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COLLABORATIVE EXPERT REVIEW OF THE DENVER-JULESBURG BASIN OIL AND GAS EMISSION INVENTORY FOR OZONE NAAQS PLANNING IN NORTHERN COLORADO

International Emission Inventory Conference - Oil and Gas Emissions Session
September 28, 2023 – 9:20 am

OUTLINE

- Context and goals for emission inventory development project
- Collaboration and transparency
- Emission inventory development and results
- Key takeaways & general future recommendations

- Team effort - acknowledgements:
 - Ramboll: John Grant, Amnon Bar-Ilan, Tejas Shah, Ralph Morris
 - State of Colorado – Air Pollution Control Division: Dale Wells, Kira Shonkwiler, Kevin Briggs, Jessica Ferko, Garry Kaufman, Sara Heald
 - External Review Experts: Jana Milford and Clement Cros
 - RAQC: Mike Silverstein and Chris Laplante

CONTEXT AND GOALS

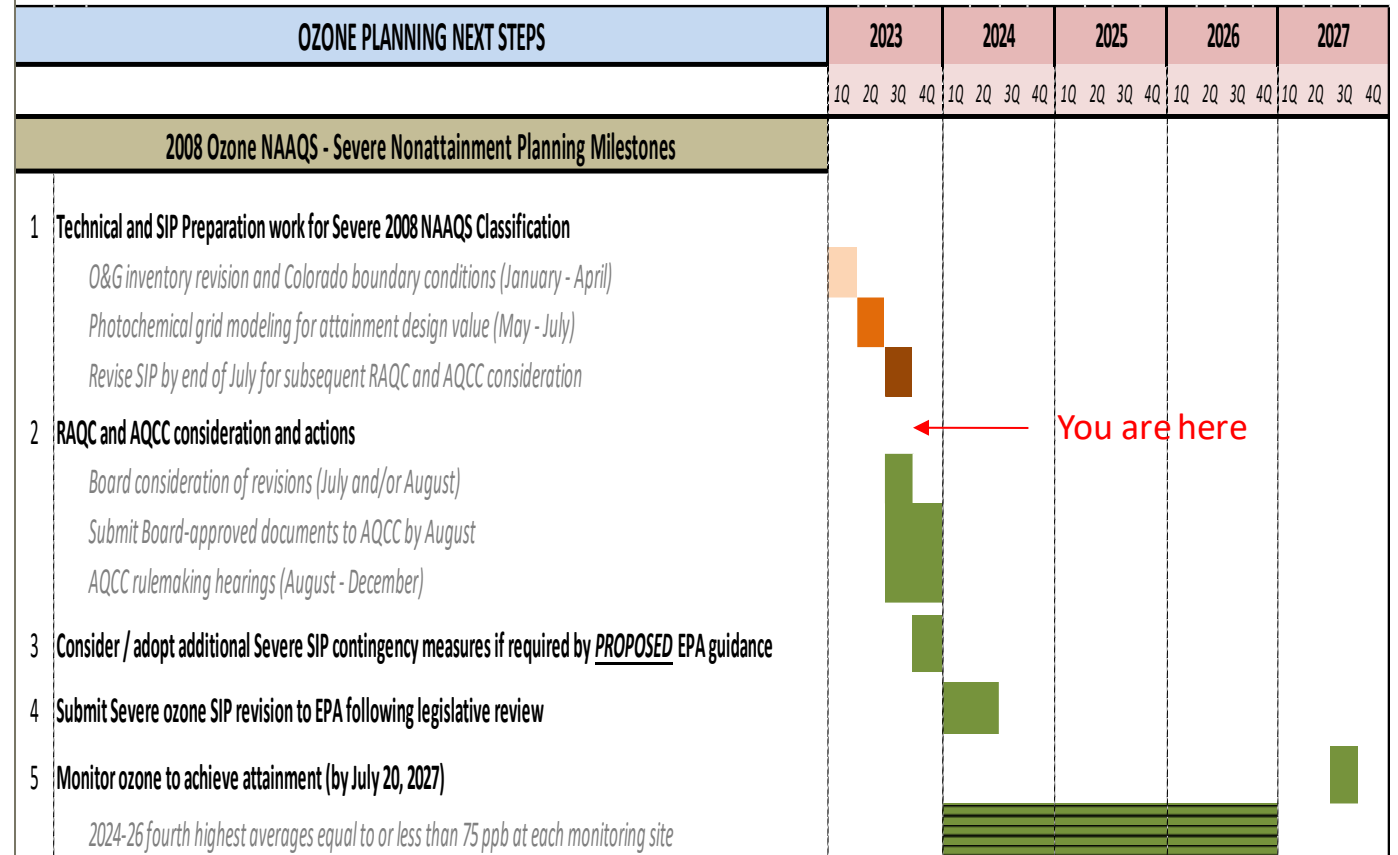
COLLABORATION & TRANSPARENCY

CONTEXT AND GOALS FOR EMISSION INVENTORY DEVELOPMENT

- Severe Ozone Nonattainment classification for 2008 75 ppb NAAQS
- O&G EI work and NAAQS attainment demo modeling completed in 2022 for:
 - Severe 75 ppb plan
 - Moderate 70 ppb plan
- Errors in O&G EI led to withdrawal of parts of Severe plan
 - also, Moderate 70 ppb plan did not demonstrate attainment
- Work on EI, followed by re-modeling of 75 ppb attainment demonstration, done from Jan. through Sept. 2023
 - Modeling results for 75 ppb plan with revised O&G EI demonstrates attainment

