

Quality Assurance Project Plan

AQRP Project: 19-023

Emission Inventory Development and Projections for the Transforming Mexican Energy Sector

Prepared for

The Texas Air Quality Research Program (AQRP)
The University of Texas at Austin

By

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The University of Texas at Austin has prepared this QAPP following EPA guidelines for a Quality Assurance (QA) Category III Project: Data Evaluation or Use for Secondary Purpose. It is submitted to the Texas Air Quality Research Program (AQRP) as required in the Work Plan requirements.

QAPP Requirements: The QAPP describes the project description and objectives, project organization and responsibilities, model selection, model calibration, model verification, model evaluation, model documentation, and reporting procedures, as prescribed in the applicable NMRL QAPP Requirements template (<https://www.tceq.texas.gov/airquality/airmod/project/quality-assurance>).

QA Requirements: Technical Systems Audits - Not Required for the Project
 Audits of Data Quality – 10% Required
 Report of Findings – Required in Final Report

Approvals Sheet

This document is a Category III Quality Assurance Project Plan for the following project: *Emission Inventory Development and Projections for the Transforming Mexican Energy Sector*. The Principal Investigator for the project is Elena McDonald-Buller and Co-Principal Investigator is Greg Yarwood.

Electronic Approvals:

This QAPP was approved electronically on Aug. 31, 2018 by David Sullivan, The University of Texas at Austin.

David Sullivan
Project Manager, Texas Air Quality Research Program

This QAPP was approved electronically on Aug. 30, 2018 by Vincent M. Torres, The University of Texas at Austin.

Vincent M. Torres
Quality Assurance Project Plan Manager, Texas Air Quality Research Program

This QAPP was approved electronically on Aug. 30, 2018 by Elena McDonald-Buller, The University of Texas at Austin.

Elena McDonald-Buller
Principal Investigator, The University of Texas at Austin

QAPP Distribution List

Texas Air Quality Research Program
David Allen, Director
David Sullivan, Project Manager

Texas Commission on Environmental Quality
Michael Ege, Project Liaison

The University of Texas at Austin
Elena McDonald-Buller, Principal Investigator

Ramboll
Greg Yarwood, Co-Principal Investigator

1.0 Project Description and Objectives

Within Texas, characterizing emission sources along its border and within Mexico has been recognized as essential for air quality modeling. Mexico's energy sector has been undergoing potentially transformational changes as part of Constitutional reforms ratified in 2013. A primary motivation is to encourage domestic and foreign investment and productivity growth in the oil, gas and power sectors. The reforms have the potential to significantly transform the magnitudes and spatial distributions of emissions from the oil and gas and power generation sectors over the next one to two decades. The overall objective of the proposed project is to apply new information to develop a bottom-up assessment of emissions for the upstream and midstream oil and gas sectors and power sector and to develop future emission projections based on potential outcomes of on-going bid rounds that are attracting new investment for exploration and production of oil and gas resources. Information and analytics for Mexico's upstream and midstream oil and gas sectors and power sector will be used to develop a 2016 base year emissions inventory, which coincides with the U.S. Environmental Protection Agency's (EPA's) national air quality modeling platform and will likely be the basis for future air quality modeling by the Texas Commission on Environmental Quality (TCEQ). Plans and results for the hydrocarbon bid rounds will be used as the basis for three future emissions projections that compare continued development of Mexico's onshore conventional and shallow water resources, which is consistent with historical practices, with expansion of its deep water and onshore shale regions that have been underdeveloped to date relative to their potential. The project is a collaborative effort between the University of Texas at Austin (UT Austin) and Ramboll.

2.0 Organization and Responsibilities

2.1 Project Personnel

The project will be directed by Dr. Elena McDonald-Buller (Principal Investigator) of the University of Texas at Austin and Dr. Greg Yarwood (Co-Principal Investigator) of Ramboll. Other staff members instrumental to the technical work include Mr. Gary McGaughey and Dr. Yosuke Kimura from the University of Texas at Austin and Mr. John Grant, Mr. Tejas Shah, Ms. Rajashi Parikh, and Ms. Lynsey Parker from Ramboll. Project participants and their responsibilities are listed in Table 1.

