CDPHE Air Emissions Study Review

"Evaluating Potential Human Health Risks from Modeled Inhalation Exposures to Volatile Organic Compounds Emitted from Oil and Gas Operations" (Holder et al., 2019)

Why is this study important?

- Utilized O&G air emissions data collected in 2014 to model health risks associated with several well pad size and exposure scenarios

- Found an *elevated risk* of short-term health effects during *drilling and completions* activities
  - Higher risk for residents within 1,000-ft from center of well pad
  - Moderate risk for residents within 2,000-ft from center of well pad

- Found *minimal risk* of both short-term and long-term health effects during *production* activities

- COGCC response:
  - Increased distance from building unit to 2,000-ft from 1,500-ft under the Director's Objective Criteria when assessing Form 2A/2 applications
  - Conduct air monitoring of oil and gas sites to better characterize emissions, sources and dispersion patterns
  - Air monitoring results will inform Mission Change, Cumulative Impacts and Alternative Site Analysis rulemakings

- Adams County response:
  - Potential resolution implementing increased scrutiny for proposed locations that have less than 2,000-ft setbacks
  - Require full suite of air quality BMPs listed in OGF regulations when site warrants it
  - Could impact future amendments to County OGF regulations

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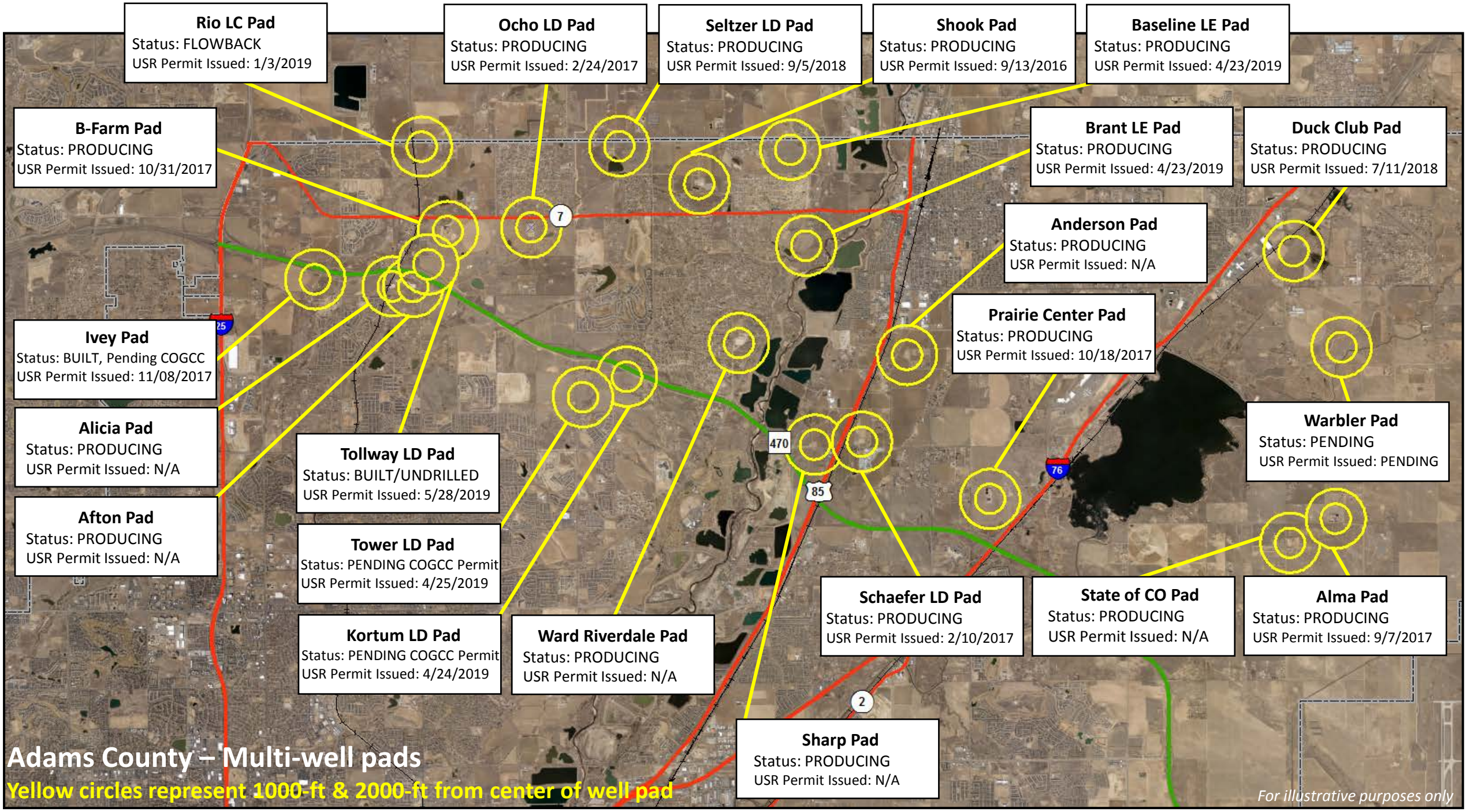
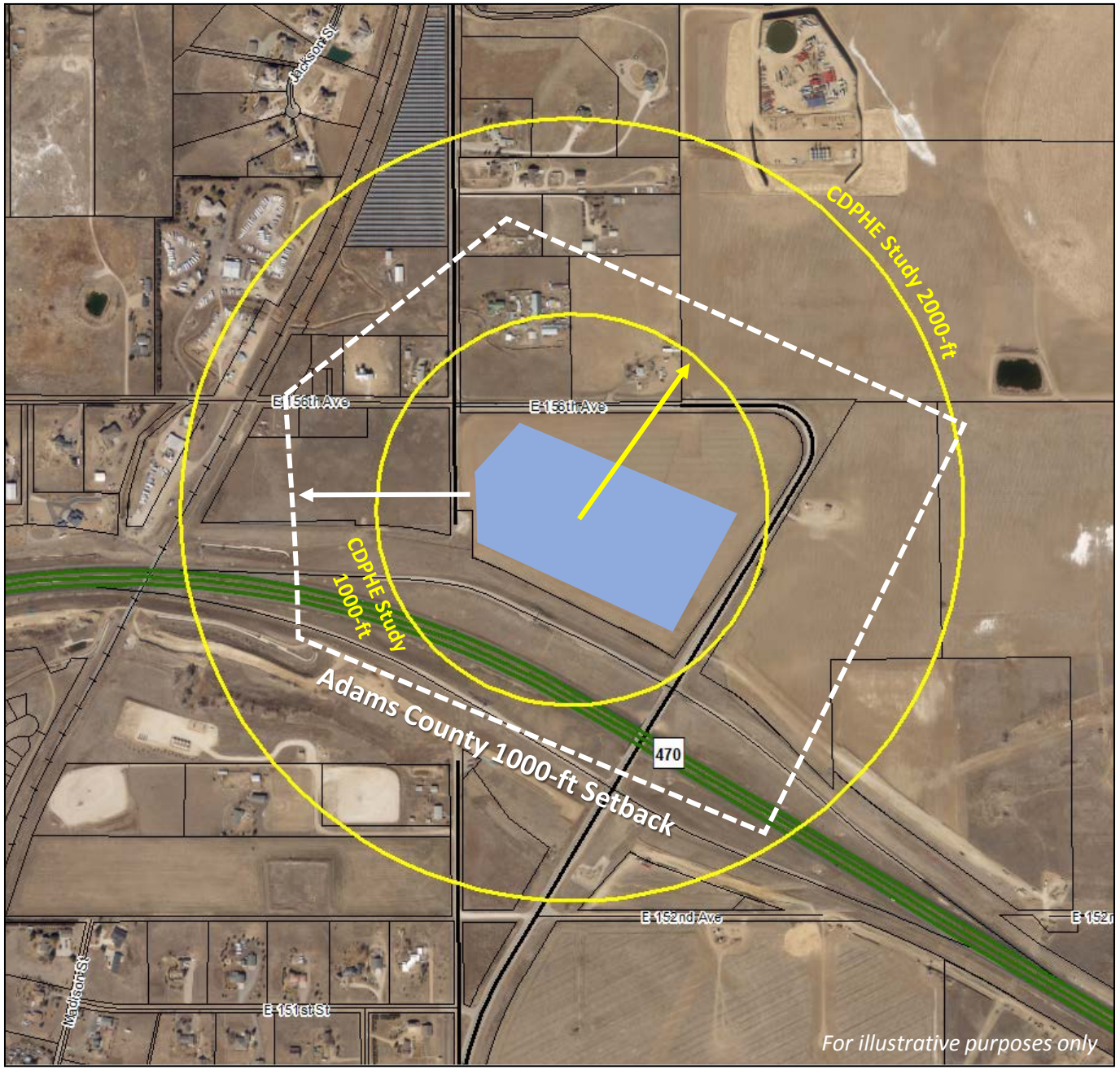
Study-specific Assumptions:

- This a modeling study utilizing actual emissions data from well sites taken between 2013-2015
  - Air monitoring conducted prior to more stringent EPA air quality regulations for oil and gas (NSPS Subpart OOOOa, eff. 8/2/2016)
- Study design did not consider aggregated exposure from background sources of emissions
- Study design did not consider cumulative impacts from multi-chemical exposures or proximal O&G locations
- O&G emission rates are highly irregular → introduces uncertainty in the results, specifically for acute health studies
- Study used a limited number of air monitoring points from absolute-maximum model iterations under conservative metrological conditions
  - may not be typical, real-world exposure/emission rates
  - "site-specific monitoring and metrological data would better characterize the relationship between highest and typical exposure"
- Study only examined specific VOCs and human carcinogens and did not calculate cancer risks for other chemicals known to be released during oil and gas operations


Rio LC Pad
Status: FLOWBACK
USR Permit Issued: 1/3/2019
Ocho LD Pad
Status: PRODUCING
USR Permit Issued: 2/24/2017
Seltzer LD Pad
Status: PRODUCING
USR Permit Issued: 9/5/2018
Shook Pad
Status: PRODUCING
USR Permit Issued: 9/13/2016
Baseline LE Pad
Status: PRODUCING
USR Permit Issued: 4/23/2019
B-Farm Pad
Status: PRODUCING
USR Permit Issued: 10/31/2017
Brant LE Pad
Status: PRODUCING
USR Permit Issued: 4/23/2019
Duck Club Pad
Status: PRODUCING
USR Permit Issued: 7/11/2018
Anderson Pad
Status: PRODUCING
USR Permit Issued: N/A
Prairie Center Pad
Status: PRODUCING
USR Permit Issued: 10/18/2017
Ivey Pad
Status: BUILT, Pending COGCC
USR Permit Issued: 11/08/2017
Alicia Pad
Status: PRODUCING
USR Permit Issued: N/A
Tollway LD Pad
Status: BUILT/UNDRILLED
USR Permit Issued: 5/28/2019
Warbler Pad
Status: PENDING
USR Permit Issued: PENDING
Afton Pad
Status: PRODUCING
USR Permit Issued: N/A
Tower LD Pad
Status: PENDING COGCC Permit
USR Permit Issued: 4/25/2019
Kortum LD Pad
Status: PENDING COGCC Permit
USR Permit Issued: 4/24/2019
Ward Riverdale Pad
Status: PRODUCING
USR Permit Issued: N/A
Schaefer LD Pad
Status: PRODUCING
USR Permit Issued: 2/10/2017
State of CO Pad
Status: PRODUCING
USR Permit Issued: N/A
Alma Pad
Status: PRODUCING
USR Permit Issued: 9/7/2017
Sharp Pad
Status: PRODUCING
USR Permit Issued: N/A
7
25
470
85
76
2
Adams County – Multi-well pads
Yellow circles represent 1000-ft & 2000-ft from center of well pad
For illustrative purposes only