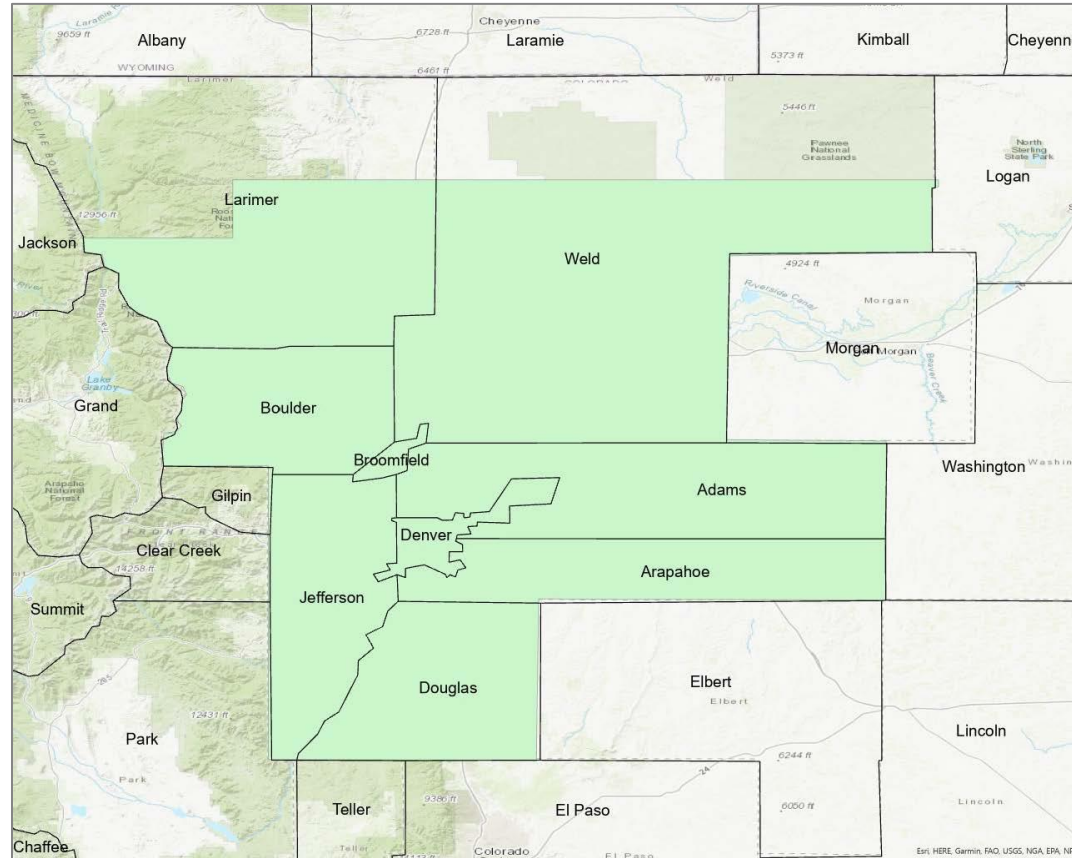


2008 Ozone Standard (75 ppb) Severe SIP Planning Milestones

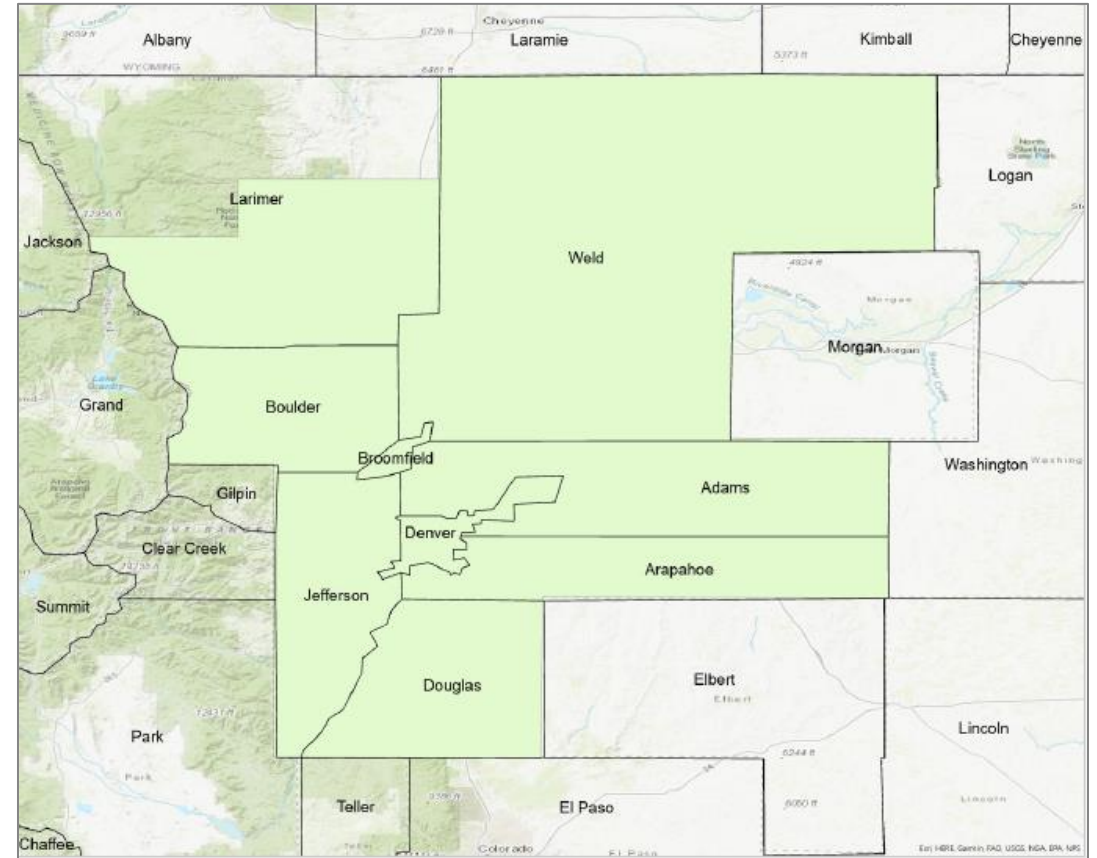


DENVER METRO/NORTH FRONT RANGE OZONE NAAQS NONATTAINMENT AREA BOUNDARIES

DMNFR 2008 Ozone NAA



DMNFR 2015 Ozone NAA



COLLABORATION & TRANSPARENCY

- Analysis by experts from APCD for base year 2017 and projection year 2026 emissions, both revised from previous estimates, review of methods, inventories, and reports
- Comprehensive review and analysis by external experts
- Analysis and revised 2017 and 2026 modeling inventories' prep by Ramboll team
- Multiple virtual meetings of these experts to discuss and reach agreement on modeling inventories' data

Public forum materials and report:

- [Public Forum: May 12, 2023 Oil & Gas Emission Inventory Results and Modeling Plans](#)
- [Ramboll DMNFR NAA OilGas EI Report 07Jul2023](#)
- Recommendations Memo in development: Potential Improvements to the Oil and Gas Emission Inventory for the DM/NFR Nonattainment Area