3.2 Project Schedule

An overall schedule of project activities by task is shown in Table 2. The project end date is August 31, 2019.

Table 1. Project participants and their key responsibilities.

Participant	Key Responsibilities
Elena McDonald-Buller	Principal Investigator from the University of Texas at Austin who will provide overall supervision and integration of the technical work and will be responsible for the preparation and submission of the monthly progress, quarterly progress, and final reports in collaboration with Dr. Yarwood and Mr. Grant from Ramboll. She will work with Mr. McGaughey on the analyses of the IHS Markit data and evaluation of the Mexican upstream sector bid rounds.
Gary McGaughey	Mr. McGaughey is a Research Associate V who will work with Dr. McDonald-Buller on the analyses of the IHS Markit data and evaluation of the Mexican upstream sector bid rounds. He will lead the application of the emissions estimation approach to the base year and future projected inventories with assistance from Dr. Kimura. Mr. McGaughey will assist Dr. McDonald-Buller with preparation of the final reports.
Yosuke Kimura	Dr. Yosuke Kimura is a Research Associate IV who will assist Mr. McGaughey with the application of the emissions estimation approach to the base year and future projected inventories. He will also provide computational, programming, and data visualization support for all aspects of the project. Dr. Kimura will conduct the independent audit of the data and analysis summaries that is intended to satisfy the QA requirement of 10% audits of data quality for this project.
Greg Yarwood	Co-Principal Investigator who will oversee Ramboll’s technical activities and provide technical input as needed on all tasks.
John Grant	Mr. Grant will lead the base year emissions, future year emissions, and midstream emissions tasks with assistance from Ms. Rajashi Parikh, Mr. Tejas Shah, and Ms. Lynsey Parker. Mr. Grant and Ms. Parikh will work with Dr. McDonald-Buller on the development of base year emission inventories and future year emission inventories, respectively. Mr. Grant, Mr. Shah, and Ms. Parker will work with Dr. McDonald-Buller on the development of the midstream emission inventories.
Tejas Shah	Mr. Shah along with Ms. Parker will assist Mr. Grant and work with Dr. McDonald-Buller on the development of the midstream emission inventories. Mr. Shah and Ms. Parker will carry out the midstream emission inventory review and updates.
Rajashi Parikh	Ms. Parikh will assist Mr. Grant and work with Dr. McDonald-Buller on the development of base year emission inventories and future year emission inventories, respectively. Ms. Parikh will carry out the literature review, emissions profile development, activity forecast scalar development, and control factor development.
Lynsey Parker	Ms. Parker will assist Mr. Grant and work with Dr. McDonald-Buller on the development of the midstream emission inventories. Mr. Shah and Ms. Parker will carry out the midstream emission inventory review and updates

Table 2. Schedule of project activities (tasks are bolded).

ID	Task	Aug 2018	Sept 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	July 2019	Aug 2019
1	Base Year Emission Inventory Estimates	X	X	X	X	X								
2	Mexico Bid Rounds and Future Projection Scenarios					X	X	X	X	X	X			
R	<i>Monthly Technical & Financial Progress</i>	X	X	X	X	X	X	X	X	X	X	X	X	X
R	<i>Quarterly</i>		X			X			X			X		
R	<i>Draft Final</i>											X	X	
R	<i>Final</i>													X
R	<i>AQRP Workshop</i>													X

3.0 Scientific Approach

3.1 Data Requirements

This work will develop a bottom-up assessment of emissions for the upstream and midstream oil and gas sectors and power sector in Mexico and develop future emissions projections based on potential outcomes of on-going bid rounds for new investments in the exploration and production of oil and gas resources. Databases used in the development of activity estimates must: (1) encompass all Mexican federal entities, (2) include the spatial locations of activities in a format compatible with visualization and assessment using ArcGIS or comparable software, (3) be available for the 2016 base year, (4) allow flexible queries of user-specified parameters for activity sectors of interest, and (5) include data export capabilities to support processing, interpretation and inventory development methods. The database should be from an established source with routine updates. It is preferable that the source also collects similar data for the U.S. upstream and midstream oil and gas sectors, as inventory development methods will draw on the team’s experience with similar efforts for the United States.

