EFO Annual Meeting

Oklahoma City, OK

October 2017

The 2014 Air Emissions Inventory for the Oil & Gas Sector in Oklahoma

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OKLAHOMA
DEPARTMENT OF ENVIRONMENTAL QUALITY

Acknowledgments

Support from OKDEQ, including the hard work of the following staff:

Mark Gibbs, Louise Esjornson, Tom Richardson, Lindsay Ross, Shelby Willeby, Carrie Schroeder, Cecelia Kleman, Cooper Garbe, Justin Milton, Jay Laughlin, Shannon Hill, Hanna Bentley

Help from ERG and Ramboll-Environ:

- Regi Oommen, Mike Pring
- John Grant, Amnon Bar-Ilan

Assistance from EPA:

- Jennifer Snyder

Overview

- Emissions Inventory – what is it
- Oil and gas part of the state inventory
  - Why it's important
  - 3 sources of information
  - National tool
  - Results
  - Conclusions
- Epilogue: Heads Up: Permit By Rule Requirements

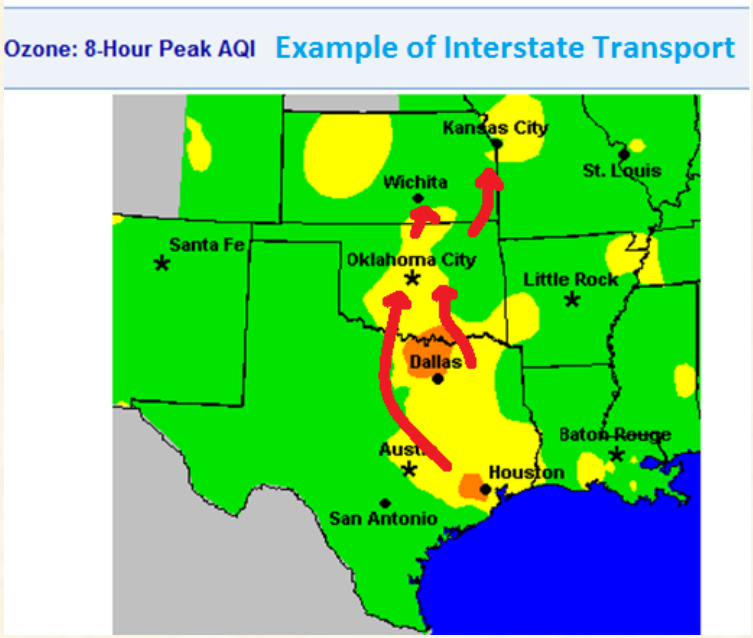
Background on Emissions Inventory

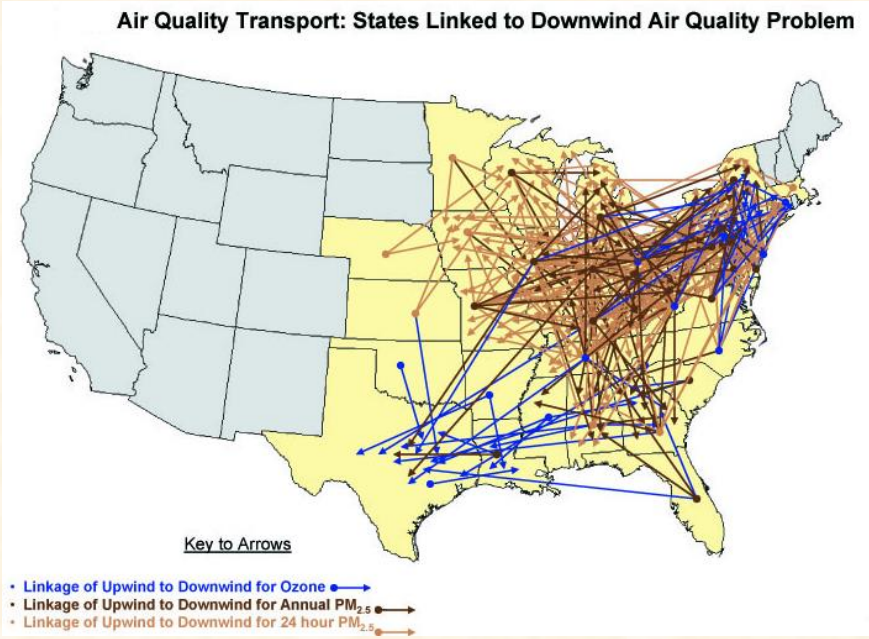
What Is An Emission Inventory?

- A report of actual emissions of regulated pollutants during a calendar year
- Provides a description to DEQ of your facility and its operations

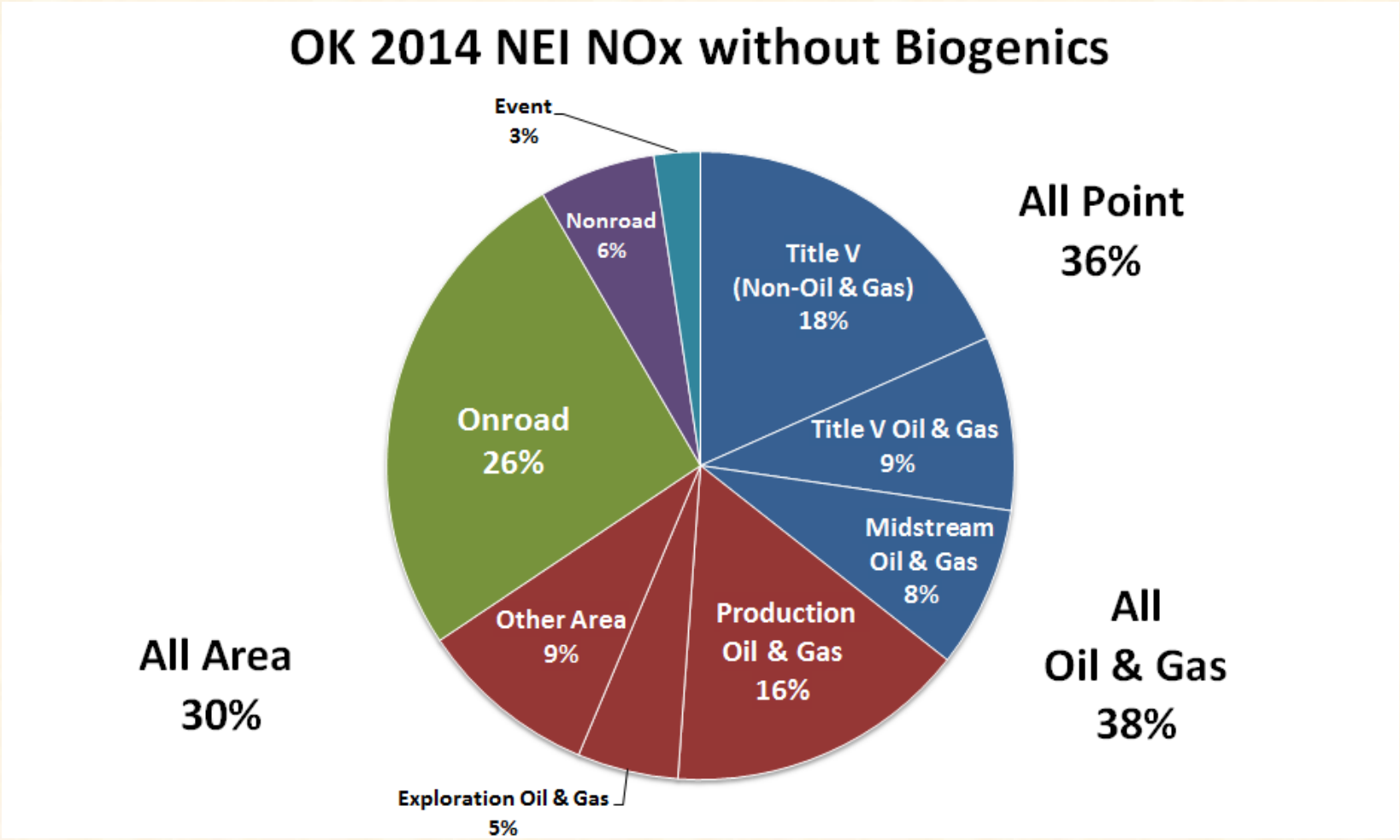
Importance of Getting It "Right"

- The emissions inventory is used to…
  1) Model interstate transport of ozone and PM-2.5 precursors
  2) Inform modeling work for major construction permits
  3) Predict health impacts and identify local hotspots
  4) Confirm the success of current rules and evaluate the need for new rules
  5) Satisfy national reporting requirements
  6) Document compliance
  7) Calculate fees





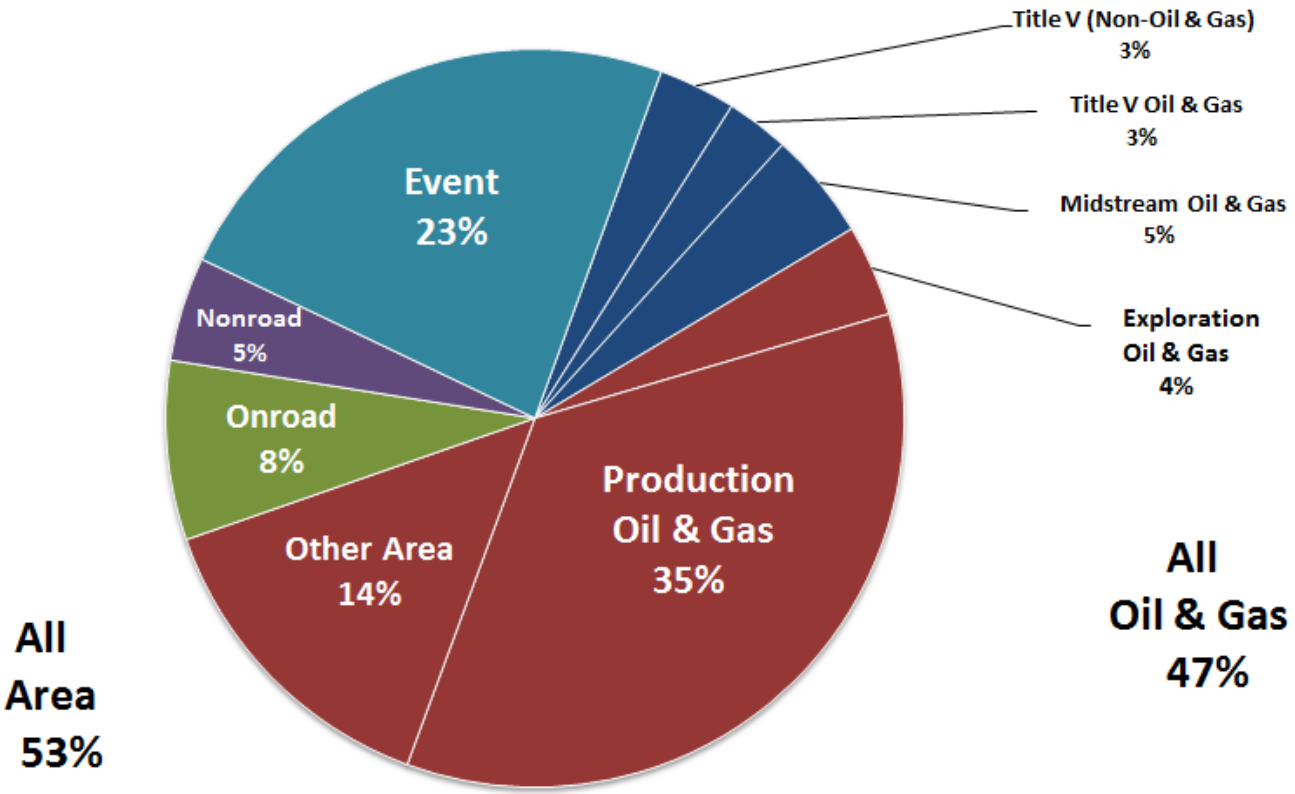
OK 2014 NEI NOx without Biogenics



	TONS	PROPORTION OF ALL SOURCES
Point	125,834	36%
Area	105,923	30%
Onroad	91,919	26%
Nonroad	21,154	6%
Event	8,454	2%
All Sources	353,284	