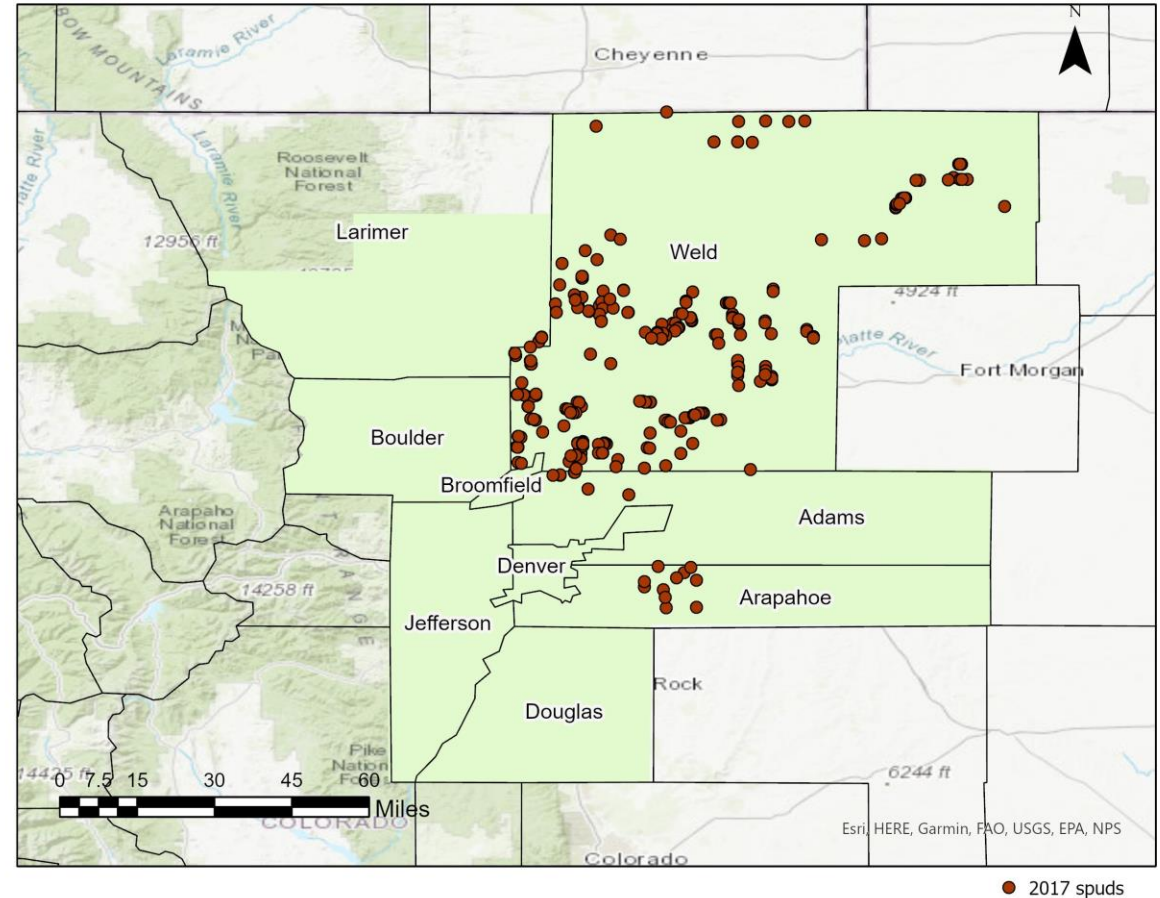
Methodology Outline: Denver Metro/North Front Range Oil and Gas Emission Inventory Ramboll US Corporation, May 10 2023
2017 Oil and Gas Emissions Inventory Spreadsheets Ramboll US Corporation, April 28, 2023
2026 Oil and Gas Emission Inventory Spreadsheets Ramboll US Corporation, May 10, 2023
Severe Ozone SIP Emission Inventory and Modeling Public Forum Presentation – May 12, 2023 RAQC staff
Revised Oil & Gas Emission Inventory Results Presentation – May 12, 2023 Ramboll US Corporation
Severe Ozone SIP Modeling Plans Presentation – May 12, 2023 Ramboll US Corporation
Modeling Forum Recording – May 12, 2023 Large file (231MB)

EMISSION INVENTORY DEVELOPMENT & RESULTS

SCOPE

- Geographical: DMNFR 2015 Nonattainment Area (NAA) and DMNFR 2008 NAA
- Pollutants: VOC and NOx
- Emission Sources
 - Nonpoint (wellsite): pre-production, production sources
 - Point (midstream): Gas gathering and boosting (compressor stations) and gas processing (gas processing plants, natural gas liquids processing plants)
- Temporal
 - 2017 historical year, 2026 future year
 - Average daily peak ozone season (May-Sep) emissions