This project also requires specific data for certain activity sectors, in particular for the upstream oil and gas sector. The database should include the status, operating dates, and coordinates of oil and associated and non-associated gas wells and fields as well as production data. Data must also identify ports, refineries, natural gas processing facilities, as well as power plants.

3.2 Data Sources

IHS Markit provides information and analytics at global and regional market levels for a range of industries including energy and natural resources. It is generally considered to be a benchmark, and their commercially available upstream database has been applied for oil and gas emission inventory development in the United States (Grant et al., 2016, Grant et al., 2014a; Grant et al., 2014b; Bar-Ilan et al., 2012; Bar-Ilan et al., 2010; Bar-Ilan et al., 2012; Bar-Ilan et al., 2009a; Bar-Ilan et al., 2009b; Friesen et al., 2009c; Bar-Ilan et al., 2008). The UT Austin team has an annual subscription for IHS Markit’s EDIN database that includes their Exploration and Production as well as Midstream Essentials data domains for Mexico. The database subscription spans much of the time period of this project and was purchased through a National Science Foundation’s (NSF’s) Critical Resilient Infrastructure Systems and Processes (CRISP) Type 2 Program grant that is examining natural gas production, electricity and water

infrastructures in the Texas-Mexico Border Region. This AQR project, which has distinct objectives from the NSF CRISP effort, is able to leverage the IHS Markit database. As part of the purchase process, the UT Austin team was required to provide a sole source justification. The level of completeness of the IHS Markit data relative to other potential resources was a major factor in its selection. This included for example the number of well, field, and production records, inclusion of onshore and offshore oil and gas resources, and identification of midstream facilities to allow comprehensive assessments of energy sector activity for Mexico. Access to the IHS database is contractually limited to the UT Austin team members. UT Austin and Ramboll will jointly identify the database parameters that are useful for emission inventory development for the 2016 base year. Ramboll will develop emission calculation methodologies that use the available data. UT Austin will then process the detailed IHS data to produce the emission inventory.

Within the Exploration and Production domain of IHS Markit's EDIN database for Mexico, information is provided for onshore, shelf, and deep water areas. It includes as subject areas identification of wells (name, basin, field, latitude/longitude, content, operations period, E/P operator, contract, status, company interests), fields (basin, coordinates, field outlines, current and historical reserves, annual production, total number of wells, company interests), monthly production (by field, volume, or company interest), platforms, companies, contract blocks (coordinates, group, operator, award date, historical stages), platforms, bidding blocks (location, area, bidding round name), and prospects. The Midstream Essentials domain includes name, location, infrastructure, and capacity information for compressor stations, electric power plants, gas processing plants, liquefied natural gas (LNG) liquefaction plants, LNG regasification plants, pipelines, ports, refineries, storage, and terminals.

A literature review will be performed to identify emission profiles (i.e., emission rates per unit of activity for each oil and gas source category) and speciation profiles most representative of oil and gas wells in Mexico based on recent oil and gas emission inventory studies. Limited information is expected to be available on Mexico specific emission profiles. For well type and source category combinations for which Mexico specific emission profiles are not available, U.S. emission profiles for similar well types will be used. To the extent feasible, any emission profiles that are not Mexico-specific will be adjusted (e.g., Mexican regulatory requirements).

Midstream facility location and emissions data available in EPA's point source inventory for Mexico from their Air Emissions Modeling site (<ftp://ftp.epa.gov/EmisInventory/2011v6/v3platform/>) will be compared to midstream facility data available from IHS Markit. Review of facility specific parameters such as location, emission magnitudes, facility throughput, and build date will be used to develop updates to the current inventory to correct any errors (e.g., incorrect facility location) and fill gaps (e.g., adding emissions for missing facilities).

