Collaborative Steps to Improve Oil and Gas Emission Inventories in Several Western US States

July 31, 2019, International Emissions Inventory Conference

John Grant, Amnon Bar-Ilan; Ramboll

Tom Moore; WESTAR-WRAP

Outline

- WESTAR-WRAP Region O&G Activity and Emissions

- Survey effort and baseline inventory improvements

- Basin specific future year O&G activity forecasts

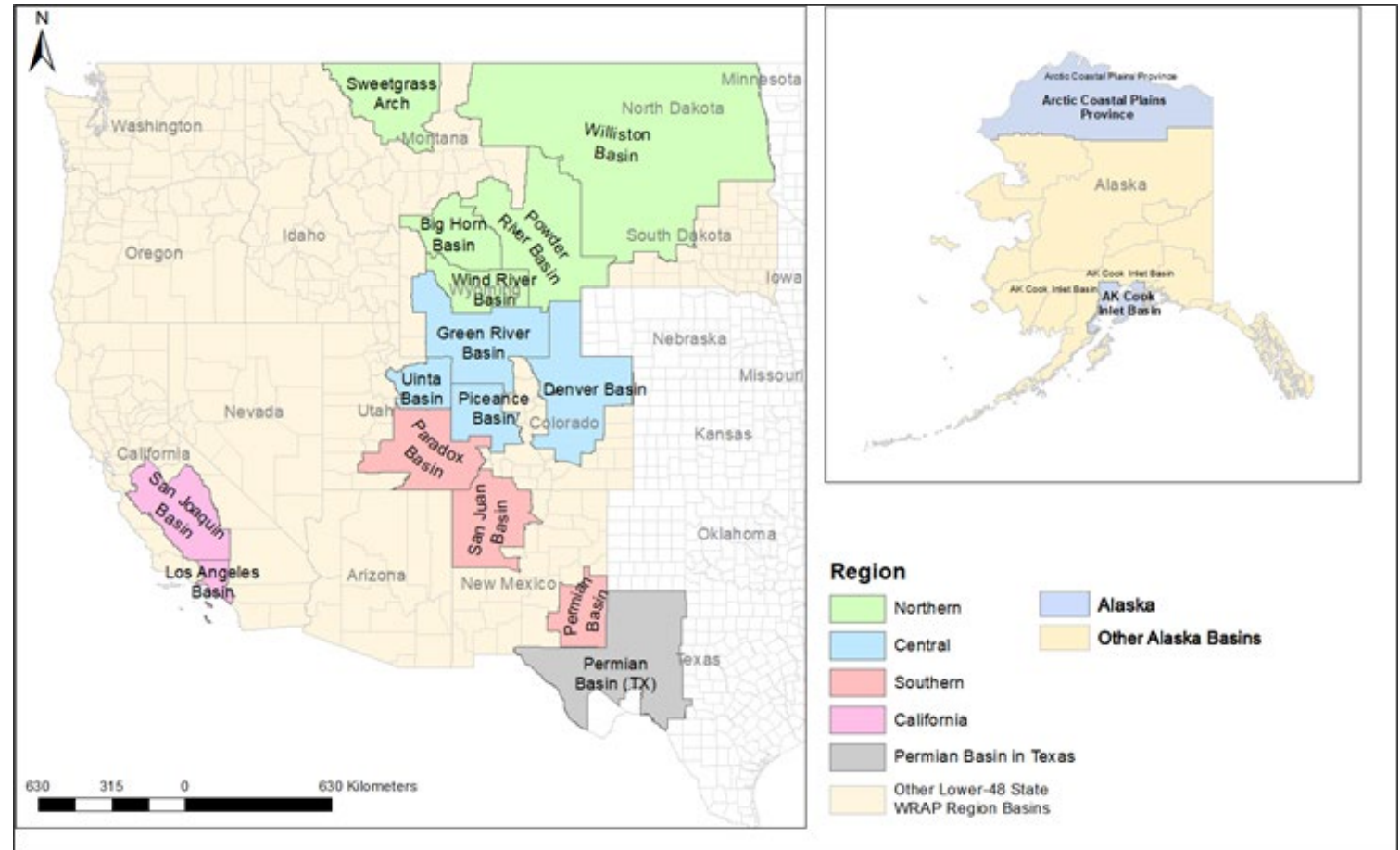# WESTAR-WRAP Region and Major Oil and Gas Basins