	TONS	PROPORTION OF ALL SOURCES
All Point	125,834	36%
Title V Oil & Gas	31,709	8%
Midstream Oil & Gas	29,395	8%
Area	105,923	30%
Production Oil & Gas	66,435	16%
Exploration Oil & Gas	18,365	5%
All Sources	353,284	

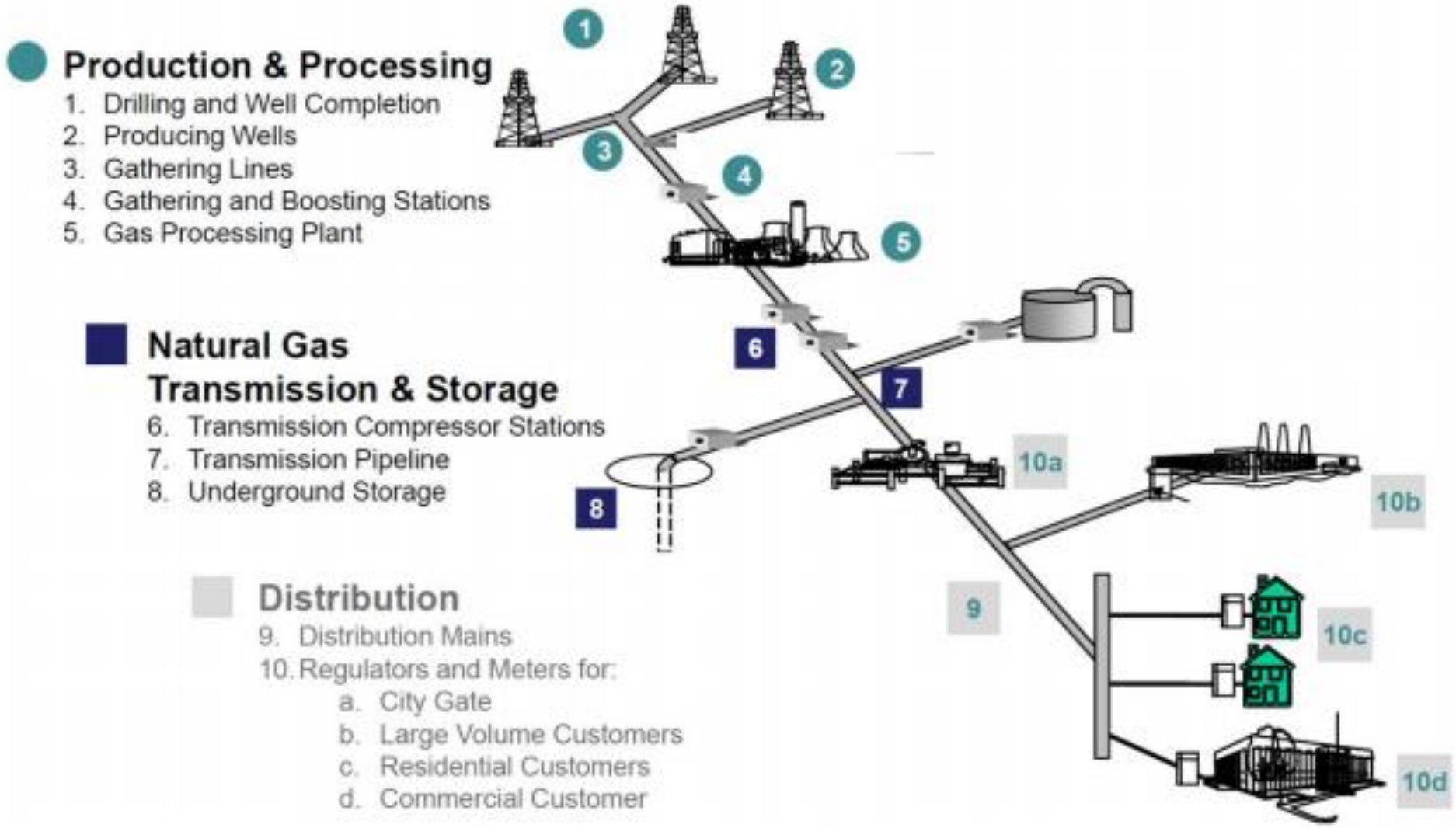
OK 2014 NEI VOC without Biogenics



	TONS	PROPORTION OF ALL SOURCES
Point	50,161	11%
Area	246,983	53%
Onroad	36,249	8%
Nonroad	21,091	5%
Event	108,272	23%
All Sources	462,756	

	TONS	PROPORTION OF ALL SOURCES
All Point	50,161	11%
Title V Oil & Gas	12,692	3%
Midstream Oil & Gas	21,792	8%
Area	246,983	53%
Production Oil & Gas	162,363	35%
Exploration Oil & Gas	19,555	4%
All Sources	462,756	

Focus on the Oil and Gas Production Sector



Source: (EPA 2014a)

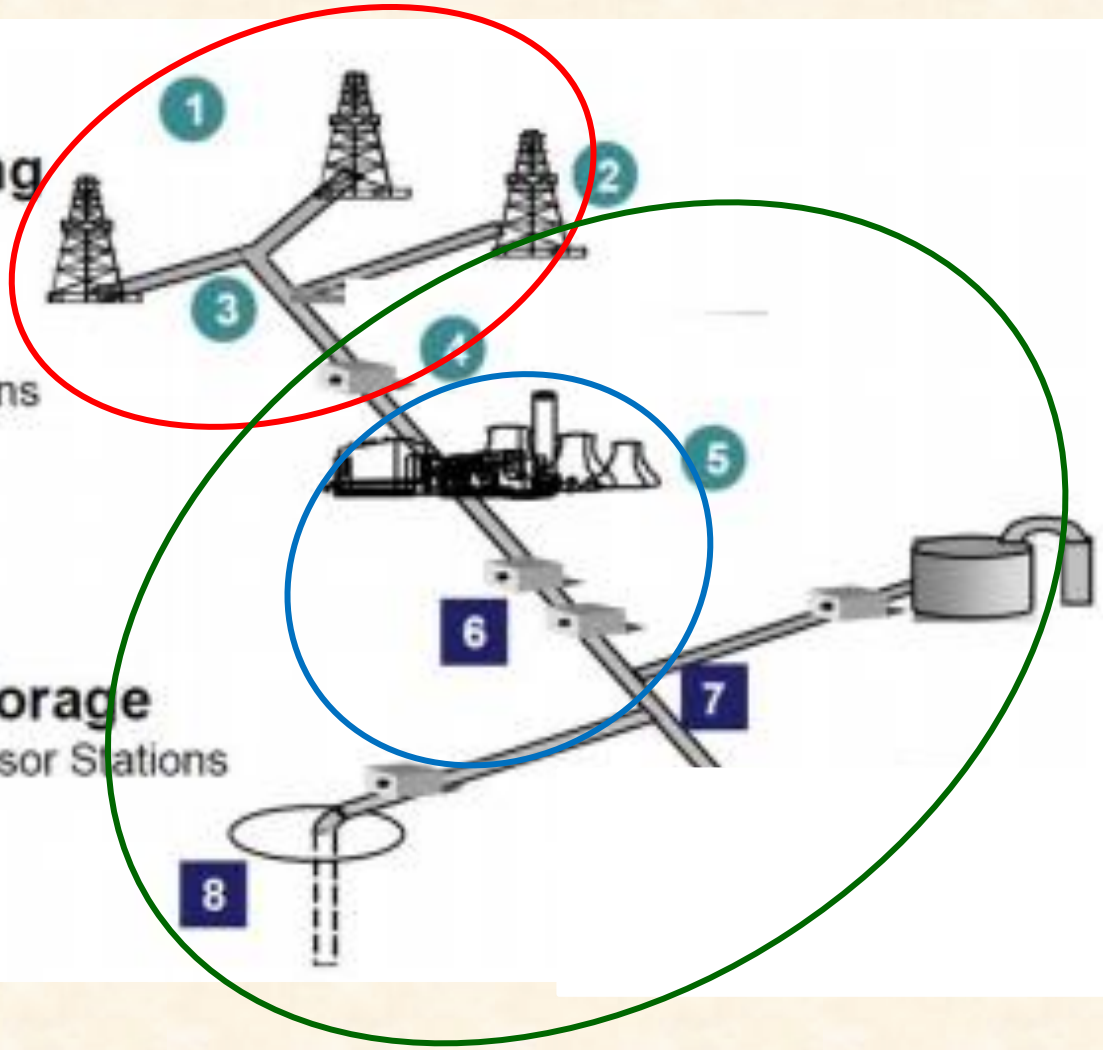
- **Oil and Gas Tool + Aggregated Permitted Wells**
- **Point Source Midstream Emissions**
- **Type A & B Potential Point Sources**

Production & Processing

1. Drilling and Well Completion
2. Producing Wells
3. Gathering Lines
4. Gathering and Boosting Stations
5. Gas Processing Plant

Natural Gas Transmission & Storage

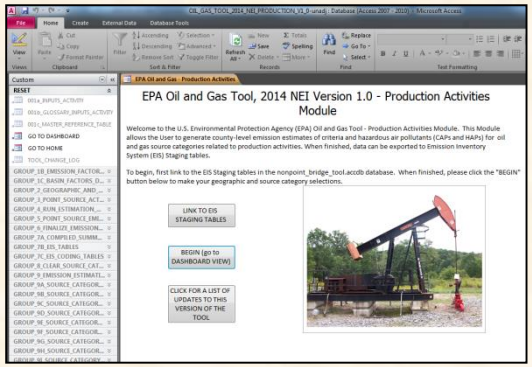
6. Transmission Compressor Stations
7. Transmission Pipeline
8. Underground Storage