4.0 Quality Metrics

The quality of the data has not been evaluated by the U.S. Environmental Protection Agency (EPA) for this specific application. As an initial data quality step, two UT Austin team members will independently review each subject area within the Exploration and Production and Midstream Essentials domains in the EDIN database for completeness to ensure that all records expected and necessary for the project have been included by IHS Markit. Initial spatial mapping of data will confirm geographic coverage throughout areas of Mexico expected to have activity. UT Austin team members will also draw on their experience with data resources from the Mexican government under the NSF CRISP project to conduct high-level summary assessments of the IHS Markit data to benchmark their consistency with statistics reported by Mexican governmental and international agencies. Representative examples of these types of assessments include comparing hydrocarbon production areas reported in the EDIN database with those

shown in the geographical atlases of Mexico's Centro Nacional de Información de Hidrocarburos (CNIH), comparing generation fuel mix and capacity for the electric power sector with data reported from the Secretaría de Energía de México (SENER), and cross-checking hydrocarbon bidding blocks with information from SENER and the Rondas Mexico website (<https://rondasmexico.gob.mx>). Detailed quality assessments of the IHS Markit data are beyond the scope of this project and will not be conducted. Rather the intent will be to assure to the extent possible that data used for the emission inventory are complete and current, as data for Mexico has become more accessible under energy reform measures. Results of the data quality assessments will be documented in the final project report.

In order to assure the quality of estimated upstream emission profiles, several steps will be taken. Emissions and emission rates will be compared to data derived from other accepted sources of information, to the extent feasible, such as: EPA AP-42, EPA NONROAD Model emissions factor data, and other studies that have examined aspects of the natural gas exploration and production processes to which the data applies. Particular attention will be paid to outlier data, data derived from fuel combustion not consistent with what is typically used in the natural gas industry, and data from engines or devices equipped with controls that are not representative of common practices or regulatory requirements. Literature review data will be evaluated based on engineering judgment. Data that appears clearly inconsistent with the application for which it is assumed it will be used and outlier data that does not appear consistent with other emissions and activity data for similar source categories will be excluded.

5.0 Data Analysis, Interpretation, and Management

5.1 Data Reporting

Activity data for the inventory development will be identified in a collaborative effort by UT Austin and Ramboll team members. The UT Austin team will extract and process the data from EDIN to create visual mappings and quantitative summaries of key elements by activity sector as appropriate for reporting purposes. Ramboll will identify emission profiles for upstream sources to be combined with oil and gas activity data to estimate emissions. Summary tables of reference emissions and/or emission rates for upstream and midstream sources along with reference data sources will be provided in the draft and final project reports. Emission results will be summarized in detail by scenario, region, emission source, and well type, to the extent feasible.

5.2 Data Validation Procedures

Mr. McGaughey with support from Dr. McDonald-Buller will lead the data extraction and processing from the EDIN database. Dr. Kimura will independently audit at least 10% of the data comparing before and after the extraction. He will evaluate at least 10% of the data summaries and activity data files to be applied with emissions profiles for inventory development. The independent audit of the data, pre- and post- extraction, as well as the evaluation of the data summaries is intended to satisfy the QA requirement of 10% audits of data quality for this project.

The approach used to analyze and quality assure the oil and gas emissions estimates will include comparison of the emissions to other recent inventories, and development of per surrogate activity emissions. Emissions and per-activity surrogate (e.g. tons per well, tons per spud, etc.) will be compared with other oil and gas emission inventory studies and any significant discrepancies in emissions and/or per-activity surrogate emissions will be carefully evaluated to determine if the emission inventory estimate is accurate and representative.

5.3 Data Storage

Data extracted from the EDIN database will reside on computing systems at the Center for Energy and Environmental Resources and at the Texas Advanced Computing Center (TACC) at UT Austin.

6.0 Reporting

As required, monthly technical, monthly financial status, and quarterly reports as well as an abstract at project initiation and, near the end of the project, the draft final and final reports will be submitted according to the schedule below. Dr. McDonald-Buller or her designee will electronically submit each report to both the AQRP and TCEQ liaisons and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources (<http://aqrp.ceer.utexas.edu/>). Dr. McDonald-Buller and Dr. Yarwood anticipate attending and presenting at the AQRP data workshop. Draft copies of any planned presentations (such as at technical conferences) or manuscripts to be submitted for publication resulting from this project will be provided to both the AQRP and TCEQ liaisons per the Publication/Publicity Guidelines included in Attachment G of the subaward. Final project data and associated metadata will be prepared and submitted to the AQRP archive. Each deliverable and required deadline for submission are presented below.