DMNFR 2015 Ozone NAA



Basis

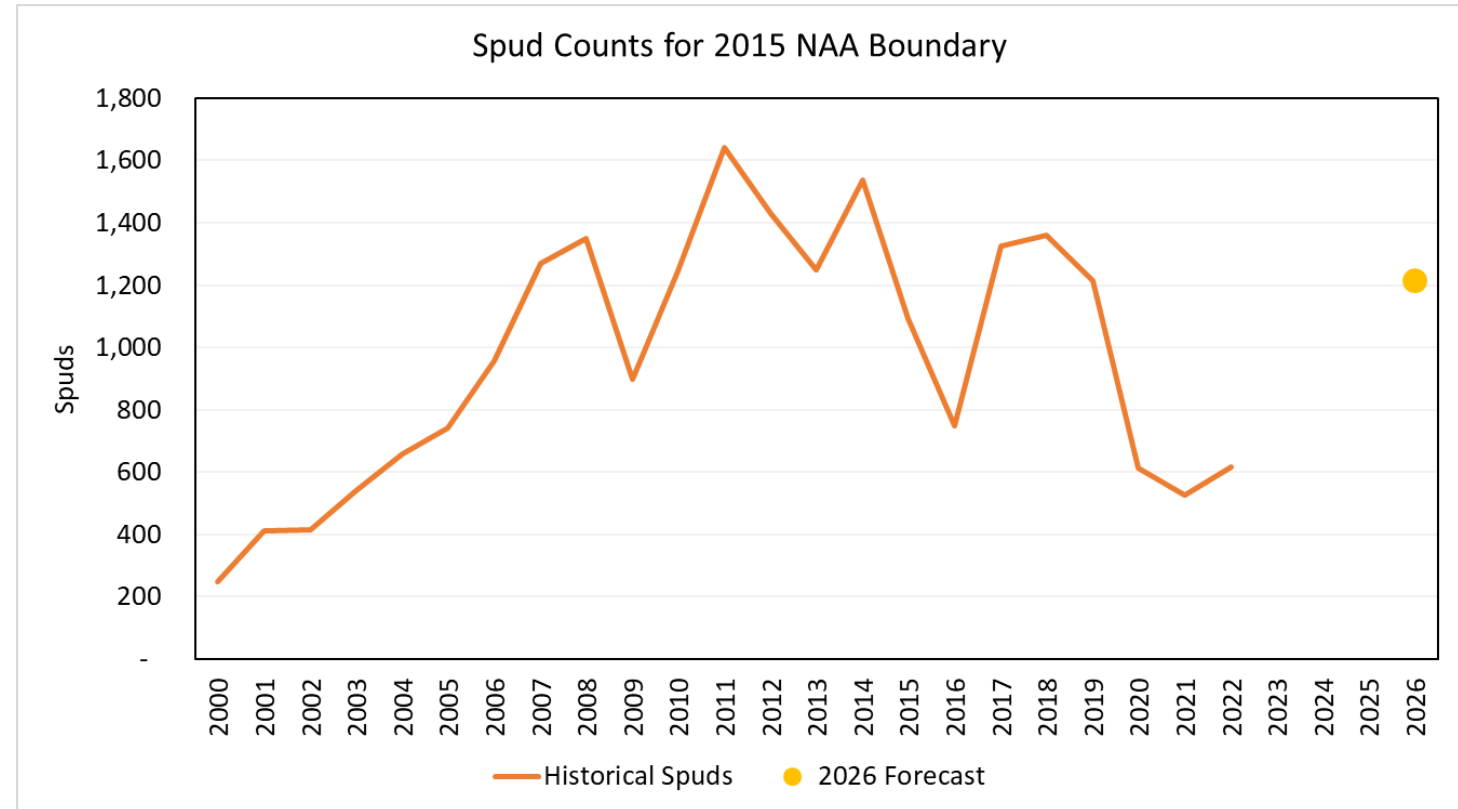
- Operator Survey
- Air Pollution Emissions Notice (APEN) Database (includes permitted wellsites and midstream facilities)
- Colorado Oil and Gas Commission Data (exploration phase and production phase activities)
- EPA 2016v2 Modeling Platform (mud degassing only)

HISTORICAL YEAR EMISSION INVENTORY DEVELOPMENT

- Started from CDPHE's previous inventory data and calculation methodology
- Developed new emission calculators
- Pre-production emissions are based on survey average emissions per spud and COGCC spud activity. Survey operator fleet included electric drill rigs.
- Production emissions sources are based on operator survey data. For operators that did not submit a survey we leveraged operator survey data and CDPHE permitting data to estimate emissions.

