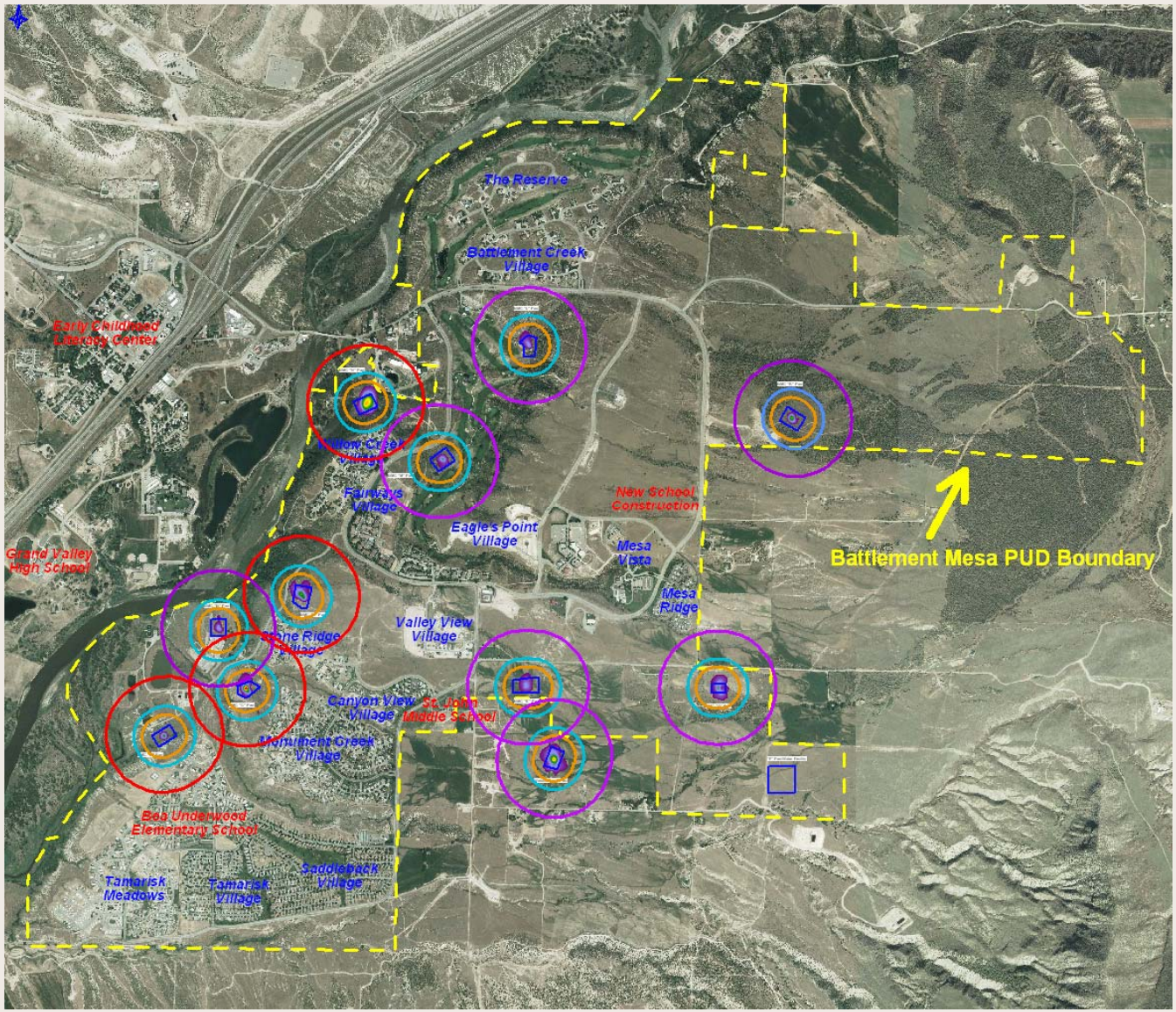
Table 1: AERMOD Modeled Benzene Impacts from Uncontrolled Tank Emissions
- Rifle Garfied County Airport Meteorological Data