Substantial Activity

- 40% of US-wide crude oil production (2017)[1]

- 26% of US-wide natural gas production (2018)[1]

Diversity of Air Permitting Agencies

- State/ Local / Tribal / Federal

[1] US Energy Information Administration

WESTAR-WRAP Region O&G Inventories

- First comprehensive inventory of nonpoint O&G emissions in early 2000s

- Several region-wide and basin specific updates

- Dynamic sector → dynamic emission inventory

  - Strong activity dependence on commodity prices

  - Emerging plays and technologies

  - Legacy wells

  - Federal and state/local regulatory programs

  - National Environmental Policy Act

- <u>Continuing need to update the most important emission inventory inputs</u>

Western Regional Air Partnership Oil and Gas Working Group (WRAP OGWG)

- Multi-agency group responsible for oil and gas sector emissions and other sector specific analyses: https://www.wrapair2.org/OGWG.aspx

- Road map to develop baseline and future year emission inventory and controls analyses: **WRAP OGWG Road Map Scope of Work**

- Process for regular agency involvement

- Agency direction and participation is key to inventory improvements

Survey Approach

- Agency-centric approach

  - WRAP OGWG determined target sources: drill rigs, fracing engines, tanks, well-head engines, gas compositions

  - Two surveys compiled: (1) full survey and (2) controls-focused

  - By operator O&G activity data distributed to states so that they can determine which operators to survey

  - Agency determines which basins and which survey to focus on

  - Two-tiered distribution approach: (1) to agency for internal data review and (2) agency distributes survey to operators

- Baseline subject matter: Current practices and equipment that are critical to inventories

- Forecast subject matter: Controls-focused

Survey Participation

- Broad participation across states and basins.
- Agency submissions:
  - Colorado (draft Denver Basin survey data)
  - Wyoming (2014 and 2017 operator inventories)
  - Utah (Uinta Basin engine data)
- 300+ gas composition files

State	Basin	No. of Returned Surveys	Percent of 2014 Basin-wide Activity Represented by Returned Surveys		
			Well Count	Oil Production	Gas Production
Montana	Big Horn	1	5%	0%	6%
	Central Montana Uplift	2	62%	5%	85%
	Powder River	1	23%	91%	90%
	Sweetgrass Arch	2	23%	19%	53%
	Williston	6	25%	64%	31%
New Mexico	Permian	4	66%	80%	86%
	San Juan	0	-	-	-
North Dakota	Williston	17	11%	25%	26%
Wyoming	Denver	1	18%	46%	52%
	Green River	4	46%	51%	53%
	Powder River	4	4%	34%	13%

Survey Samples

Full Survey

A. Representative Drill Rig Data for Well Type and Spud Type Configuration 1

Spud Type	Horizontal
Well Type	Oil
Average Total Well Depth (ft)	

		EPA O&G Tool v2.1 Default Rig Data			Surve	
		Note: EPA tool provides two rig configurations :- (1) Diesel-mechanical and (2) Diesel-electric (DE) powered drill rig. ONLY mechanical drill rig configuration defaults are presented below for a selected basin				
		Engine 1	Engine 2	Engine 3	Engine 1	Engine 2
Representative Engine Configuration						
Engine Function		Draw Rig	Mud Pump	Generator		
Number of Engine per Rig (number/rig)		-	-	1.88		
Rated Horsepower (hp/engine)		-	-	2,206		
Hours of Operation (hours/spud)		-	-	507		
Percent of Engines Electrified (%)		0%	0%	0%		
Fuel Type		Diesel	Diesel	Diesel		
Fleet Control Data						
Percent of Engines by Tier Level	Uncontrolled	N/A	N/A	N/A		
	Tier 1	N/A	N/A	N/A		
	Tier 2	N/A	N/A	N/A		
	Tier 3	N/A	N/A	N/A		
	Tier 4	N/A	N/A	N/A		
Average Engine Turnover Frequency (years)		N/A	N/A	N/A		

Survey Samples

Controls Focused

A. Representative Drill Rig Data for Well Type and Spud Type Configuration 1

Spud Type		EPA O&G Tool defaults not displayed in the table below because spud type has not been selected
Well Type		
Average Total Well Depth (ft)		