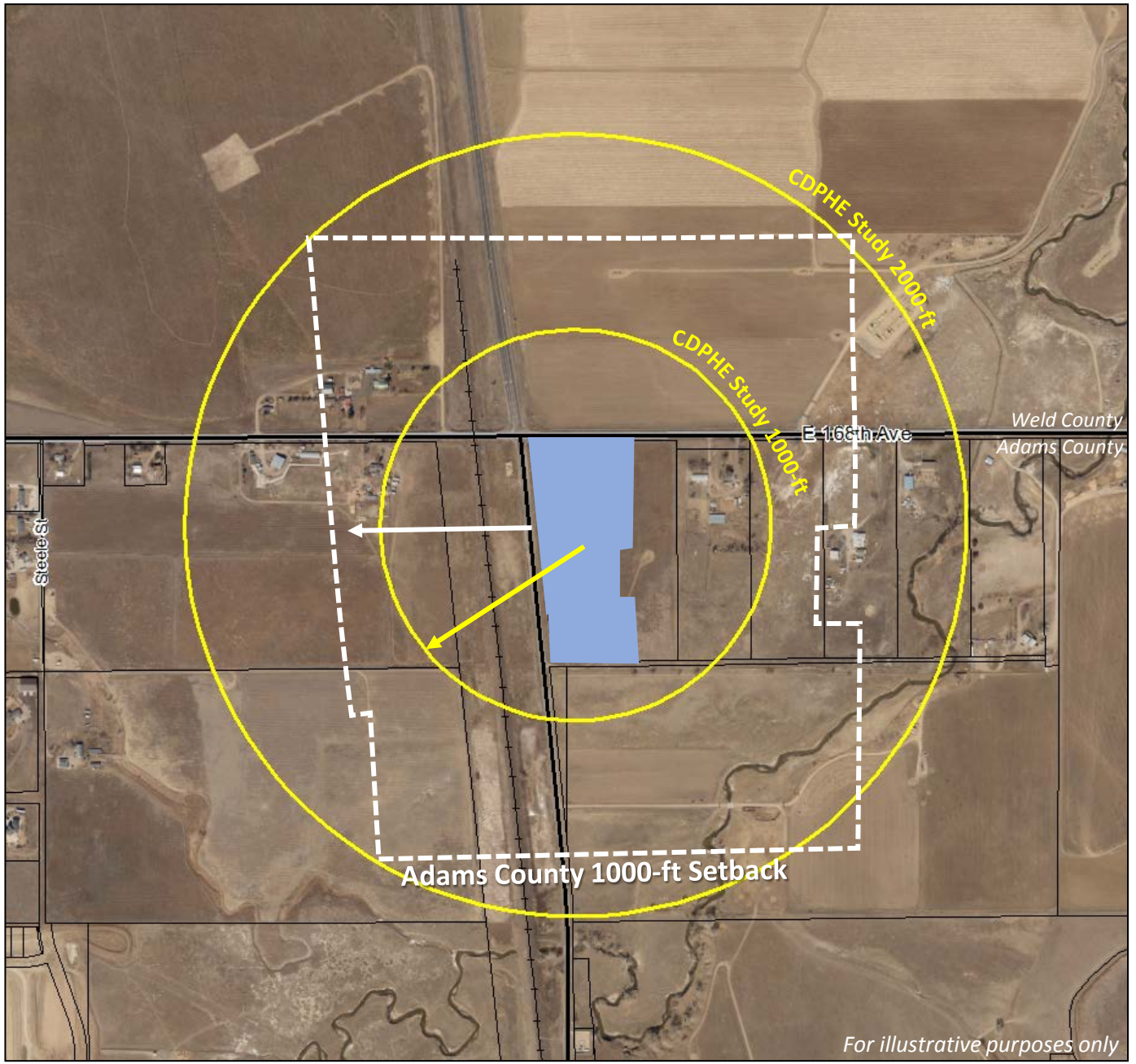
Tollway LD Pad: Permitted 5/28/2019

- 15.3 –acre well pad
- 30 horizontal wells
  - ✓ 0 Drilled – Building Location
  - ✓ 30 Remaining
- 8 structures within CDPHE Study 1,000-ft radius
- 6 residences within OGF regulation 1,000-ft setback
- Nearest High Occupancy Building Unit: 4,620-ft
  - ✓ Elementary school
- BMPs in place via MOU and CoAs of USR Permit
  - ✓ Baseline water well sampling within ½ mile
  - ✓ Emergency Preparedness Plan in place
  - ✓ Oil transportation via pipeline
  - ✓ Traffic impact fee paid
  - ✓ Continuous air monitoring program
    - 2-week baseline test prior to on-site activities
- OGF regulation setback extends beyond study's 1,000-ft radius