Pad Location	Distance to Sensitive Receptor (feet)	Maximum Modeled Benzene Concentrations (µg/m3)			Comparison To Acceptable Health-Based Threshold Concentrations (µg/m3)	
		Closest Sensitive Receptor[2]	Average of Monitored Benzene Samples collected in Parachute			
		24-hr (acute)	24-hr Background	Total	Acute (24-hr) - EPA[1]	Acute (24-hr) - Utah TLV[2]
Pad N	~615'	6.17	3.0	9.2	30 (µg/m^3)	53 (µg/m3)
	~515'	0.67	3.0	3.7		
Watson Pad	~680'	0.90	3.0	3.9		
Pad A	~529'	0.55	3.0	3.6		
Pad B	~585'	0.80	3.0	3.8		
Pad C	~535'	3.79	3.0	6.8		
Pad D	~540'	3.10	3.0	6.1		
Pad E	~730'	1.56	3.0	4.6		
Pad G	~1030'	1.65	3.0	4.7		
Pad K	~2600'	0.24	3.0	3.2		
Pad L	~1056'	4.52	3.0	7.5		
Pad M	~745'	1.20	3.0	4.2		

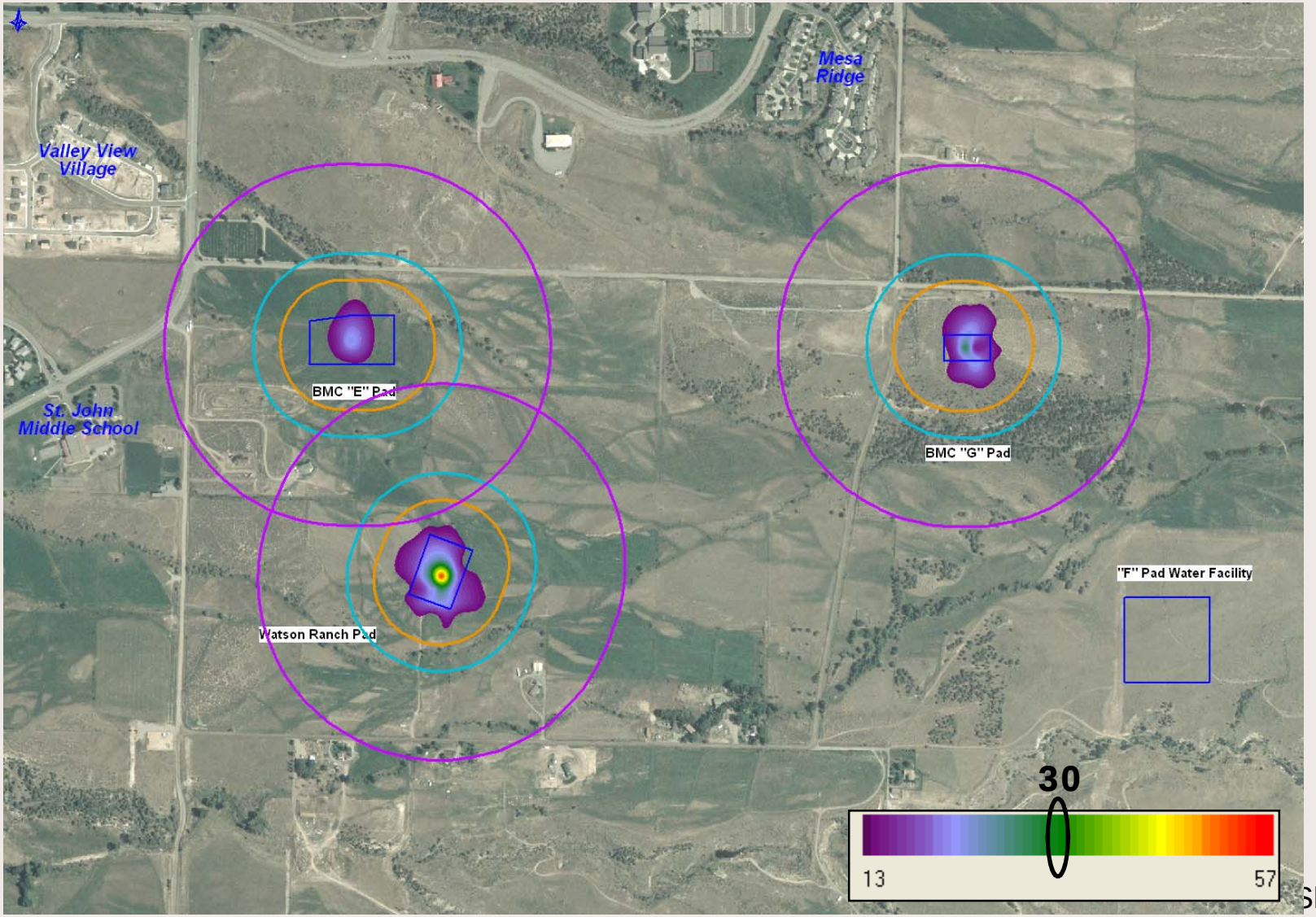
** Acute exposures are considered short-term 24-hr exposures