Oklahoma Oil & Gas NEI Submission History

	Before 2008	2008 NEI	2011 NEI	2014 NEI
Wellhead	Not Inventoried	CENRAP Study	Oil & Gas Tool	Oil & Gas Tool + Aggregated Permitted Wells
Midstream	Minor Facilities Not Reported	Aggregated Midstream Emissions	Point Source Midstream Emissions	Point Source Midstream Emissions
Major Point Sources	Type A & B Actuals	Type A & B Actuals	Type A & B Potential	Type A & B Potential

Oklahoma Area Source Oil & Gas Production Emissions



2014 O&G Production Tool

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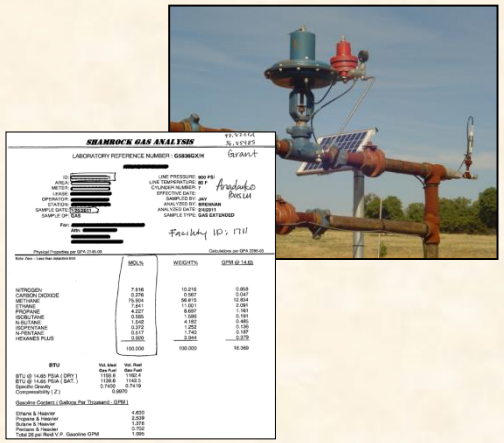

Oklahoma Changes

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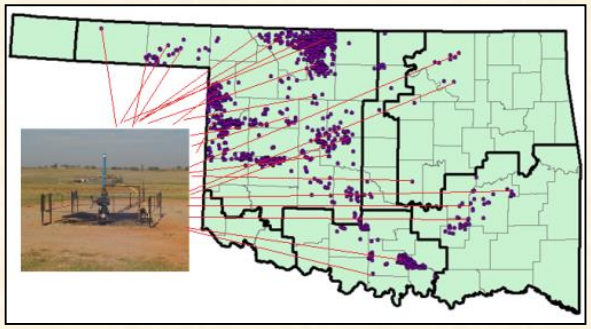

Point Source Inventories from Permitted Wellheads

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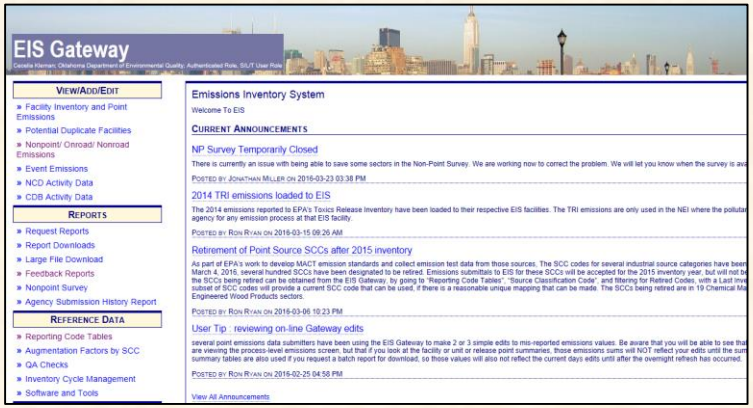
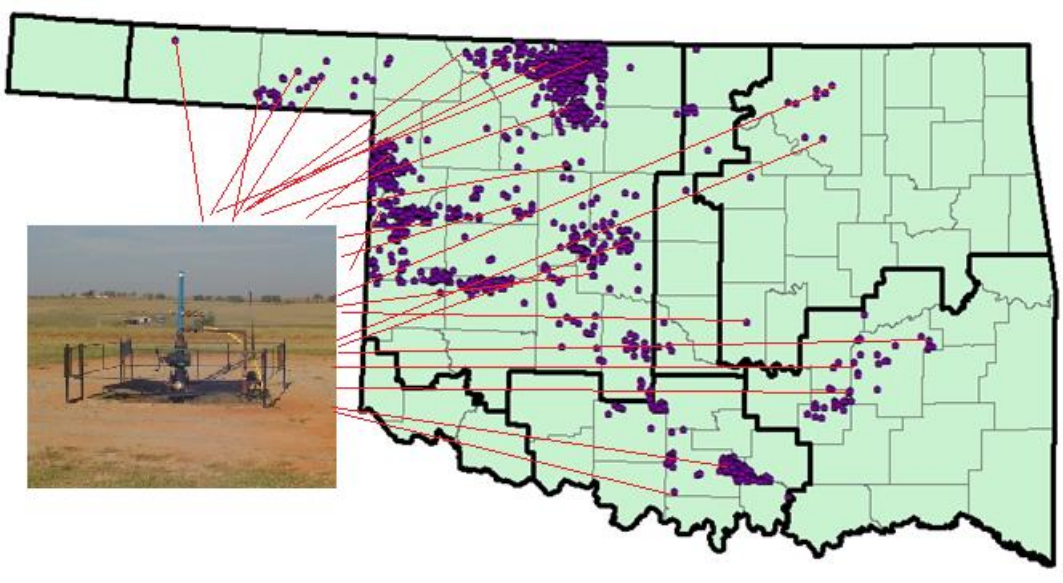


2014 NEI Area Oil and Gas Submission to EIS

Gas Composition Data



SHAMROCK GAS ANALYSIS

LABORATORY REFERENCE NUMBER : G5836GX/H

[redacted]

ID: [redacted]
AREA: [redacted]
METER: [redacted]
LEASE: [redacted]
OPERATOR: [redacted]
STATION: [redacted]
SAMPLE DATE: 1/25/2011
SAMPLE OF: GAS

LINE PRESSURE: 900 PSI
LINE TEMPERATURE: 85 F
CYLINDER NUMBER: 7
EFFECTIVE DATE:
SAMPLED BY: JAY
ANALYZED BY: BRENNAN
ANALYZED DATE: 2/4/2011
SAMPLE TYPE: GAS EXTENDED

For: [redacted]
Attn: [redacted]

Physical Properties per GPA 2145-09 — Calculations per GPA 2286-09

	MOL%	WEIGHT%	GPM @ 14.65
NITROGEN	7.616	10.216	0.858
CARBON DIOXIDE	0.276	0.567	0.047
METHANE	75.904	56.815	12.834
ETHANE	7.841	11.001	2.091
PROPANE	4.227	8.697	1.161
ISOBUTANE	0.585	1.586	0.191
N-BUTANE	1.542	4.182	0.485
ISOPENTANE	0.372	1.252	0.136
N-PENTANE	0.517	1.740	0.187
HEXANES PLUS	0.920	3.944	0.379
	100.000	100.000	18.369

BTU	Vol. Ideal Gas Fuel	Vol. Real Gas Fuel
BTU @ 14.65 PSIA (DRY)	1158.8	1162.4
BTU @ 14.65 PSIA (SAT.)	1138.6	1142.5
Specific Gravity	0.7400	0.7419
Compressibility (Z)	0.9970	

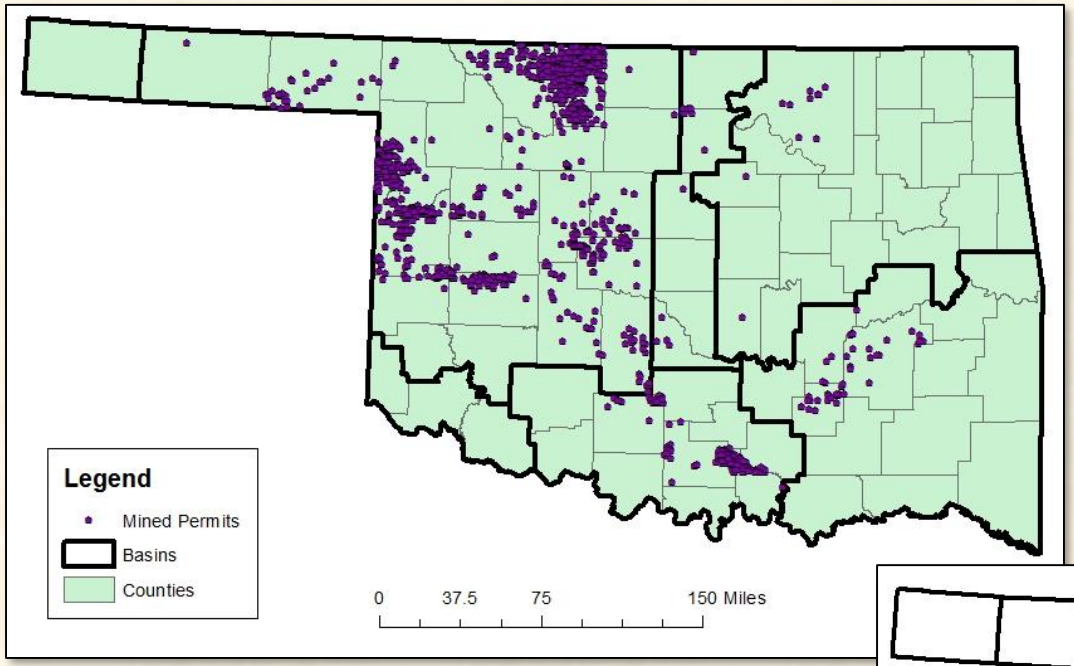
Gasoline Content (Gallons Per Thousand - GPM)

Ethane & Heavier	4.630
Propane & Heavier	2.539
Butane & Heavier	1.378
Pentane & Heavier	0.702
Total 26 psi Reid V.P. Gasoline GPM	1.095