Abstract: At the beginning of the project, an Abstract will be submitted to the Project Manager for use on the AQRP website. The Abstract will provide a brief description of the planned project activities, and will be written for a non-technical audience.

Abstract Due Date: Friday, August 31, 2018

Quarterly Reports: Each Quarterly Report will provide a summary of the project status for each reporting period. It will be submitted to the Project Manager as a Microsoft Word file. It will not exceed 2 pages and will be text only. No cover page is required. This document will be inserted into an AQRP compiled report to the TCEQ.

Quarterly Report Due Dates:

Report	Period Covered	Due Date
Aug2018 Quarterly Report	June, July, August 2018	Friday, August 31, 2018
Nov2018 Quarterly Report	September, October, November 2018	Friday, November 30, 2018
Feb2019 Quarterly Report	December 2018, January & February 2019	Thursday, February 28, 2019
May2019 Quarterly Report	March, April, May 2019	Friday, May 31, 2019
Aug2019 Quarterly Report	June, July, August 2019	Friday, August 30, 2019
Nov2019 Quarterly Report	September, October, November 2019	Friday, November 29, 2019

Monthly Technical Reports (MTRs): Technical Reports will be submitted monthly to the Project Manager and TCEQ Liaison in Microsoft Word format using the AQRP FY16-17 MTR Template found on the AQRP website.

MTR Due Dates:

Report	Period Covered	Due Date
Aug2018 MTR	Project Start - August 31, 2018	Monday, September 10, 2018
Sep2018 MTR	September 1 - 30, 2018	Monday, October 8, 2018
Oct2018 MTR	October 1 - 31, 2018	Thursday, November 8, 2018
Nov2018 MTR	November 1 - 30 2018	Monday, December 10, 2018
Dec2018 MTR	December 1 - 31, 2018	Tuesday, January 8, 2019
Jan2019 MTR	January 1 - 31, 2019	Friday, February 8, 2019
Feb2019 MTR	February 1 - 28, 2019	Friday, March 8, 2019
Mar2019 MTR	March 1 - 31, 2019	Monday, April 8, 2019
Apr2019 MTR	April 1 - 28, 2019	Wednesday, May 8, 2019
May2019 MTR	May 1 - 31, 2019	Monday, June 10, 2019
Jun2019 MTR	June 1 - 30, 2019	Monday, July 8, 2019
Jul2019 MTR	July 1 - 31, 2019	Thursday, August 8, 2019

Financial Status Reports (FSRs): Financial Status Reports will be submitted monthly to the AQRP Grant Manager (Maria Stanzione) by each institution on the project using the AQRP FY16-17 FSR Template found on the AQRP website.

FSR Due Dates:

Report	Period Covered	Due Date
Aug2018 FSR	Project Start - August 31	Monday, September 17, 2018
Sep2018 FSR	September 1 - 30, 2018	Monday, October 15, 2018
Oct2018 FSR	October 1 - 31, 2018	Thursday, November 15, 2018
Nov2018 FSR	November 1 - 30 2018	Monday, December 17, 2018
Dec2018 FSR	December 1 - 31, 2018	Tuesday, January 18, 2019
Jan2019 FSR	January 1 - 31, 2019	Friday, February 15, 2019
Feb2019 FSR	February 1 - 28, 2019	Friday, March 15, 2019
Mar2019 FSR	March 1 - 31, 2019	Monday, April 15, 2019
Apr2019 FSR	April 1 - 28, 2019	Wednesday, May 15, 2019
May2019 FSR	May 1 - 31, 2019	Monday, June 17, 2019
Jun2019 FSR	June 1 - 30, 2019	Monday, July 15, 2019
Jul2019 FSR	July 1 - 31, 2019	Thursday, August 15, 2019
Aug2019 FSR	August 1 - 31, 2019	Monday, September 16, 2019
FINAL FSR	Final FSR	Tuesday, October 15, 2019

Draft Final Report: A Draft Final Report will be submitted to the Project Manager and the TCEQ Liaison. It will include an Executive Summary. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources. It will also include a report of the QA findings.