[1]EPA accepted standard for short-term exposures below which no inhalation health impacts are anticipated

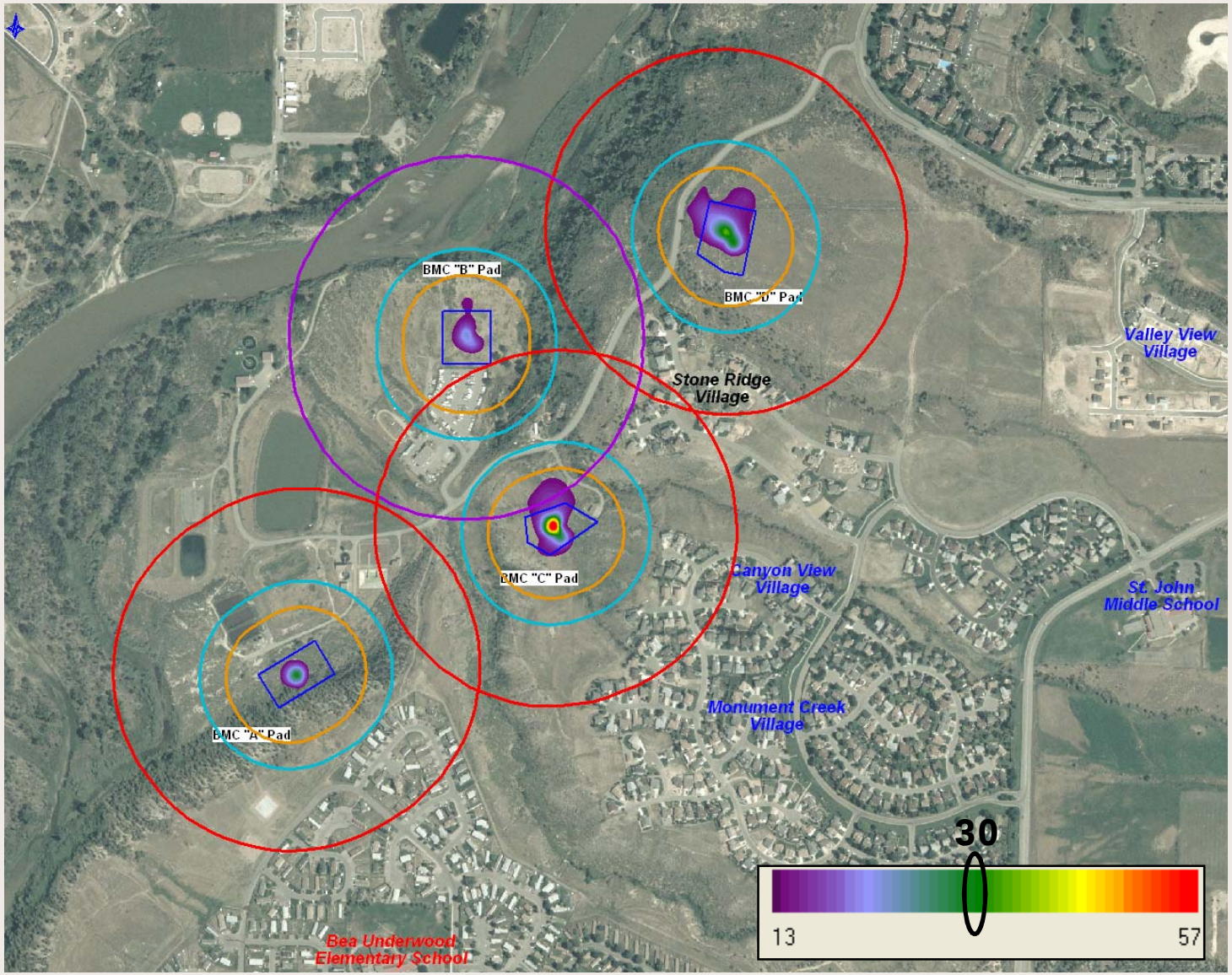
Air Quality – Base Map



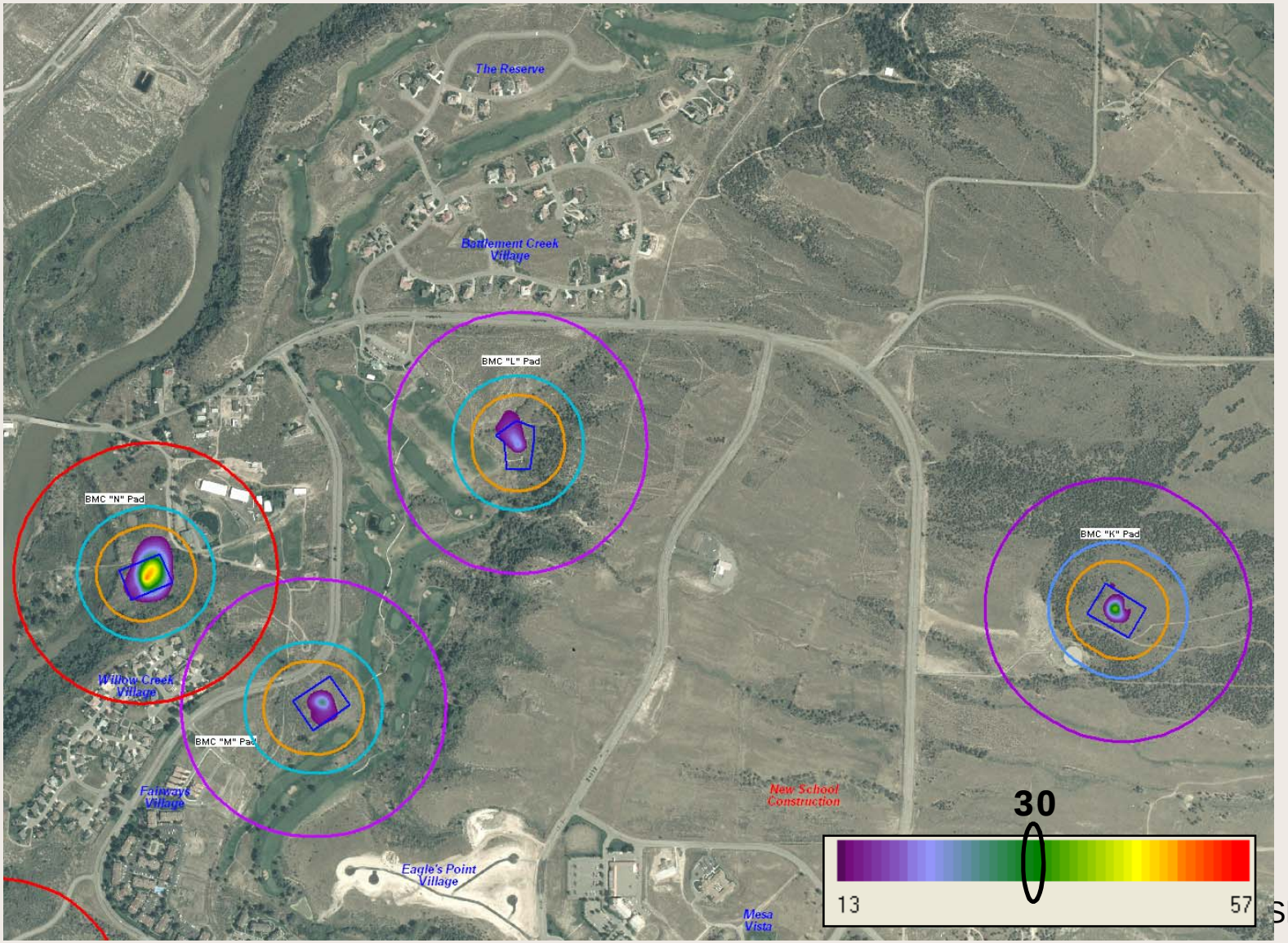
Air Quality – Southeastern Pads



Air Quality - Southwestern Pads