		EPA O&G Tool v2.1 Default Rig Data Note: EPA tool provides two rig configurations :- (1) Diesel-mechanical and (2) Diesel-electric (DE) powered drill rig. ONLY mechanical drill rig configuration defaults are presented below for a selected basin			Surve	
		Engine 1	**Engine 2**	**Engine 3**	**Engine 1**	**Engine 2**
		Fleet Control Data				
Percent of Engines Electrified (%)		N/A	N/A	N/A		
Percent of Engines by Tier Level	Uncontrolled	N/A	N/A	N/A		
	Tier 1	N/A	N/A	N/A		
	Tier 2	N/A	N/A	N/A		
	Tier 3	N/A	N/A	N/A		
	Tier 4	N/A	N/A	N/A		
Average Engine Turnover Frequency (years)		N/A	N/A	N/A		

RAMBØLL

WESTAR
Western States Air Resources Council

WRAP
Western Regional Air Partnership

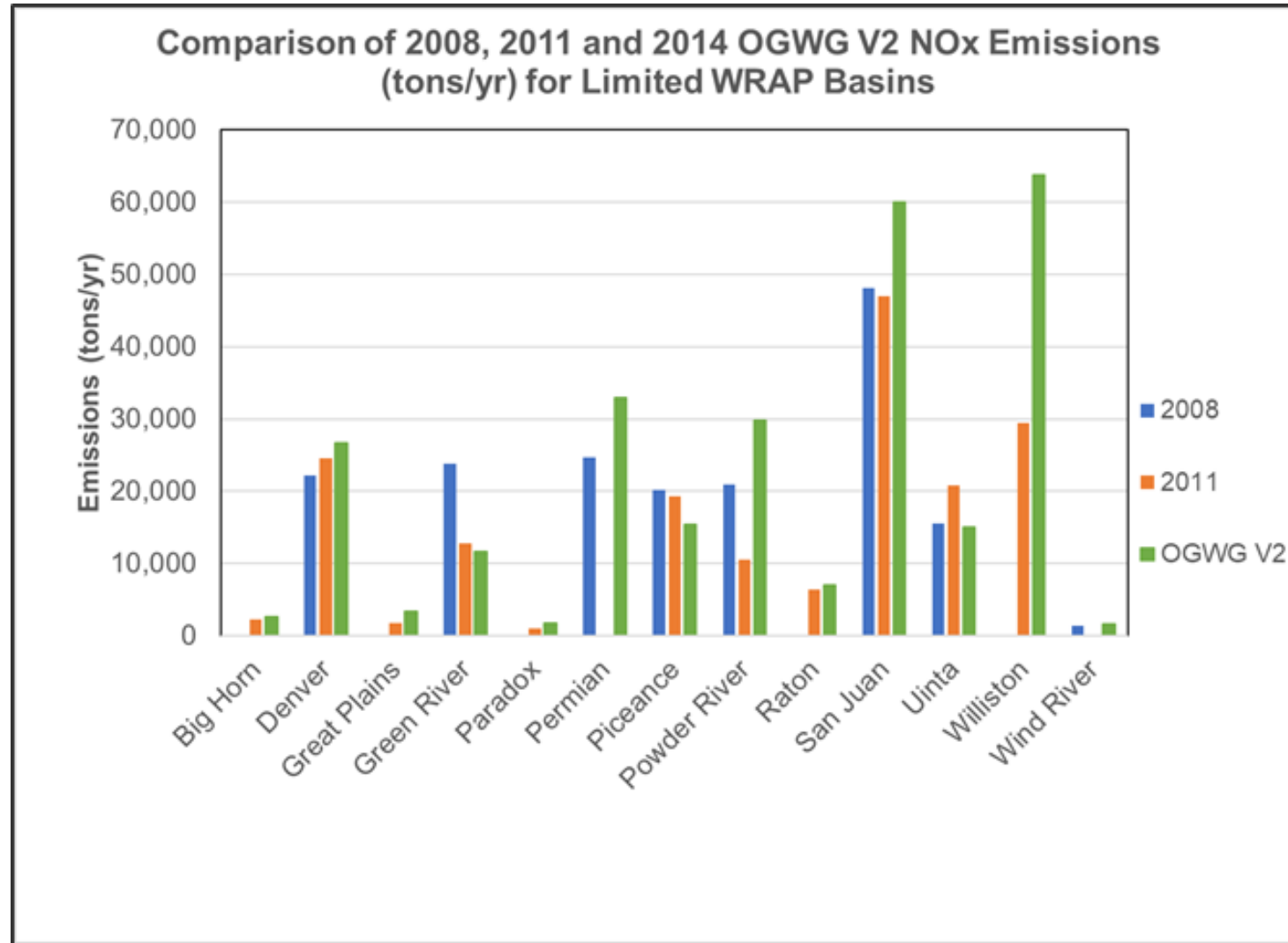# Survey-based Baseline Improvements

Major Findings

- Hydraulic fracturing engines: Increased engine power

- Drill rigs: lower drilling times
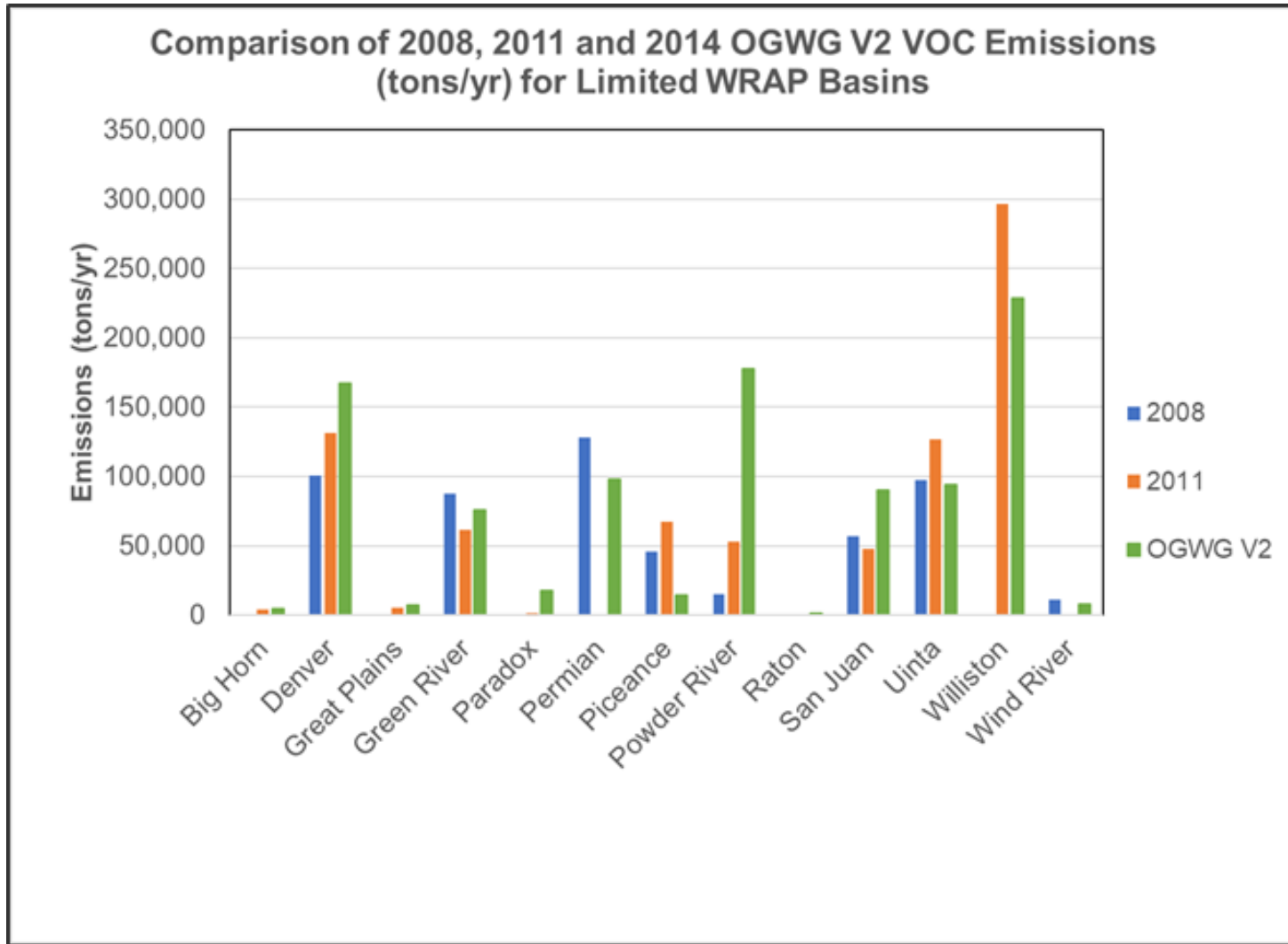
- Tanks: more controls