Draft Final Report Due Date: Thursday, August 1, 2019

Final Report: A Final Report incorporating comments from the AQRP and TCEQ review of the Draft Final Report will be submitted to the Project Manager and the TCEQ Liaison. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources.

Final Report Due Date: Tuesday, September 3, 2019

Project Data: All project data including but not limited to QA/QC measurement data, metadata, databases, modeling inputs and outputs, etc., will be submitted to the AQRP Project Manager within 30 days of project completion (September 30, 2019). The data will be submitted in a format that will allow AQRP or TCEQ or other outside parties to utilize the information. It will also include a report of the QA findings.

AQRP Workshop: A representative from the project will present at the AQRP Workshop in the first half of August 2019.

Presentations and Publications/Posters: All data and other information developed under this project which is included in **published papers, symposia, presentations, press releases, websites and/or other publications** shall be submitted to the AQRP Project Manager and the TCEQ Liaison per the Publication/Publicity Guidelines included in Attachment G of the Subaward.

7.0 References

Bar-Ilan, A., J. Grant, R. Friesen, A. Pollack, D. Henderer, D. Pring, Kathleen Sgamma, Development of Baseline 2006 Emissions from Oil and Gas Activity in the Denver-Julesburg Basin, Prepared for Colorado Department of Public Health and Environment Air Pollution Control Division, April 2008.

Bar-Ilan, A., J. Grant, R. Friesen, A. Pollack, D. Henderer, D. Pring, Kathleen Sgamma, Final Report: Development of Baseline 2006 Emissions from Oil and Gas Activity in the Piceance Basin, January 2009a.

Bar-Ilan, A., J. Grant, R. Parikh, A. Pollack, D. Henderer, D. Pring, Kathleen Sgamma, Final Report: Development of Baseline 2006 Emissions from Oil and Gas Activity in the South San Juan Basin, November, 2009b.

Bar-Ilan, A., J. Grant, R. Parikh, A. Pollack, D. Henderer, D. Pring, Kathleen Sgamma, Final Report: Development of Baseline 2006 Emissions from Oil and Gas Activity in the Wind River Basin, July 2010.

Bar-Ilan, A., J. Grant, R. Parikh, D. Henderer, Kathleen Sgamma, Final Report: Development of Baseline 2006 Emissions from Oil and Gas Activity in the Powder River Basin, September 2011.

Bar-Ilan, A., J. Grant, R. Parikh, D. Prin, Kathleen Sgamma, Final Report: Development of Baseline 2006 Emissions from Oil and Gas Activity in the Powder River Basin, November 2012.

Estes, M, personal communication with E. McDonald-Buller, May 3, 2018.

Friesen, R., R. Parikh, J. Grant, A. Bar-Ilan, A. Pollack, D. Henderer, D. Pring, Kathleen Sgamma, Phil Schlagel, Final Report: Development of Baseline 2006 Emissions from Oil and Gas Activity in the Uinta Basin, March 2009.

Grant, J.G., R. Parikh, J. King, A. Bar-Ilan, San Juan and Permian Basin 2014 Oil and Gas Emission Inventory Inputs, Report prepared for the Bureau of Land Management, New Mexico State Office and Western States Air Resources Council, October 2016.

Grant, J., R. Parikh, A. Bar-Ilan, R. Morris, Development of Baseline 2011 and Future Year 2015 Emissions from Oil and Gas Activity in the Great Plains Basin: Final Report. Prepared for the Bureau of Land Management, Montana/Dakotas State Office and Western States Air Resources Council. August 2014a.

Grant, J., R. Parikh, A. Bar-Ilan, R. Morris, Development of Baseline 2011 and Future Year 2015 Emissions from Oil and Gas Activity in the Williston Basin Final Report. Prepared for the Bureau of Land Management, Montana/Dakotas State Office and Western States Air Resources Council. August 2014b.