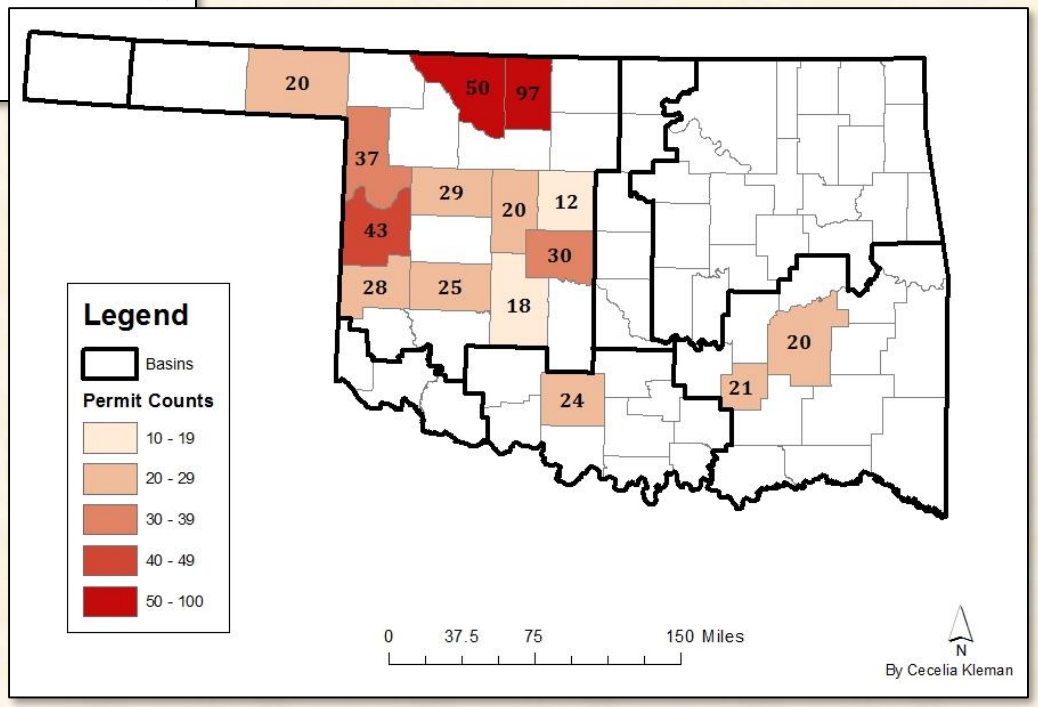
Gas Composition Data

- Mined Oklahoma DEQ (ODEQ) permit applications for unique sales gas composition analyses
- Included counties that had at least 10 unique analyses
- **Gas Composition: Weight % VOC**
  - Calculated ODEQ Weight % VOC averages for each county and compared those to Weight % VOC basin averages used by the Oil & Gas Tool from the CenSARA 2012 Study
- **Checked Resulting VOC Emissions**
  - Ran the Oil & Gas Tool with a "No Change" scenario and an "ODEQ" scenario, which used spatially heterogeneous gas compositions
  - Collected VOC emissions (TPY) output from the Oil & Gas Tool for both Pneumatics & Fugitives categories
  - Observed ***significant changes at the county level***, but only ***a small net change statewide***

Gas Composition Data

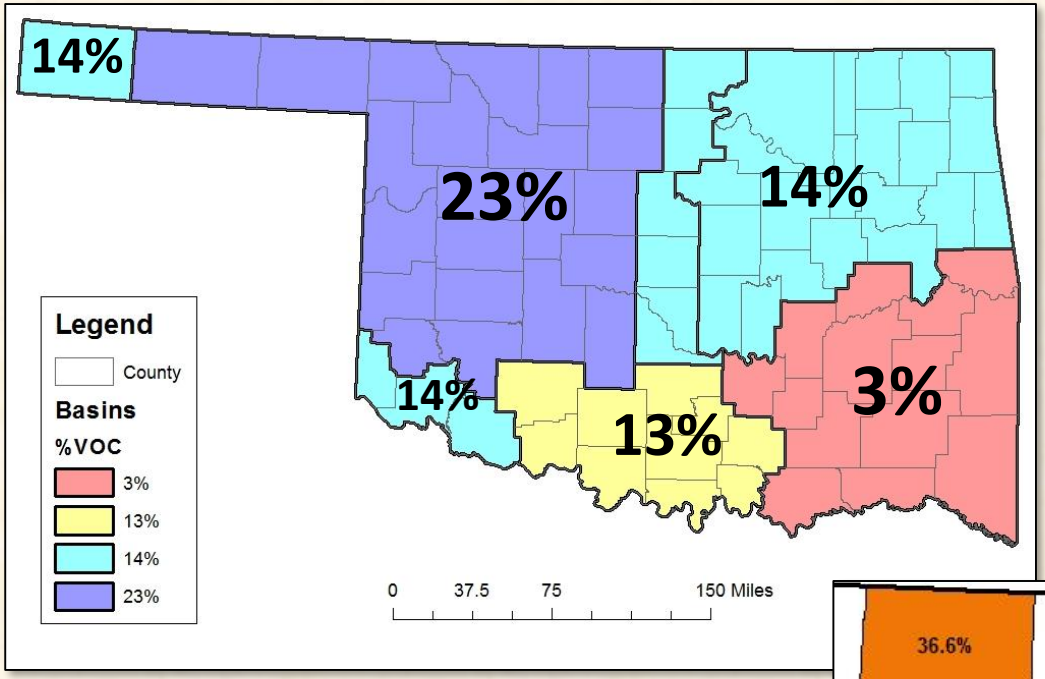


Gas analyses from permits for wellheads



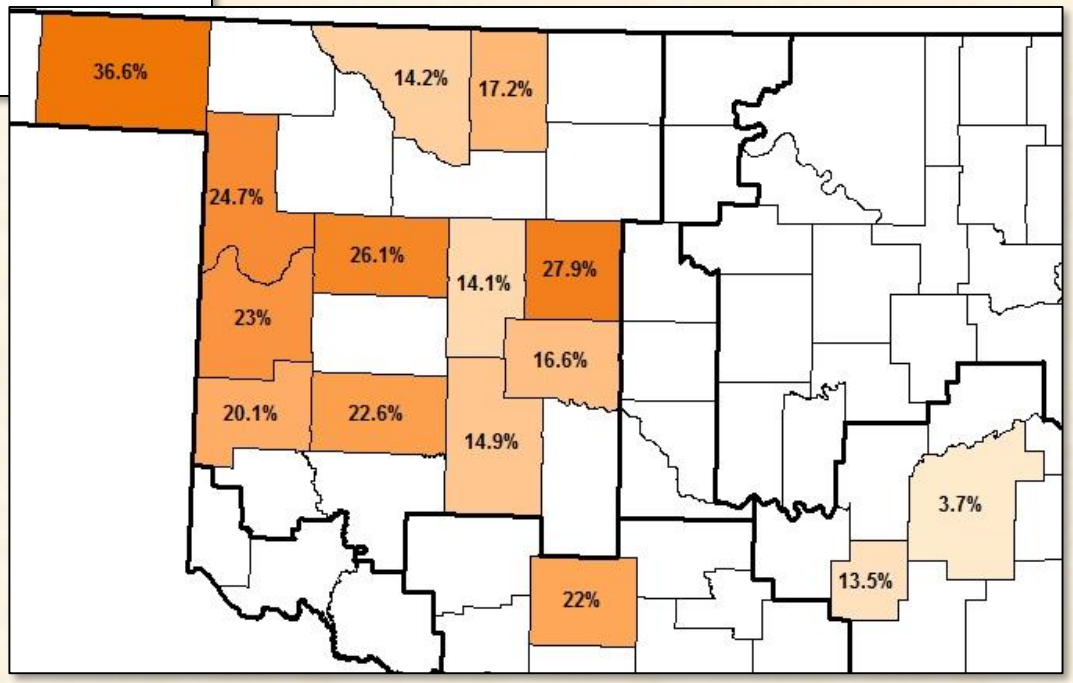
Number of unique gas analyses per county (for counties with at least 10 unique analyses)

Gas Composition Data



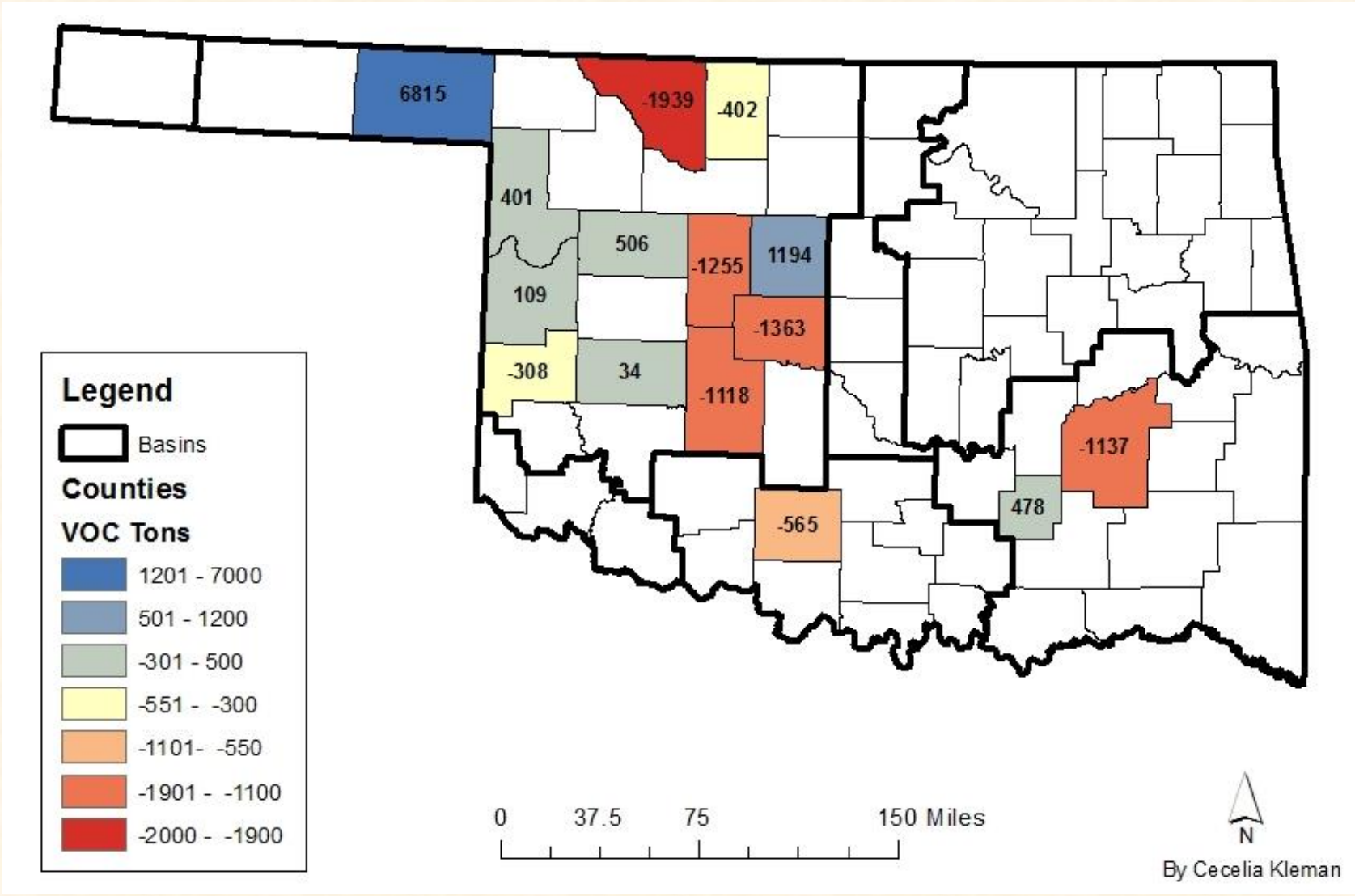
Weight % VOC used for pneumatic device and fugitive emissions in the **Oil & Gas Tool**

Weight % VOC for pneumatic device and fugitives emissions based on gas analyses from **OKDEQ mined permits**



Difference in VOC Emissions (TPY) From Pneumatics and Fugitives

Oklahoma DEQ Mined Permits – EPA Oil & Gas Tool



Pneumatics Study

Pneumatics Emissions

Prior to the OIPA study, the National Oil and Gas Emissions Estimation Tool estimated **86,614** tons of VOC emissions from pneumatic devices, in Oklahoma, which represented **42%** of emissions from the Oil and Gas Exploration & Production Sectors.