Basin	Emissions (tons/year)	
	NOx	VOC
Hydraulic Fracturing Engin	23,096	1,933
Artificial Lift Engines	13,977	3,186
Generator Engines	2,833	334
Nonpoint Compressor Eng	2,025	31
Drill Rigs	-17,812	-789
Oil Tanks	858	-326,939
Condensate Tanks	18	537
Total Change	**24,995**	**-321,708**
Percent Change	**8%**	**-24%**

Basin	Emissions (tons/year)	
	NOx	VOC
Williston , ND	19,108	-280,542
Permian , NM	4,900	-25,719
Sweetgrass , MT	1,789	600
Williston , MT	-1,036	-16,169
Powder River , MT	-1	5
Central Montana Uplift , M	226	116
Big Horn , MT	9	0
Total Change	**24,995**	**-321,708**
Percent Change	**8%**	**-24%**

RAMBOLL

NOx Emissions from 2008 to circa-2014

Comparison of 2008, 2011 and 2014 OGWG V2 NOx Emissions (tons/yr) for Limited WRAP Basins

VOC Emissions from 2008 to circa-2014

Comparison of 2008, 2011 and 2014 OGWG V2 VOC Emissions (tons/yr) for Limited WRAP Basins

O&G Activity Forecasts

- Guiding principles
  - Basin specific
    - Basins with the greatest activity and emissions, forecasts will be based on historical trends: these basins represent 98.6% of gas production, 99.6% of oil production, 99.5% of spuds, and 97.6% of active well count in the WRAP region in 2014
    - Activity in other basins will be assumed unchanged from 2014
  - To the extent feasible distinguish between legacy and new production
  - Near term forecast preferred (2023)
- Medium scenario: status quo persists
- Low and High Scenario
  - Yet to be determined

Forecast Methods

- Each SCC is assigned to the activity parameter most closely associated with its emissions (e.g., drill rigs to spuds, oil tanks to oil production)