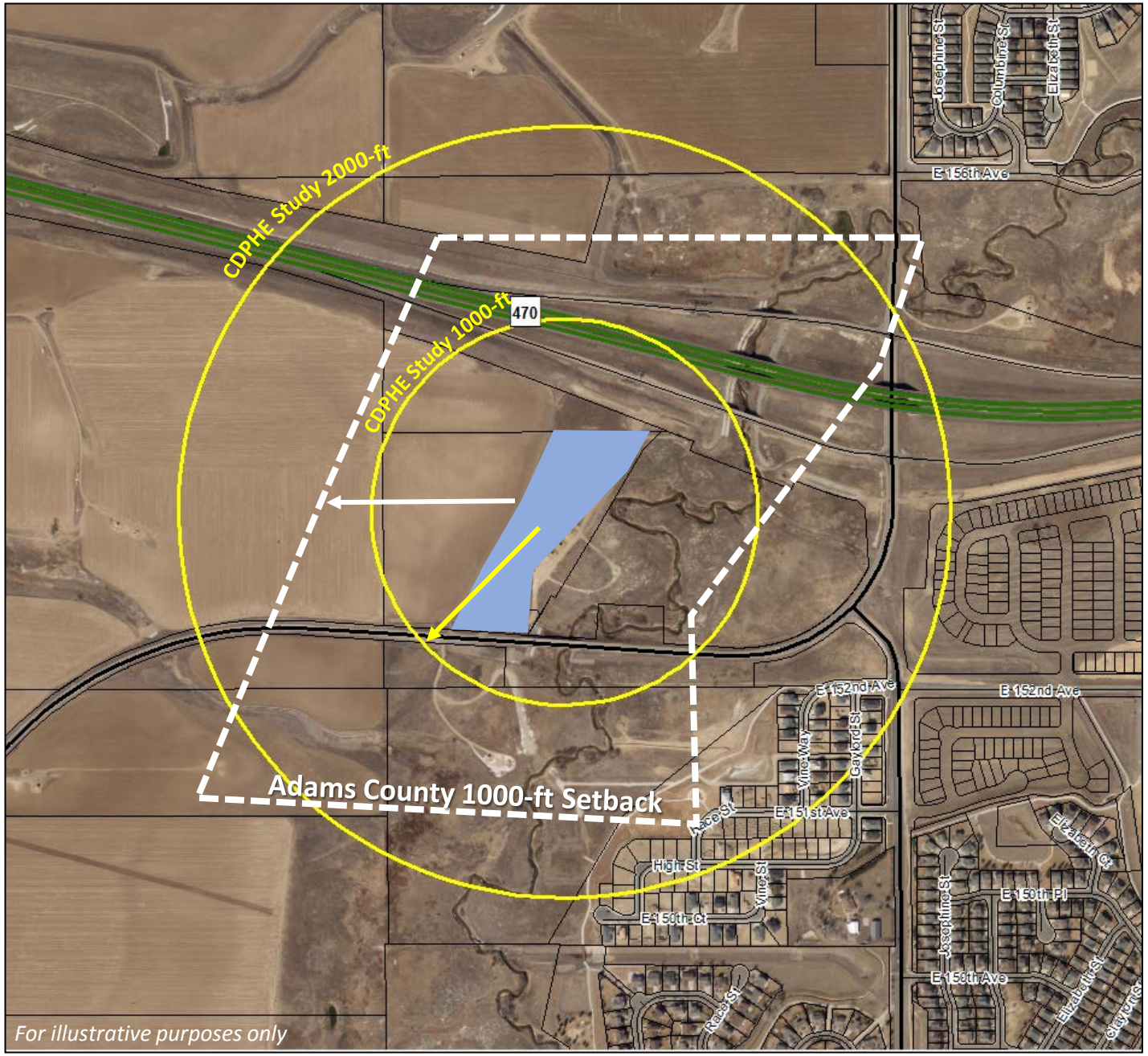
Rio LC Pad: Permitted 1/3/2019

- 13.9 –acre well pad
- 26 horizontal wells
  - ✓ 11 Drilled – Flowing Back Production
  - ✓ 15 Remaining
- 4 structures within CDPHE Study 1,000-ft radius
- 4 residences within OGF regulation setback (within ADCO)
- Nearest High Occupancy Building Unit: >1 mile
  - ✓ Elementary school – 10,225-ft
- BMPs in place via MOU and CoAs of USR Permit
  - ✓ Baseline water well sampling within ½ mile
  - ✓ Landscaping, weed mitigation and fencing plans
  - ✓ Oil transportation via pipeline
  - ✓ Traffic impact fee paid
- OGF regulation setback extends beyond study's 1,000-ft radius



Ivey Pad: Permitted 11/8/2017

- 6.8 –acre well pad
- 26 horizontal wells
  - ✓ 0 drilled – Location built, Pending COGCC Permits
  - ✓ 26 Remaining
- No structures within CDPHE Study 1,000-ft setback
- 0-3 residences within OGF regulation setback (subdivision)
- Nearest High Occupancy Building Unit: 2,854-ft
  - ✓ Child Care Facility
  - ✓ 3,479-ft from Elementary school
- BMPs in place via MOU and CoAs of USR Permit
  - ✓ Baseline water well sampling within ½ mile
  - ✓ Emergency Preparedness Plan in place
  - ✓ Closed loop drilling system utilized
  - ✓ Oil transportation via pipeline
- OGF regulation setback extends beyond study's 1,000-ft radius



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Take Aways:

- New OGF regulations are currently equipped to address potential increased risks of acute health effects presented by CDPHE study
- Best location selected via alternative site analysis requirement
- 1,000-ft setback requirement; waiver does not have to be granted
- Air quality BMPs and controls currently required for all new sites:
  - ✓ Reduced emission completions
  - ✓ No flaring or venting of gas
  - ✓ Enclosed combustion devices with 98% hydrocarbon destruction efficiency
  - ✓ Restricted activities on ozone alert days
  - ✓ Tanks with 98% HC emission destruction control
  - ✓ 72-hour leak repair
- Air quality BMPs and emission controls that could be required for sites located within CDPHE study setback radius:
  - ✓ Tier 4 engines / electric powered drill rigs
  - ✓ Air monitoring – baseline and continuous
  - ✓ Tankless production techniques
  - ✓ Zero emission dehydrators
  - ✓ Pipeline transport of produced (flowback) water
  - ✓ No-bleed continuous and intermittent pneumatic devices
  - ✓ Automated tank gauging