Source Category	VOC (TPY)
Artificial Lifts	87
Associated Gas	1,295
Condensate Tanks	20,944
Crude Oil Tanks	25,825
Dehydrators	5,829
Drill Rigs	162
Fugitives	11,206
Gas-Actuated Pumps	15,932
Heaters	577
Hydraulic Fracturing	16
Lateral/Gathering Compressors	511
Liquids Unloading	20,658
Loading Emissions	4,823
Mud Degassing	11,094
Pneumatic Devices	86,614
Produced Water	0
Well Completions	1,917
Wellhead Compressor Engines	1,044
Totals	208,533

Pneumatic Controller Emissions Study

- Performed by the Oklahoma Independent Petroleum Association (OIPA) in 2014
- 172 oil and gas production sites
  - 205 producing wells
  - 680 pneumatic controllers
  - 50/50 new vs older sites
- 97% intermittent bleed and normally functioning
  - Bleed rate 1.05 scf/hr/device
  - Device count of 3.6 per well

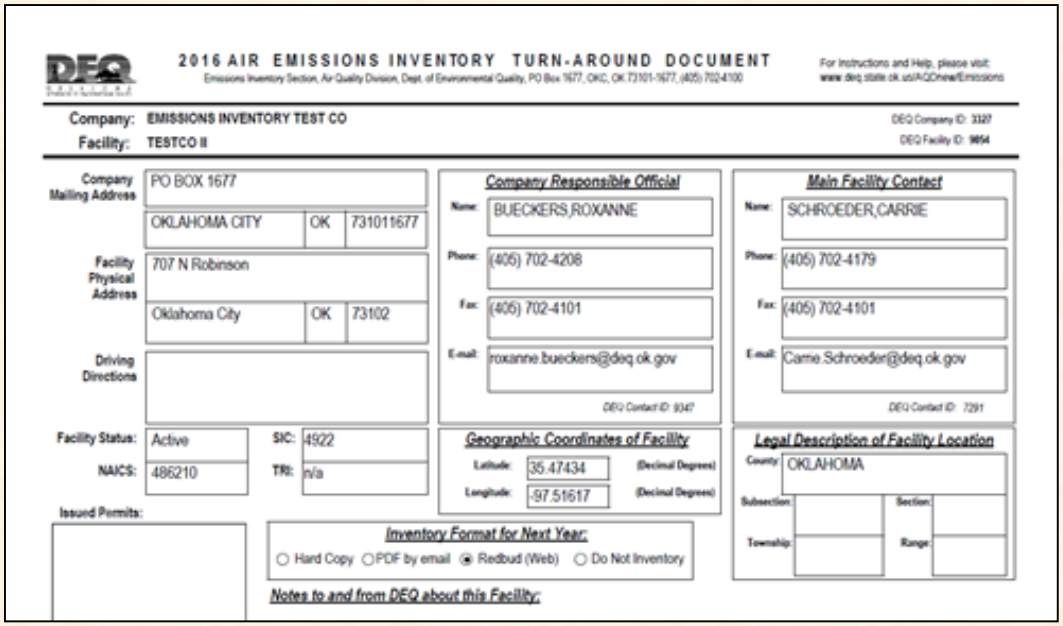
Inventory Changes from the Pneumatic Controller Emissions Study

Descriptor	VOC Emissions (TPY) Associated with Pneumatic Devices		
	Previous Value	Corrected Value	Net Change
Oil production pneumatic devices	14,859	6,513	- 8,346
Gas production pneumatic devices	69,604	6,390	- 63,214
CBM production pneumatic devices	2,150	158	- 1,992
Leaking or malfunctioning pneumatic device emissions – Gas production/fugitives: other source category	0	12,172	+ 12,172
Leaking or malfunctioning pneumatic device emissions – Oil production/fugitives: other source category	0	12,406	+ 12,406
Leaking or malfunctioning pneumatic device emissions – CBM production/fugitives: other source category	0	301	+ 301
Totals	86,613	37,940	**- 48,643**

Inventoried Wellheads

Point Source Inventories from Permitted Wellheads

- For the 2014 NEI, we incorporated point source inventory data from over 4,000 oil and gas wellheads into our area source submission
  - This number of wells and their associated activity was removed from the National O&G Emissions Estimation Tool



DEQ

2016 AIR EMISSIONS INVENTORY TURN-AROUND DOCUMENT

Emissions Inventory Section, Air Quality Division, Dept. of Environmental Quality, PO Box 1677, OKC, OK 73101-1677, (405) 702-4100

For instructions and Help, please visit: www.deq.state.ok.us/AQDnew/Emissions

Company: EMISSIONS INVENTORY TEST CO — DEQ Company ID: 3327

Facility: TESTCO II — DEQ Facility ID: 9654

Company Mailing Address	PO BOX 1677		
	OKLAHOMA CITY	OK	731011677
Facility Physical Address	707 N Robinson		
	Oklahoma City	OK	73102
Driving Directions			

Company Responsible Official

Name:	BUECKERS,ROXANNE
Phone:	(405) 702-4208
Fax:	(405) 702-4101
E-mail:	roxanne.bueckers@deq.ok.gov

DEQ Contact ID: 9347

Main Facility Contact

Name:	SCHROEDER,CARRIE
Phone:	(405) 702-4179
Fax:	(405) 702-4101
E-mail:	Carrie.Schroeder@deq.ok.gov

DEQ Contact ID: 7291

Facility Status:	Active	SIC:	4922
NAICS:	486210	TRI:	n/a

Geographic Coordinates of Facility

Latitude:	35.47434	(Decimal Degrees)
Longitude:	-97.51617	(Decimal Degrees)

Legal Description of Facility Location

County:	OKLAHOMA		
Subsection:		Section:	
Township:		Range:	

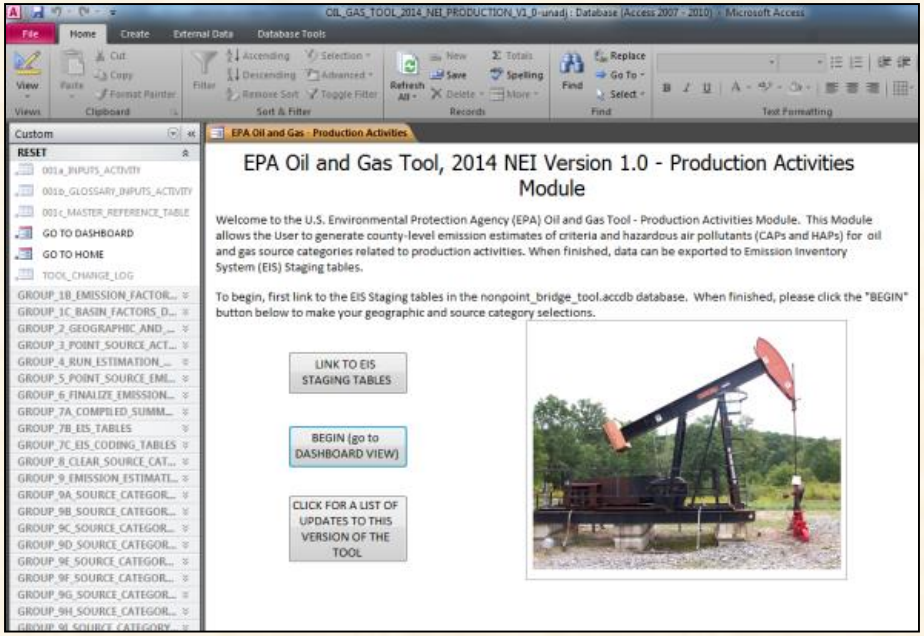
Issued Permits:

Inventory Format for Next Year:

○ Hard Copy ○ PDF by email ◉ Redbud (Web) ○ Do Not Inventory

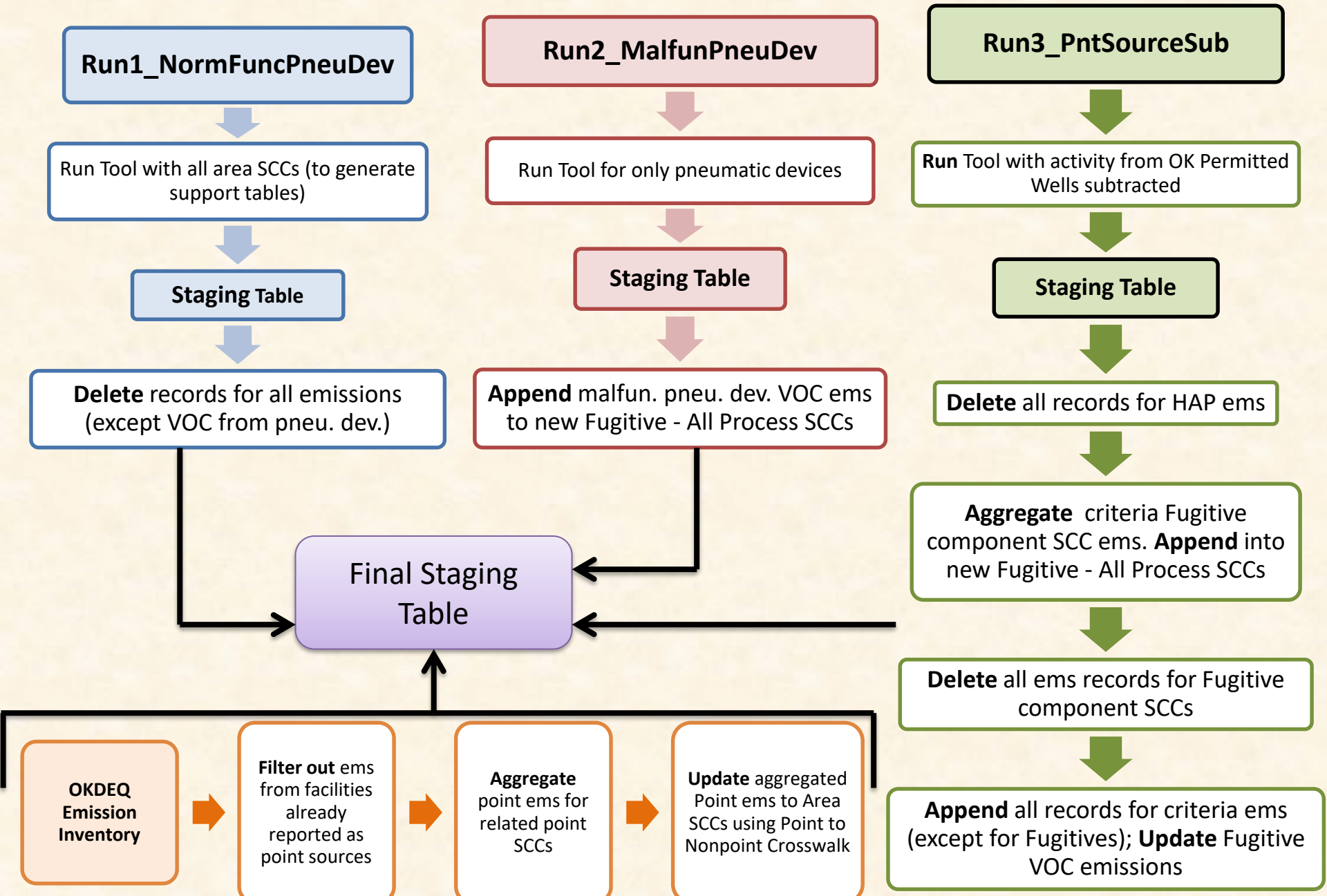
Notes to and from DEQ about this Facility:

Running the Tool

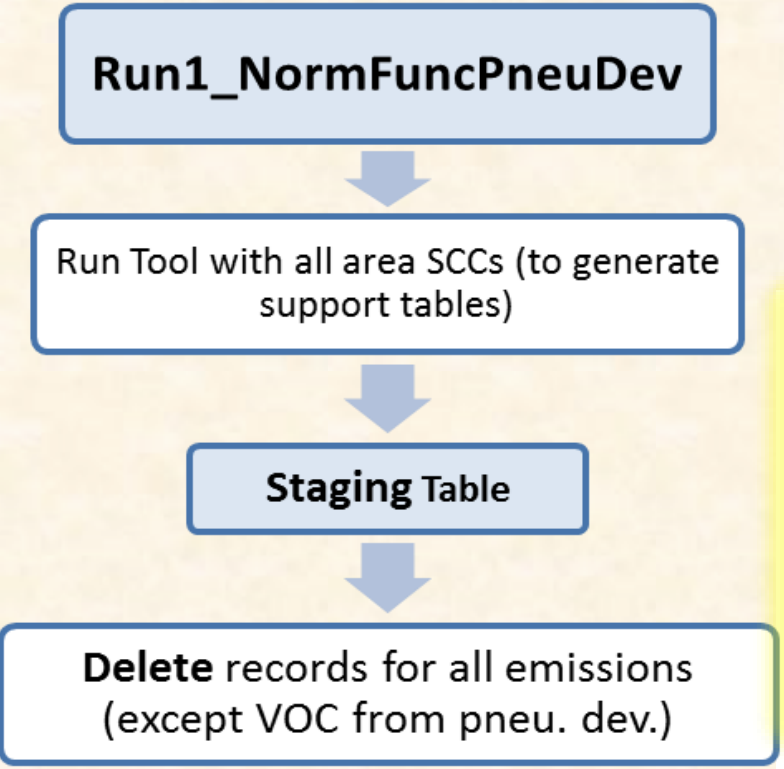


Area Oil & Gas Emissions Estimation Tool

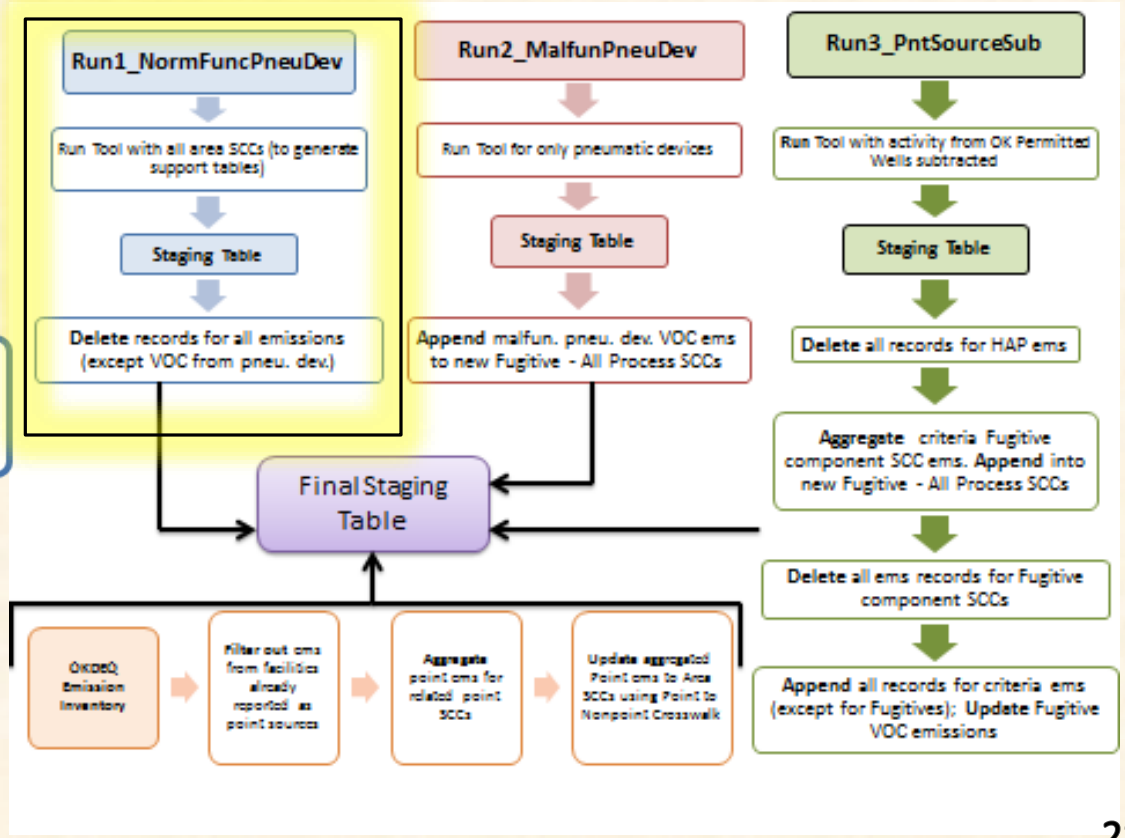
- **Goal:** To capture the best estimate of criteria pollutant and HAP emissions from the Production oil and gas sector across the state of Oklahoma
  - Involved many runs of the tool, and manipulation of the staging tables
  - **Main objective:** prioritize getting point source emissions into the final staging table over perfecting the point to nonpoint crosswalk (TONS matter more than SCCs)
  - EPA/ERG performed HAP augmentation to better characterize HAP emissions from OK point (and nonpoint) sources


Run1_NormFuncPneuDev
Run Tool with all area SCCs (to generate support tables)
Staging Table
Delete records for all emissions (except VOC from pneu. dev.)
Run2_MalfunPneuDev
Run Tool for only pneumatic devices
Staging Table
Append malfun. pneu. dev. VOC ems to new Fugitive - All Process SCCs
Run3_PntSourceSub
Run Tool with activity from OK Permitted Wells subtracted
Staging Table
Delete all records for HAP ems
Aggregate criteria Fugitive component SCC ems. Append into new Fugitive - All Process SCCs
Delete all ems records for Fugitive component SCCs
Append all records for criteria ems (except for Fugitives); Update Fugitive VOC emissions
Final Staging Table
OKDEQ Emission Inventory
Filter out ems from facilities already reported as point sources
Aggregate point ems for related point SCCs
Update aggregated Point ems to Area SCCs using Point to Nonpoint Crosswalk

Run1_NormFuncPneuDev



STEP 1: Produce VOC emissions from normally-functioning pneumatic devices



Run1_NormFuncPneuDev

- Run of the tool that generates emissions from **normally functioning pneumatic devices**
- Includes:
  - OKDEQ local gas composition data (speciation profiles for pneumatic devices)
  - Pneumatic device basin factor data for normally functioning pneumatic devices (OIPA, 2014)
  - Running all area SCCs to generate support tables; only emissions from normally functioning pneumatics are kept

Run1_NormFuncPneuDev

BASIN FACTOR - DATA_CATEGORY	CURRENT_VALUE	CURRENT_REFERENCE
Number of No Bleed devices (COUNT)		OIPA_STUDY_2014
Bleed rate, No Bleed devices (SCF/HR/DEVICE)		OIPA_STUDY_2014
Number of Low Bleed devices (COUNT)		OIPA_STUDY_2014
Bleed rate, Low Bleed devices (SCF/HR/DEVICE)		OIPA_STUDY_2014
Number of High Bleed devices (COUNT)		OIPA_STUDY_2014
Bleed rate, High Bleed devices (SCF/HR/DEVICE)		OIPA_STUDY_2014
Number of Intermittent Bleed devices (COUNT)	3.6	OIPA_STUDY_2014
Bleed rate, Intermittent Bleed devices (SCF/HR/DEVICE)	1.05	OIPA_STUDY_2014

OIPA Basin Factors: for **normally** functioning pneumatic devices.

OKDEQ Speciation Profiles: calculated only for counties with at least 10 unique sales gas composition analyses

County	Reference	Alfalfa
MW of vented gas (G/MOL)	OKDEQ_STUDY_2015	19.87562
Wt Frac VOC	OKDEQ_STUDY_2015	0.17202
Wt Frac H2S	OKDEQ_STUDY_2015	0.00000
Wt Frac CO2	OKDEQ_STUDY_2015	0.01119
Wt Frac CH4	OKDEQ_STUDY_2015	0.68427
Wt Frac Benzene/VOC	OKDEQ_STUDY_2015	0.00000
Wt Frac E-Benzene/VOC	OKDEQ_STUDY_2015	0.00000
Wt Frac Toluene/VOC	OKDEQ_STUDY_2015	0.00000
Wt Frac Xylene/VOC	OKDEQ_STUDY_2015	0.00000
Wt Frac CH4/VOC	OKDEQ_STUDY_2015	4.21549
Wt Frac H2S/VOC	OKDEQ_STUDY_2015	0.00000

Run2_MalfunPneuDev

Run2_MalfunPneuDev

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Run Tool for only pneumatic devices