Air Quality – Northern Pads



Air Modeling Study - Conclusions

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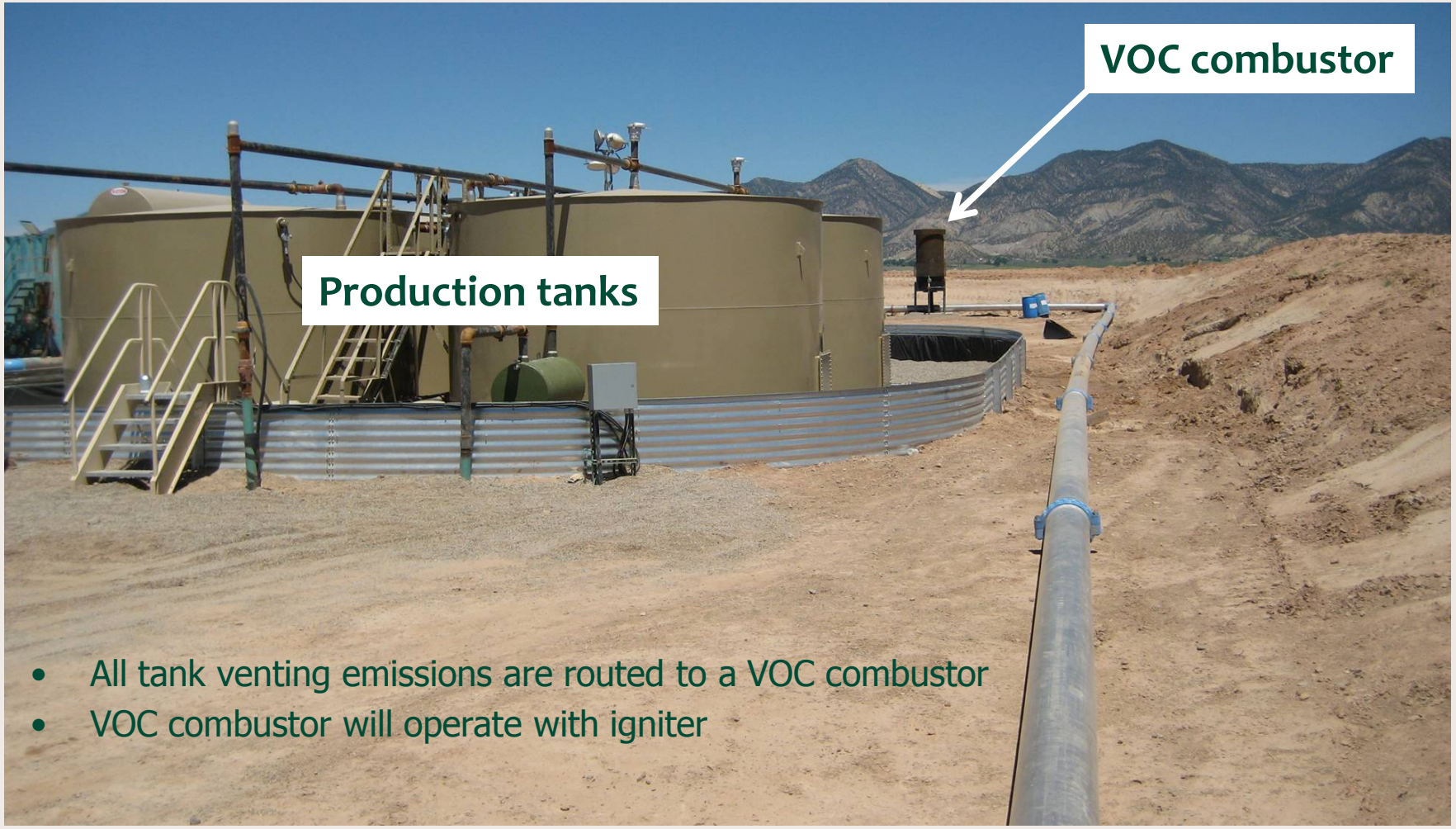
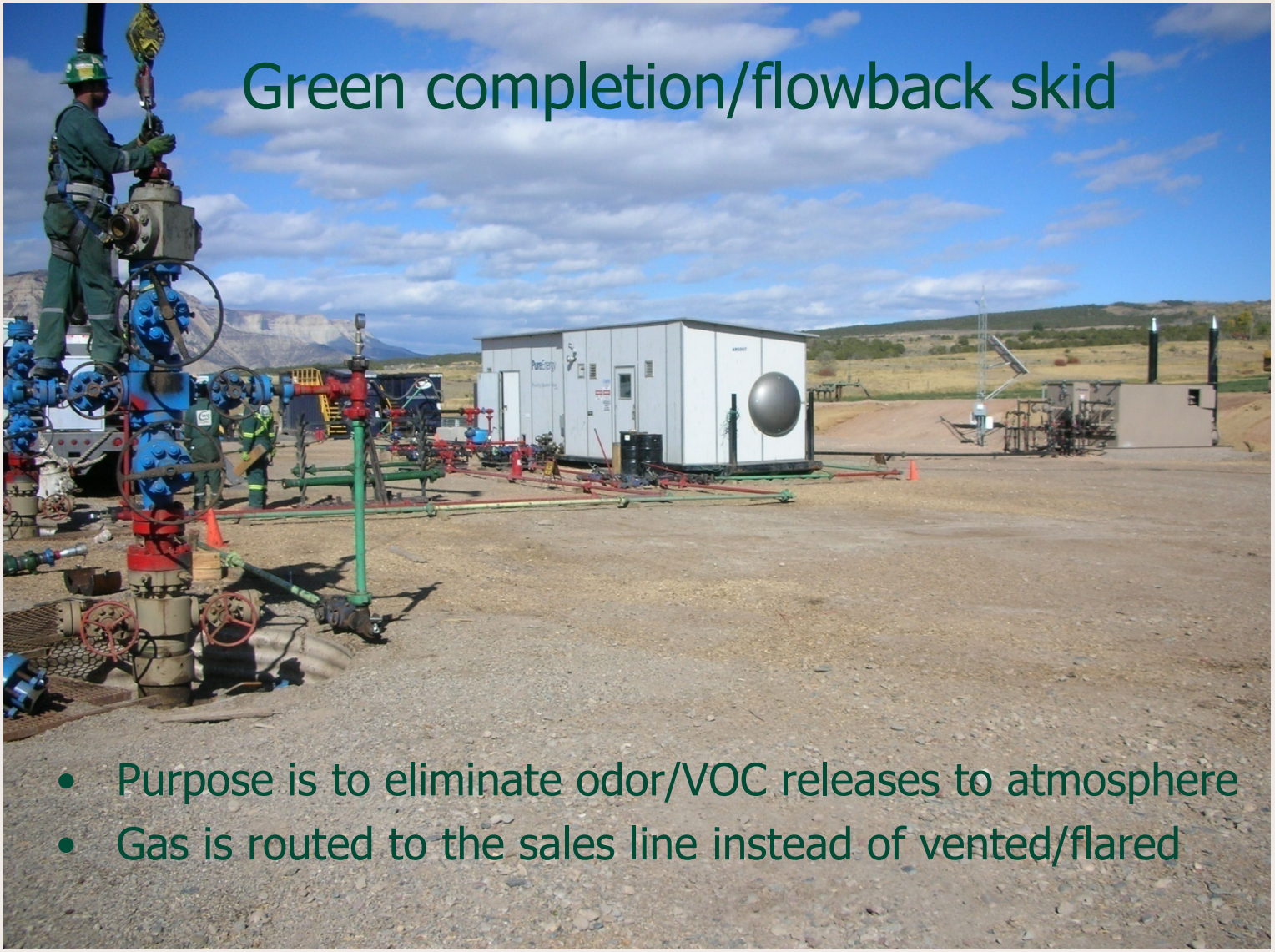
- The modeled benzene concentrations at or above the EPA health based standard of 30 µg/m^3 do not extend beyond pad boundaries
- The modeled benzene concentrations at ALL residential receptors are between 3.2 and 9.2 ug/m^3 - well below the 24-hr EPA acceptable exposure threshold of 30 ug/m^3 (includes background)
- Antero installed control measures will reduce incremental benzene emissions by approximately 95%
- The highest modeled benzene concentration (worst case scenario) at nearest residence is about 30% of the acceptable EPA health based standard, average is about 19% of the acceptable EPA health based standard