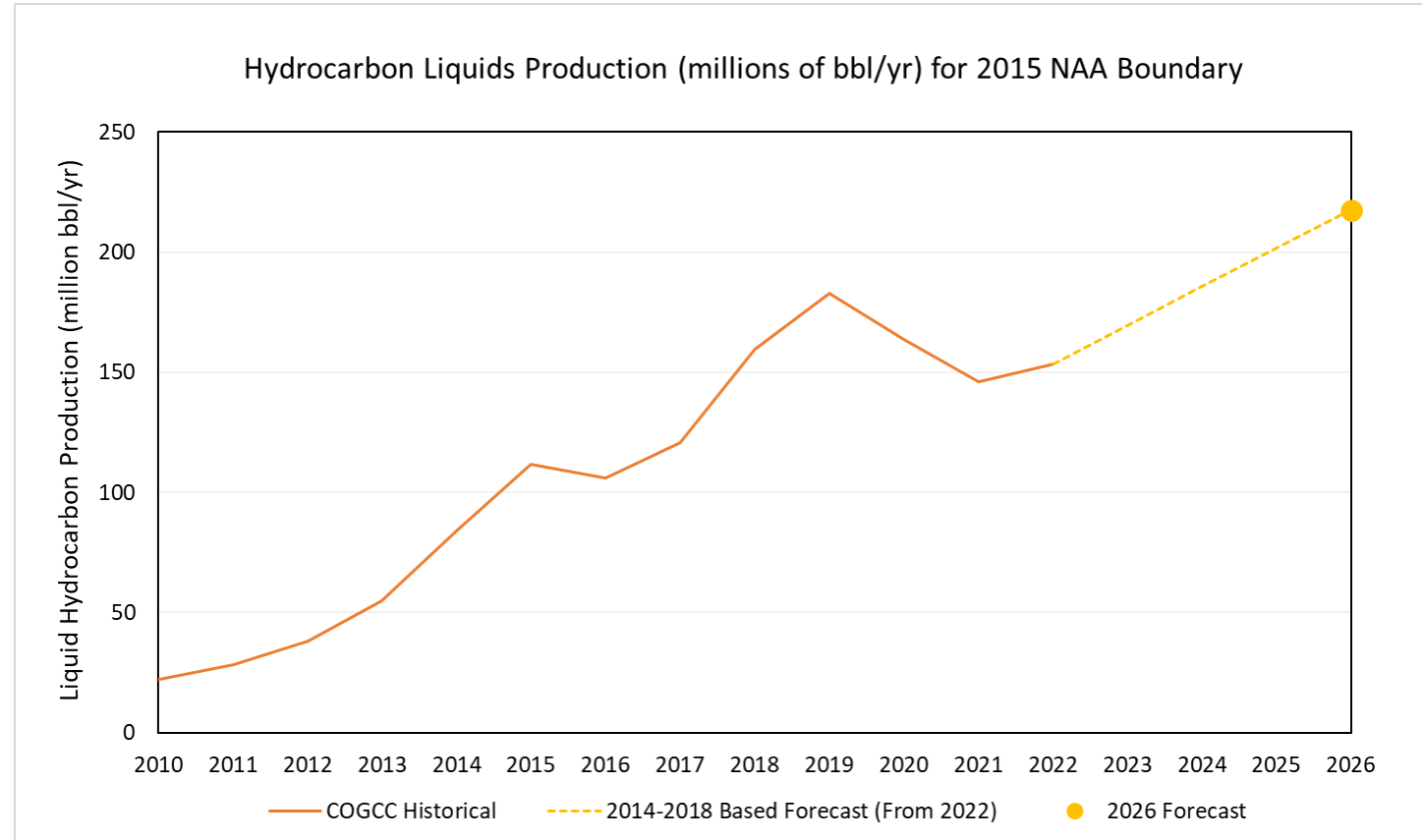
FUTURE YEAR EMISSION INVENTORY DEVELOPMENT

- Overall Activity Projections: Spuds (pre-production phase) and liquid hydrocarbon (production phase).
- Existing (as of 2017) Production Sites: Declined production-related (e.g., liquid hydrocarbon tanks, truck loadout) and held constant facility-related (e.g., process heaters, well-pad engines, fugitive components) emissions
- New (2018+) Production Sites: Assumed conformance to highly controlled 2017 configurations including multiple stages of separation
- Explicit on-the-books regulation-based adjustments accounted for pneumatic devices, but not other source categories