- By source category control factor scalars to be developed based on on-the-books and on-the-way controls and survey responses
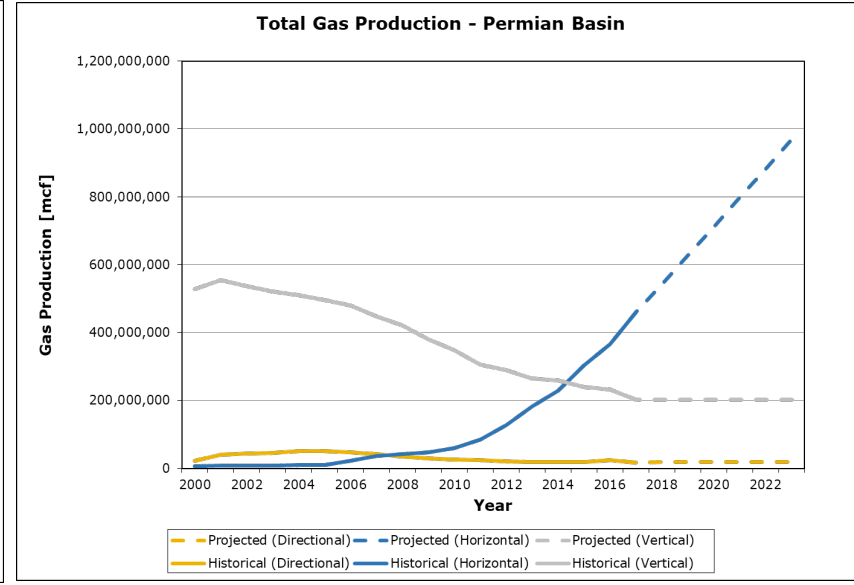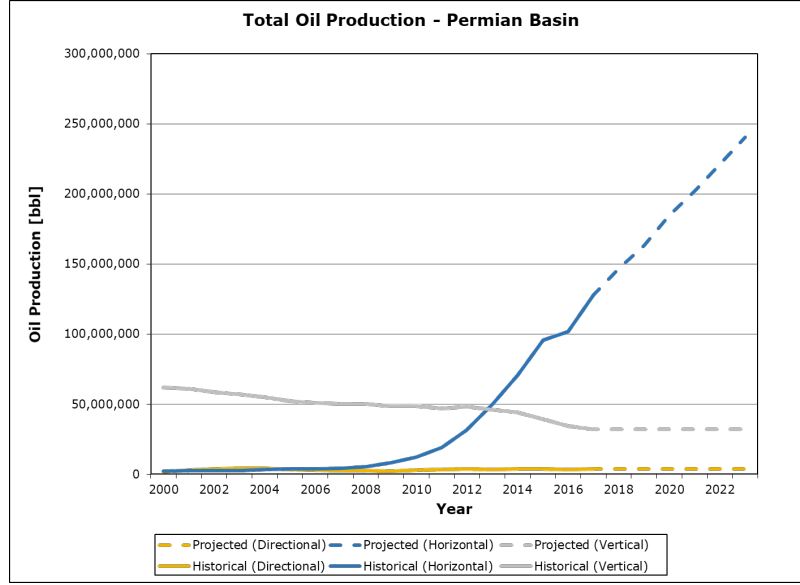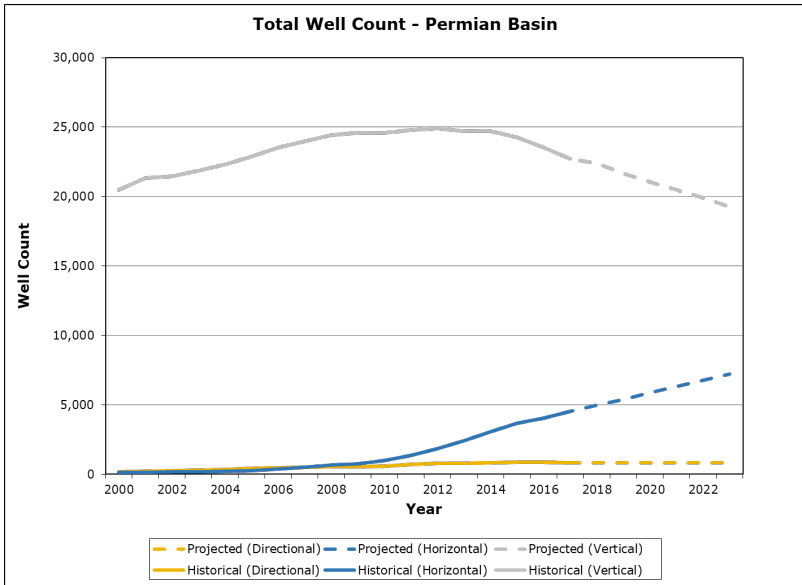
$$E_{2028,scc,pol} = E_{2014,scc,pol} \times GDF_{scc} \times CF_{scc,pol}$$