Air Quality – Odor Mitigation



- All tank venting emissions are routed to a VOC combustor
- VOC combustor will operate with igniter

Air Quality – Odor Mitigation



Air Quality – Odor Mitigation

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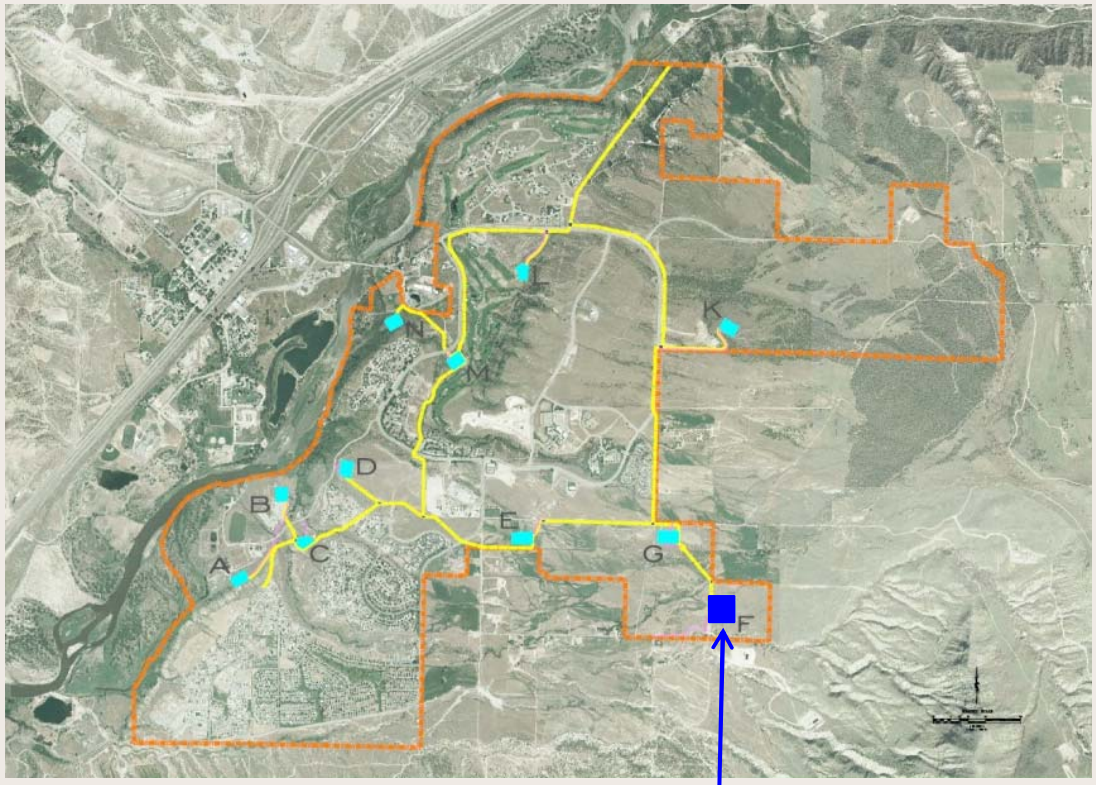
Storage tanks enclosed for odor control

Air Quality – Odor Mitigation



Water Storage and Treatment Facility (Pad F)

Example of Cover Technology for Water Handling Facilities

Air Quality – Summary

- **Well Pads – potential air emissions reduced and/or eliminated with controls or design** (e.g. electric power from grid)

- **Production Tank Air Quality Modeling Study**
  - Dr. Walker of Mesa State said during his August 2, 2009 GVCA annual meeting that "air quality modeling is a useful predictive tool for estimating exposures to VOC emissions from oil and gas."
  - The modeled benzene concentrations at ALL residential receptors are well below the 24-hr EPA acceptable exposure threshold of 30 ug/m^3