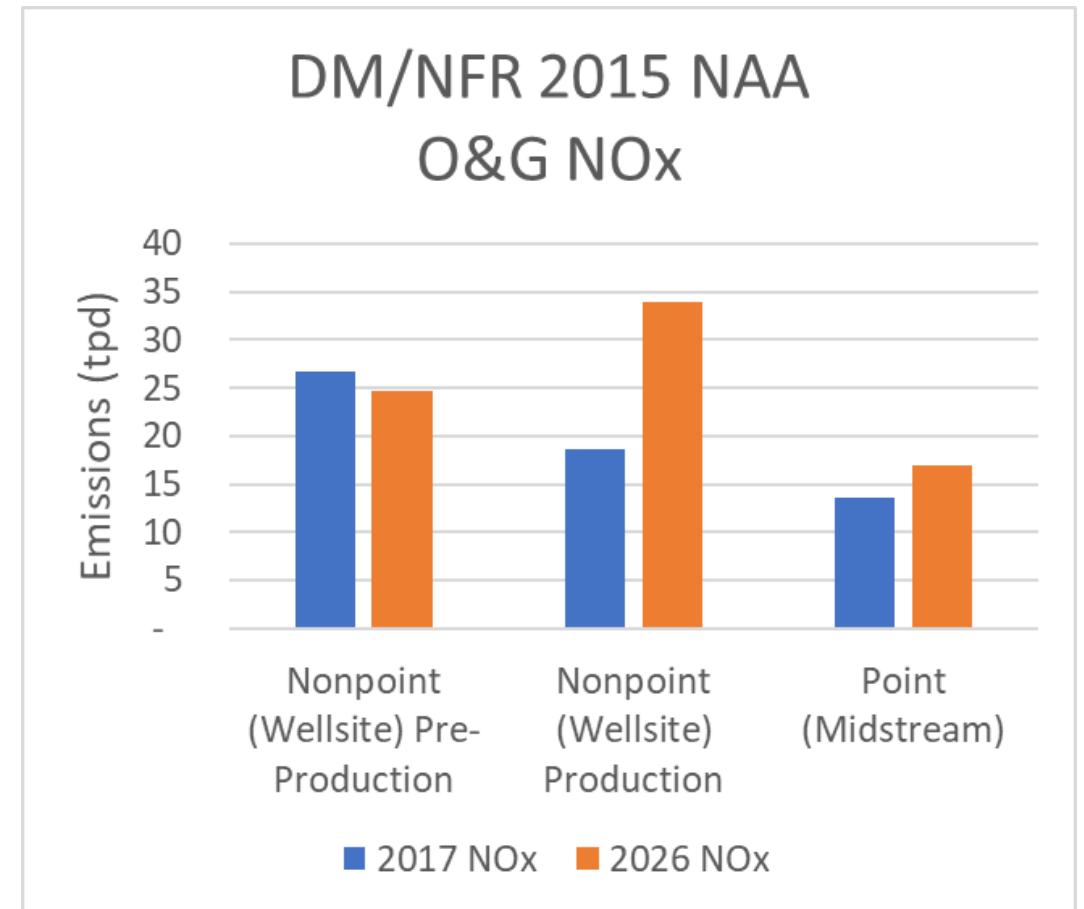
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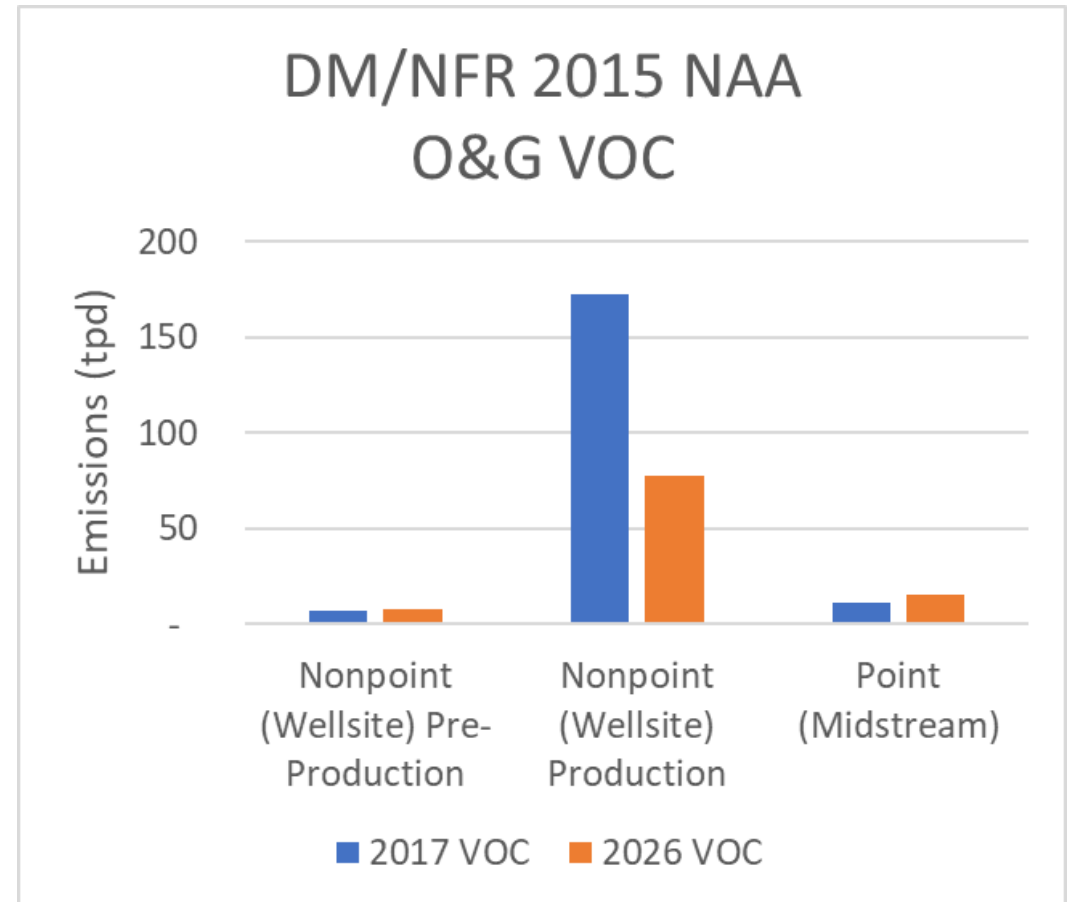
DM/NFR 2015 NAA NOx EMISSIONS

- Five emission categories comprise >95% of NOx emissions:
 - Pre-Production: Fracturing engines, drill rigs
 - Production: Well-pad internal combustion engines, process heaters
 - Midstream: Point internal combustion engines
- Major changes from 2017 to 2026
 - Pre-Production: Small decrease in spud count from 2017 to 2026
 - Production: Existing well-pad engine and process heater emissions conservatively held constant. Rules affecting well-pad engines emissions post-2017 were not included



DM/NFR 2015 NAA VOC EMISSIONS

- Largest VOC emissions contributors
 - Liquid Hydrocarbon Tanks (17-18%)
 - Pneumatic Devices (18%-19%)
- Major changes from 2017 to 2026
 - Steep decline in existing 2017 wellsite production phase emissions to 2026
 - Highly controlled hydrocarbon tank and pneumatic device emissions for new facilities