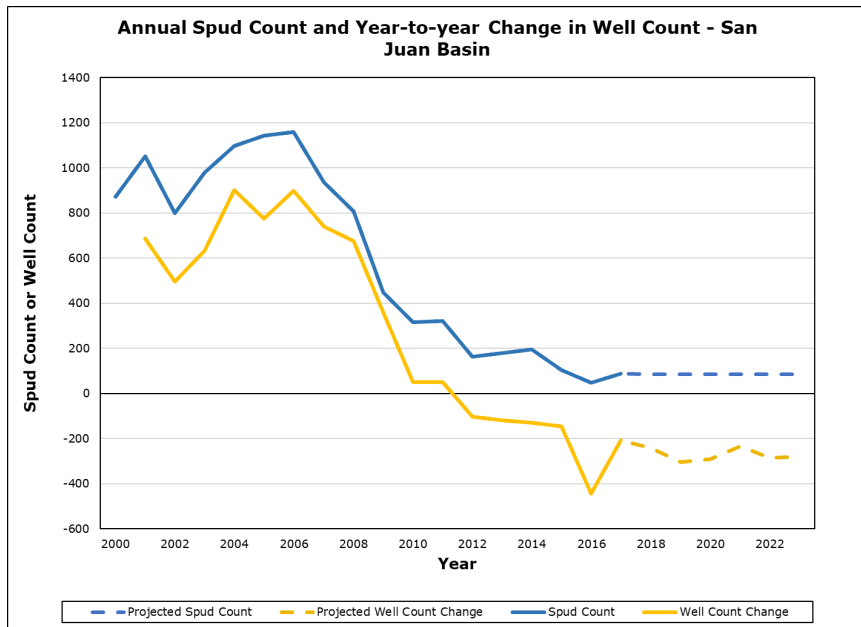$E_{2028,scc,pol}$ = 2028 future year emissions by SCC and pollutant
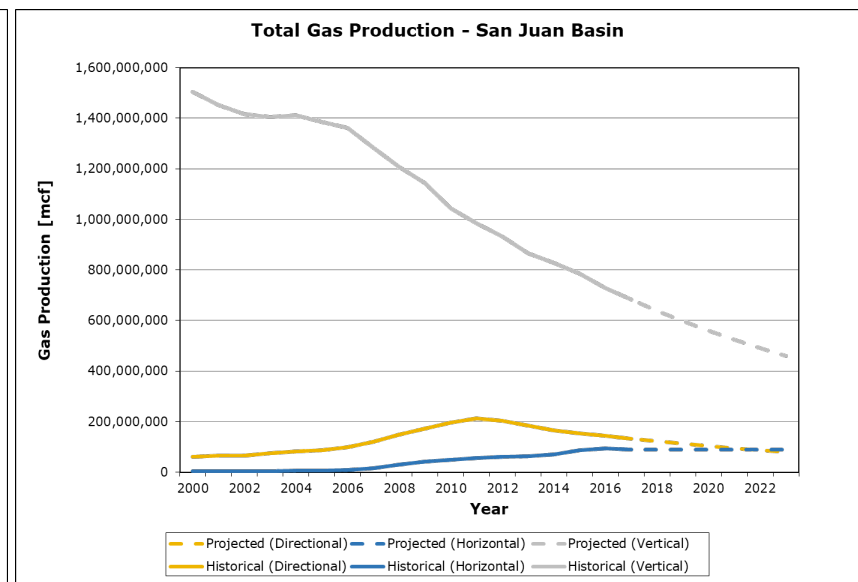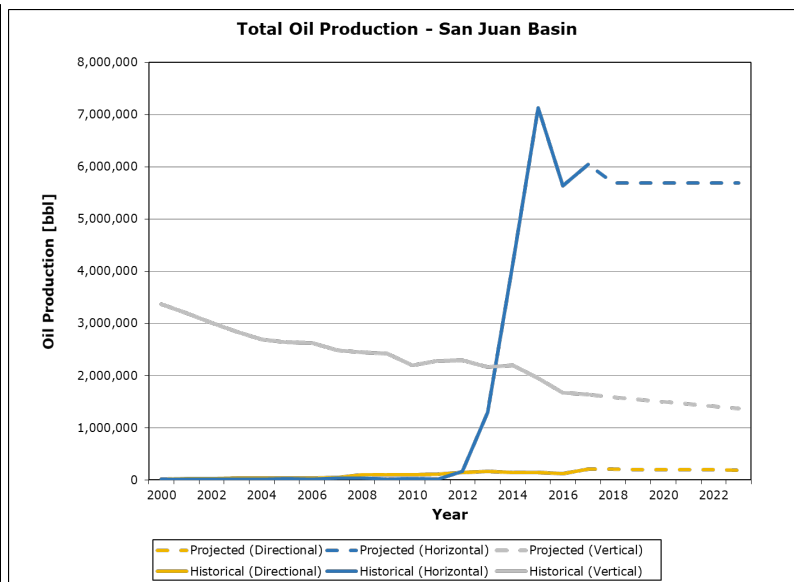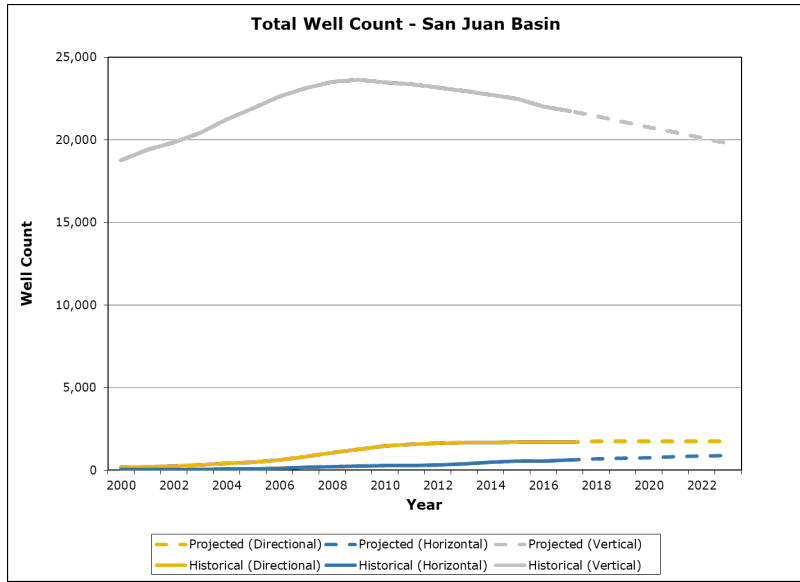
$E_{2014,scc,pol}$ = 2014 base year emissions by SCC and pollutant