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Staging Table

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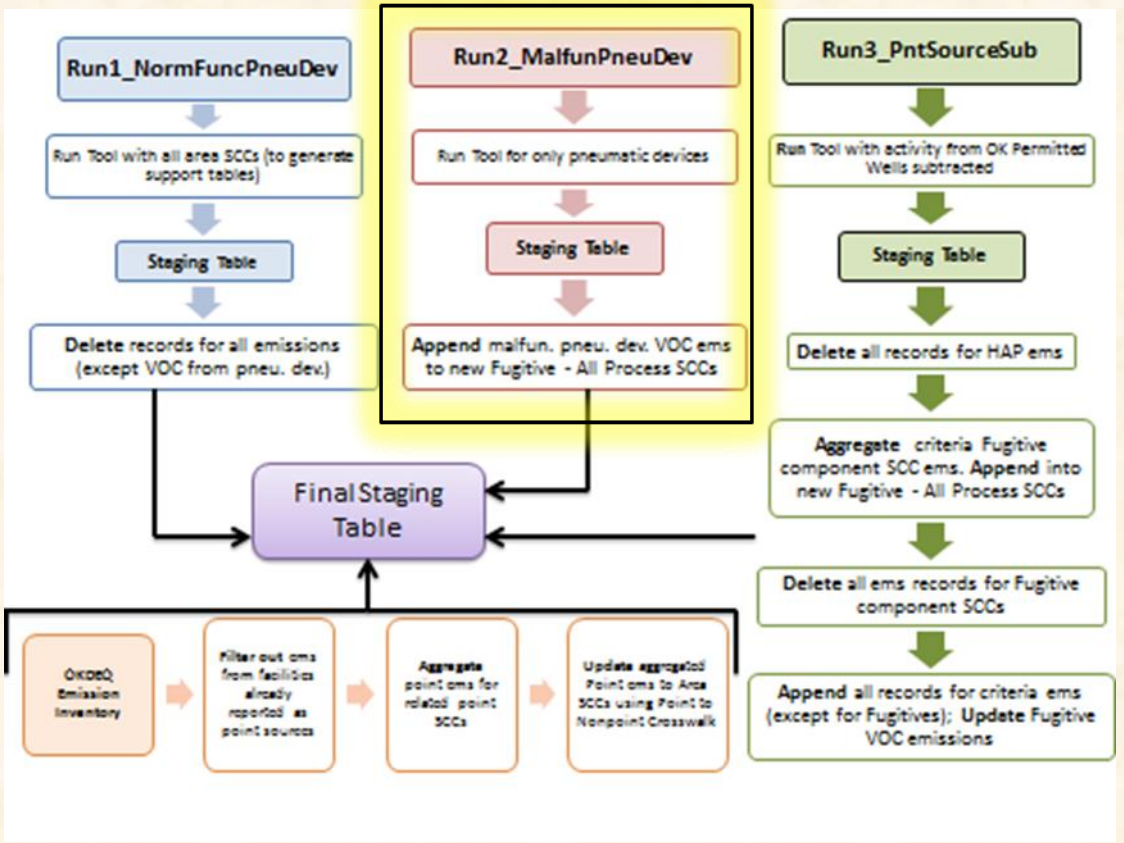
Append malfun. pneu. dev. VOC ems to new Fugitive - All Process SCCs

STEP 2: Add VOC emissions from malfunctioning pneumatic devices to Fugitives: All Process SCCs



Run2_MalfunPneuDev

- Run of the tool that generates emissions from **malfunctioning pneumatic devices**
- The emissions are aggregated to fugitive SCCs and added to the final staging table
- Includes:
  - ONLY pneumatic device SCCs
  - Pneumatic device basin factor data for malfunctioning pneumatic devices (OIPA, 2014)
  - OKDEQ local gas composition data (speciation profiles for pneumatic devices)

Run2_MalfunPneuDev

BASIN FACTOR - DATA_CATEGORY	CURRENT_VALUE	CURRENT_REFERENCE
Number of No Bleed devices (COUNT)		OIPA_STUDY_2014
Bleed rate, No Bleed devices (SCF/HR/DEVICE)		OIPA_STUDY_2014
Number of Low Bleed devices (COUNT)		OIPA_STUDY_2014
Bleed rate, Low Bleed devices (SCF/HR/DEVICE)		OIPA_STUDY_2014
Number of High Bleed devices (COUNT)		OIPA_STUDY_2014
Bleed rate, High Bleed devices (SCF/HR/DEVICE)		OIPA_STUDY_2014
Number of Intermittent Bleed devices (COUNT)	3.6	OIPA_STUDY_2014
Bleed rate, Intermittent Bleed devices (SCF/HR/DEVICE)	**2.0**	OIPA_STUDY_2014; Allen_Study_2014

OIPA Basin Factors: for **malfunctioning** pneumatic devices. (Emissions from normally operating pneumatic devices were generated from the previous run.)

Run3_PntSourceSub

Run3_PntSourceSub

↓

Run Tool with activity from OK Permitted Wells subtracted

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Staging Table

↓

Delete all records for HAP ems

↓

Aggregate criteria Fugitive component SCC ems. **Append** into new Fugitive - All Process SCCs

↓

Delete all ems records for Fugitive component SCCs

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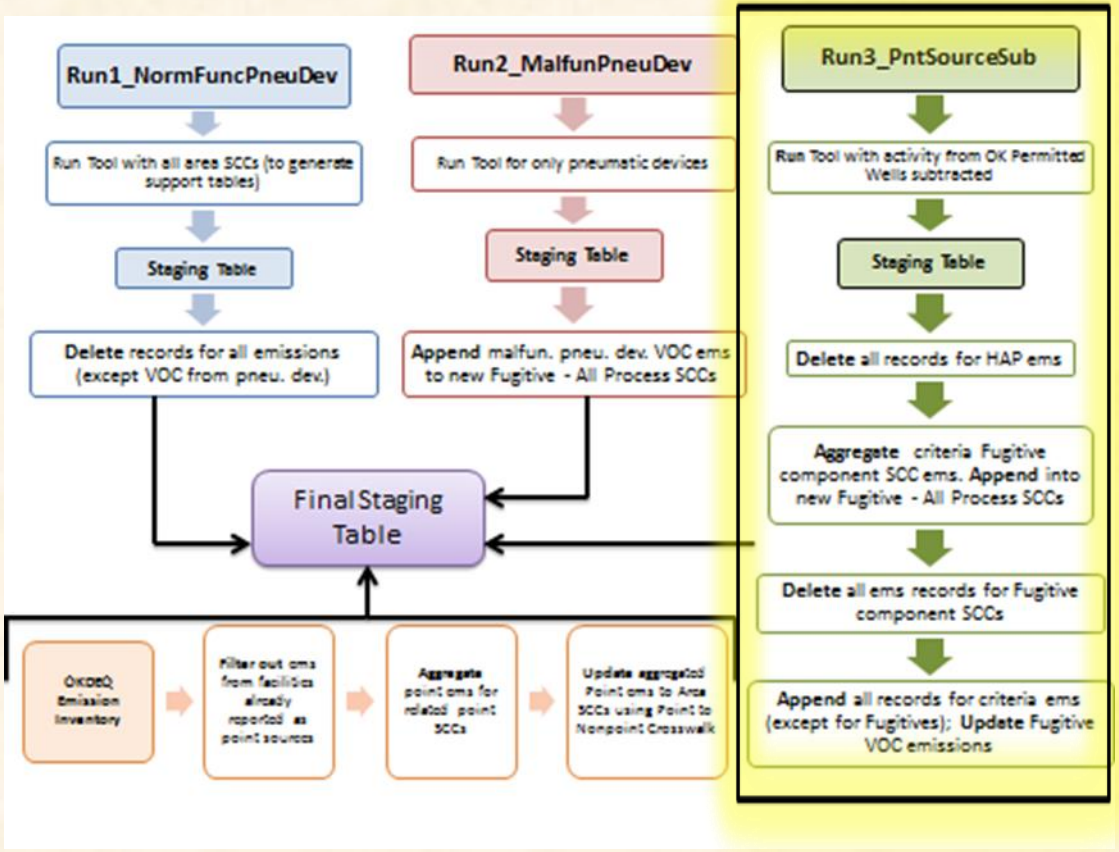
Append all records for criteria ems (except for Fugitives); **Update** Fugitive VOC emissions

<u>RUN 3:</u> Subtract permitted wellhead activity; accounts for unpermitted wellhead emissions



Run3_PntSourceSub

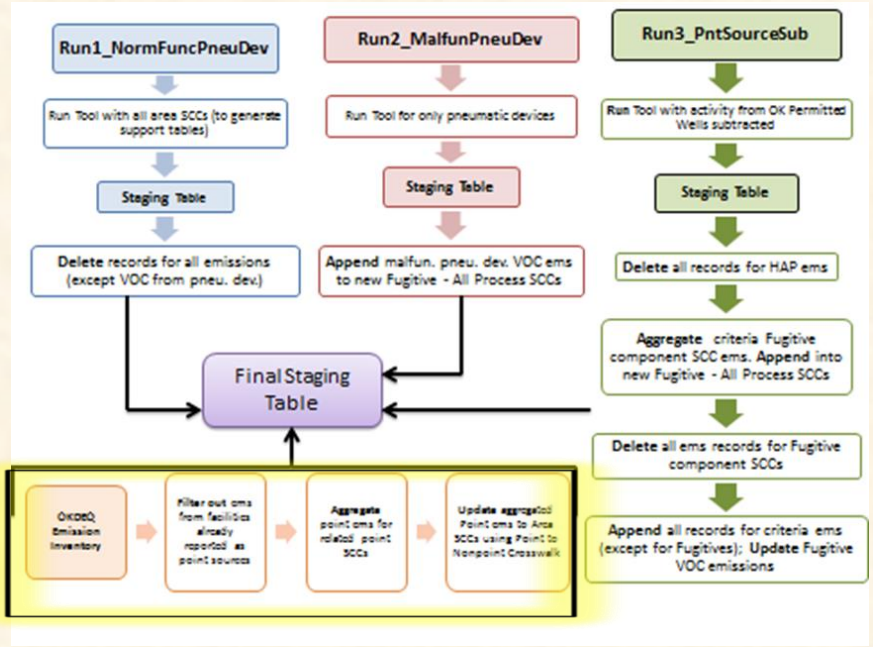
- Subtraction of:
  - AERR type A &B point source activity
  - OKDEQ permitted/inventoried well activity that have matched API numbers in the HPDI database
- Emissions after the point source subtraction are added to the final staging table
- Includes:
  - All SCCs **EXCEPT** pneumatic devices
  - OKDEQ local gas composition data (speciation profiles for fugitives, gas-actuated pumps, and liquids unloading)

Comparison: OKDEQ Point Source Activity Data

	OKDEQ Permitted Wells	TOTAL (HPDI)	% Point
Total Liquids (BBL)	55,901,885	117,319,665	48%
Total Gas (MCF)	713,638,549	2,162,187,694	33%
# Oil Wells	3,397	21,060	16%
# Gas Wells	843	31,395	2.7%
# CBM Wells	66	3,113	2.1%

- Note the range in coverage
- OKDEQ permitted wells capture:
  - Almost **50%** of the total liquids production, but only **16%** of oil wells
  - **33%** of the total gas production and less than **3%** of gas wells