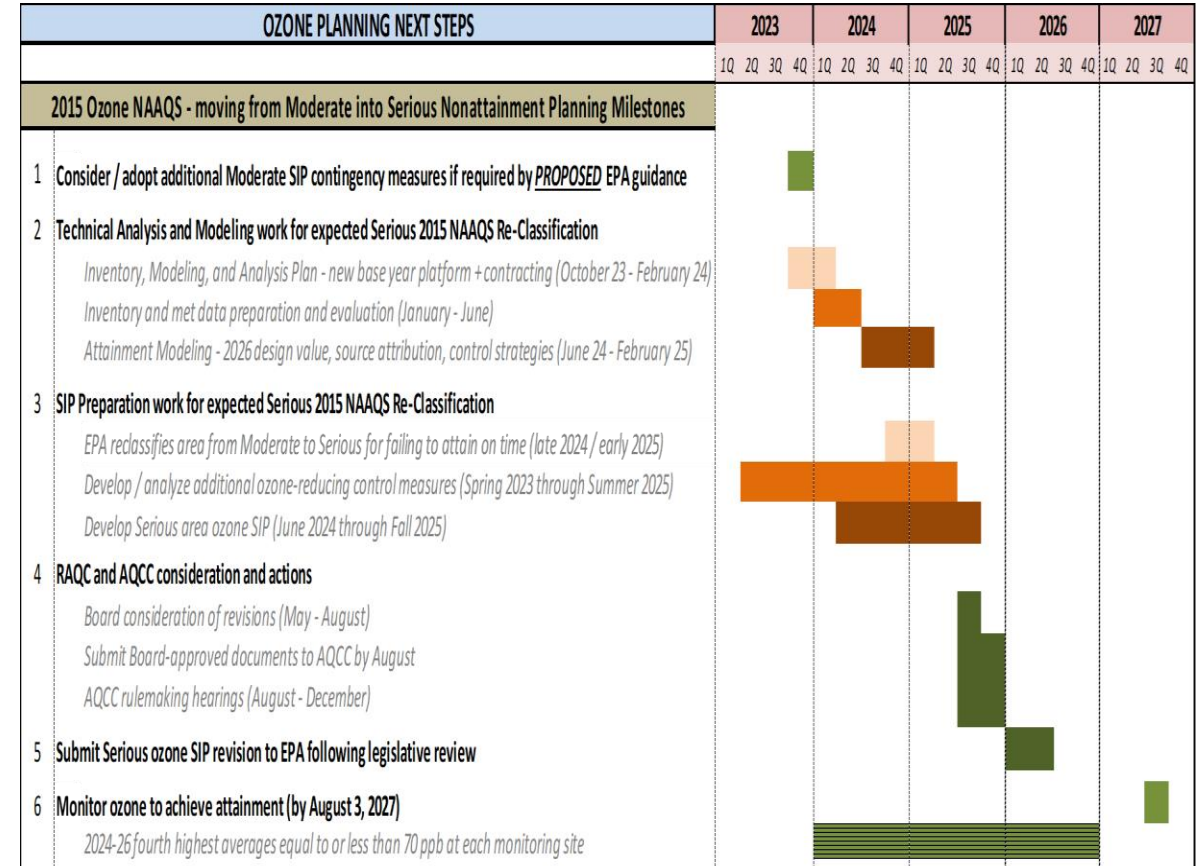
KEY TAKEAWAYS & GENERAL FUTURE RECOMMENDATIONS

70 PPB ATTAINMENT PLANNING – BIG PICTURE IMPROVEMENTS

Motivations to develop 2022-based modeling platform

- 2016 base year out of date
- Comply with EPA guidance
- Use a post-pandemic, more current year
 - Improved and more complete data for O&G and other emissions categories
 - Up-to-date / better understood basis to project attainment year activity and emissions
 - Account for O&G and other emission categories' control programs and source changes over past several years
- National 2022 emissions modeling platform in development to provide boundary and background inputs for Colorado and DM/NFR region air quality modeling
- Improve approaches and use current data to test control strategies

2015 Ozone Standard (70 ppb) Serious SIP Planning Milestones



GENERAL RECOMMENDATIONS FOR FUTURE DM/NFR NAA OIL AND GAS EMISSION INVENTORIES

- Leverage available operator reported data from new Colorado Air Pollution Control Division reporting requirements
- Use refined operational data from the Energy and Carbon Management Commission
- Reevaluate control efficiency, rule penetration, and rule effectiveness assumptions for on-the-books rules
- Develop projection methods that account for recent and ongoing changes to operations, rules and regulations, and changes in energy supply
- Estimate emissions based on DMNFR NAA-specific data to the greatest degree possible

END



Mission: We collaborate to improve air quality and protect Colorado’s health, environment, and economy through planning, policy development, and program implementation.

Vision: Clean air provides us the opportunity to breathe easy.

Bright ideas. Sustainable change.

RAMBOLL