GDF_{scc} = O&G activity growth/decline factor (i.e., the ratio of 2023 to 2014 O&G activity) by SCC

$CF_{scc,pol}$ = control factor scalar (ratio of emissions control in future year 2028 to emissions control in future year 2014) by SCC and pollutant

Total Well Count - Permian Basin

Total Oil Production - Permian Basin

Total Gas Production - Permian Basin

Annual Spud Count and Year-to-year Change in Well Count – Permian Basin
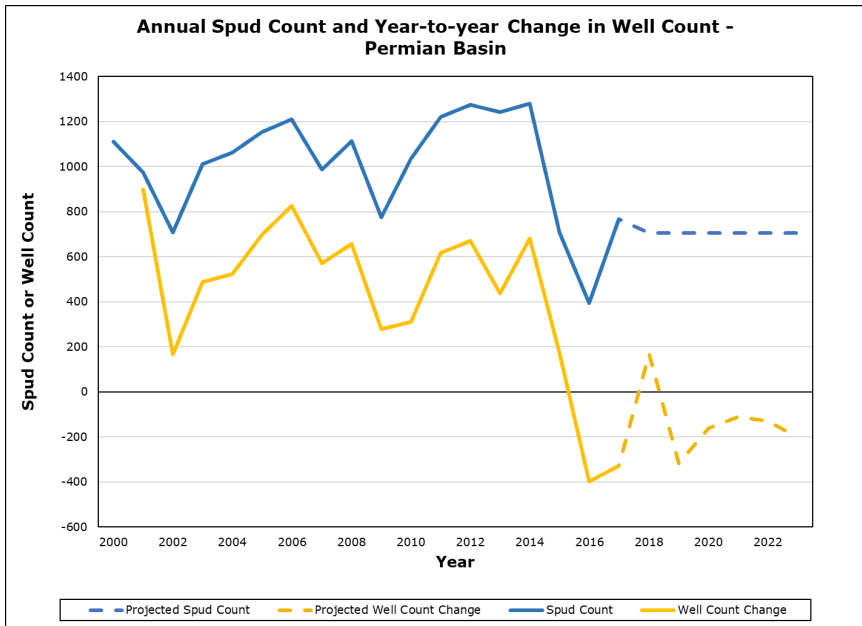
Permian (NM) Example: Strong Recent Growth

Greater San Juan Basin: Strong Legacy Production

Conclusions

- Targeted survey efforts with state agencies to improve emission inventory are repeatable and can substantially improve emission inventory accuracy

- Targeted basin specific O&G forecasts are feasible; spud type can be used for many basins to distinguish emerging production areas from legacy activity

- More robust tracking of well inputs by age could increase inventory accuracy

- Next project steps (https://www.wrapair2.org/OGWG.aspx)

  - Future year inventories (medium, low, and high)

  - Controls analysis

Acknowledgements

- The authors wish to acknowledge the extensive support received from WRAP OGWG member agencies who participate in the survey effort and review of study products. We would specifically like to acknowledge the direction and support of the WRAP OGWG Project Management Team and the WRAP OGWG Project Management Team co-chairs, Darla Potter (WYDEQ), Mark Jones (NMED), and Amanda Brimmer (RAQC).