Run4_OKPermitWellAgg



OKDEQ Emission Inventory

→ **Filter out** ems from facilities already reported as point sources

→ **Aggregate** point ems for related point SCCs

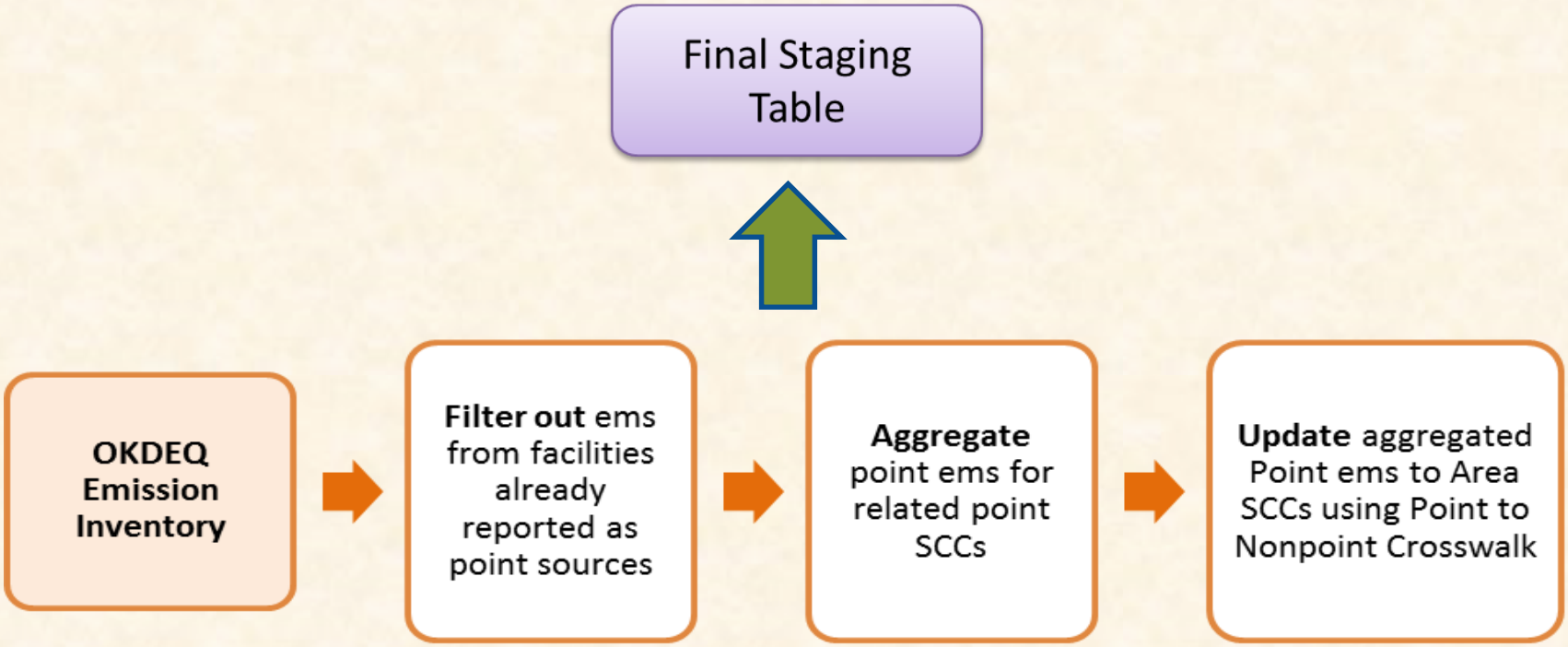
→ **Update** aggregated Point ems to Area SCCs using Point to Nonpoint Crosswalk

Run4_OKPermitWellAgg

- Not a run of the Tool, but the process of mapping our permitted wellhead emission data into the final staging table
  - After filtering out facilities in our inventory that had already reported as AERR Type A and B sources, we aggregated the remaining point emissions by SCC grouping, pollutant, and well type
  - Grouped point SCCs are cross-walked to area SCCs
  - Emissions are added to the final staging table

Run4_OKPermitWellAgg

Once point emissions were aggregated into a chosen group, they were allocated to gas, oil, and CBM wells in each county using well-type ratios



Results

Final Comparison Analysis

Pollutant	Run with EPA defaults – The Oil and Gas tool v2.1 without any point source subtraction or other alteration	Final Run - Total emissions from the final staging table of the flow chart procedures.
NOx (tons)	41,300	54,900
VOC (tons)	148,900	162,300

Comparison of Emissions per Well (Nonpoint vs. Point)

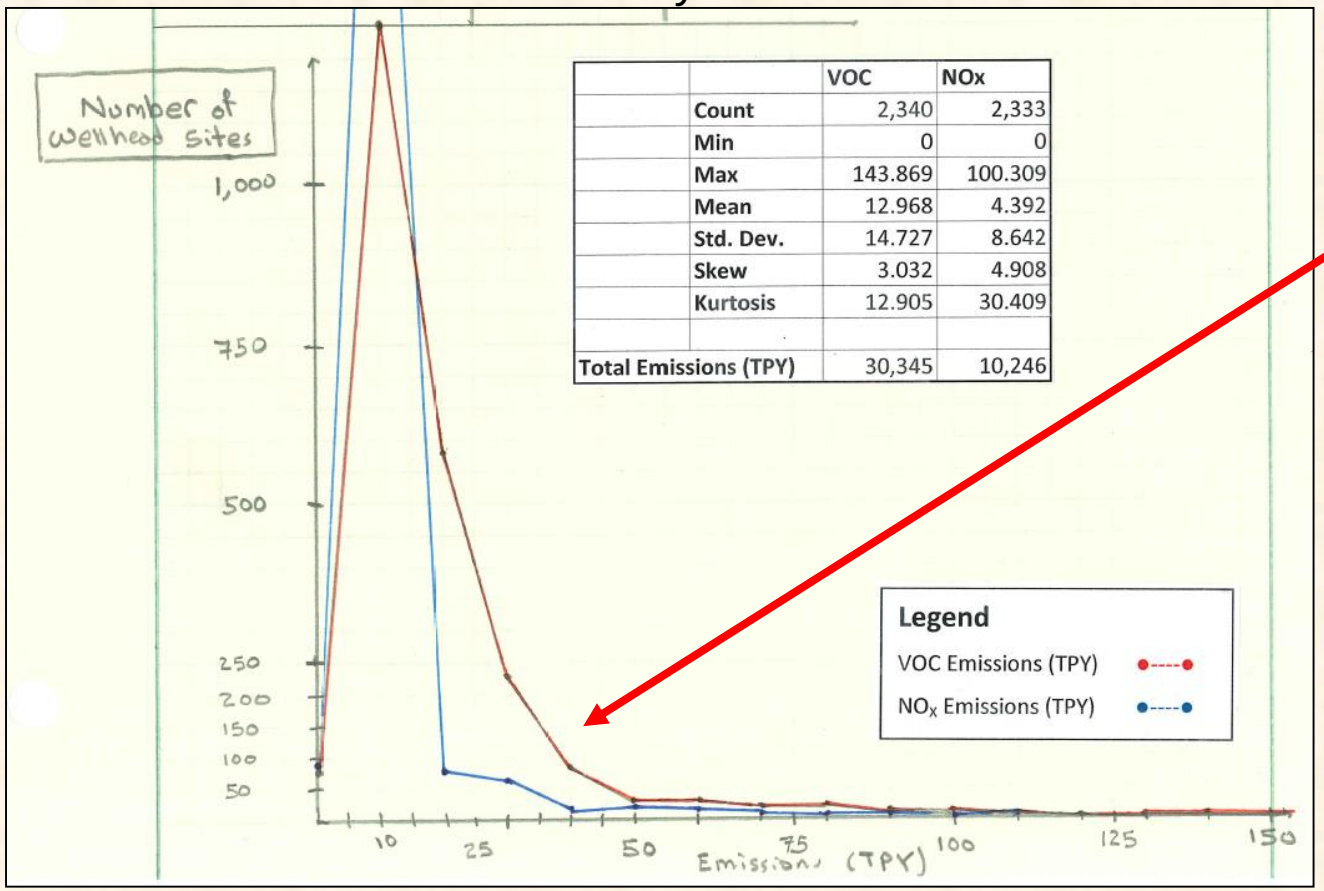
	2014 O&G Tool v1.0 w/o Modifications	Oklahoma Permitted Wells
Total Number of Wells (Oil, Gas, & CBM Combined)	55,568	4,306
Total Emissions		
NO_X (tons)	42,166	16,190
VOC (tons)	147,984	38,836
Per Well Emissions		
NO_X (tons/well)	0.759	3.760
VOC (tons/well)	2.663	9.019

Remaining Questions and Concerns

Remaining Questions/Concerns

- Better Characterizing Super-Emitters (a.k.a, fat tails)
  - A small fraction of sources account for a disproportionate amount of emissions

2013 Oklahoma Wellhead Facility Emissions



		VOC	NOx
	Count	2,340	2,333
	Min	0	0
	Max	143.869	100.309
	Mean	12.968	4.392
	Std. Dev.	14.727	8.642
	Skew	3.032	4.908
	Kurtosis	12.905	30.409
Total Emissions (TPY)		30,345	10,246

Fat Tail (skewed, log-normal distribution)

Remaining Questions/Concerns (Continued)

- Temporal Profile of Emissions
- Reconciling Top-Down vs Bottom-Up Estimates
- Closing the Midstream Gap
- Identifying and Characterizing Other Missing Sources
- Emissions from Stripper Wells
- Other Improvements [???]

Overall Conclusions

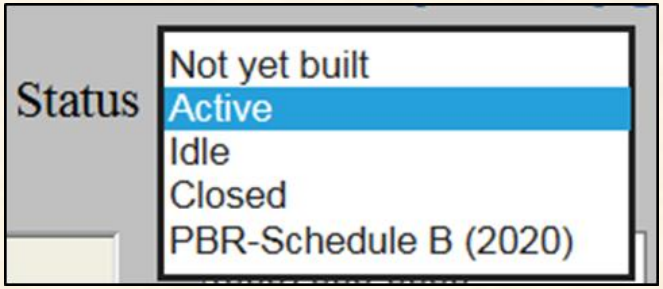
- The oil and gas inventory continues to improve, but there is always room for additional improvement.
- Industry input can have a major impact on refining estimates.
- Detailed field studies can improve our understanding of key emission sources.
- Spatial heterogeneity can be significant at the county level.

Heads Up!

Triennial Permit By Rule (PBR) Reporting Requirement

Heads Up: PBR Requirements

- 2017 is an NEI year so *all* PBRs will be loaded into Redbud
- PBRs must calculate their emissions for the reporting year (2017) to determine if they need to report for 2017 or not until 2020.
  - Facilities over 5 TPY (for any regulated pollutant) must report for 2017
  - Facilities at or below 5 TPY (for all regulated pollutants) may elect the 2020 schedule
  - If a new facility registered under the PBR in 2017 and thus 2017 will be their first inventory, then they must report, regardless of emission amounts.
- We will bill based on the last reported inventory



Questions?

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