

Potential Costs of Ozone Nonattainment in the Corpus Christi Metropolitan Area

Report Prepared for

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EXECUTIVE SUMMARY

This study provides a quantitative analysis for the potential costs to the Corpus Christi metropolitan statistical area (MSA) as a result of a hypothetical scenario of an ozone nonattainment designation based on the U.S. Environmental Protection Agency's (EPA) National Ambient Air Quality Standards (NAAQS). The current NAAQS for ground-level ozone is 70 parts per billion (ppb).

Historically, Corpus Christi has never failed to meet the EPA's ozone NAAQS. Also, the Texas Commission on Environmental Quality (TCEQ) has never designated any part of this area as "nonattainment" with respect to ozone. However, continued population and economic growth, particularly rapid development of industrial manufacturing plants in the Port of Corpus Christi district and across San Patricio County, are expected to further degrade local air quality and thus increase ozone impairment in the future.

The purpose of this study is to project the economic consequences, or potential losses, to the economies in the Corpus Christi metro area and its three counties that could arise after receiving either a marginal or moderate nonattainment designation. Economic costs are determined according to lost output measured alternatively by gross regional product (GRP), gross business sales or revenues, wage earnings, and jobs that might occur in the respective cases of marginal and moderate nonattainment.

It is not conceivable that Corpus Christi would receive one of the more serious nonattainment classifications, such as serious, severe, and extreme, in the immediate future. The quantitative findings in this report can also be interpreted as the economic benefits of taking voluntary actions or implementing preemptive policy measures to maintain or even reduce ozone levels in an attainment area. The costs associated with local residents' health risk are outside the scope of this study.

Estimates for the potential economic impacts of nonattainment include:

1. costs of Nonattainment New Source Review (NNSR) and permitting,
2. economic losses associated with delays in industrial construction projects,
3. potential loss of industrial expansion or firm relocation to the area,
4. costs of point source reductions in nitrogen oxide (NOx) and volatile organic compounds (VOC)
5. economic losses due to road construction delays,
6. economic losses associated with vehicle inspection fees,
7. additional costs of educational programs, and

8. additional costs of voluntary control measures, such as the Texas Emissions Reduction Plan (TERP) programs.

The first four types of economic impacts broadly refer to losses of local economic activity as a result of new federal requirements under a nonattainment designation. Other than the additional economic costs that would potentially constrain future industrial growth in the area, a nonattainment area will also face lost economic activity due to point source emission offsets, road construction delays and vehicle inspection fees due to the new transportation conformity requirements. In addition, the area will incur additional costs associated with the implementation of educational programs and voluntary control measures.

The following table summarizes estimates for the average annual potential costs in the Corpus Christi metro area associated with the alternative marginal and moderate nonattainment designations. All figures are expressed in 2020 dollars. The low estimates represent our conservative projections of economic impacts, while the high estimates represent the effects of extreme yet probable hypothetical situations. The impact on local industry includes permitting costs, costs associated with industrial project delays, potential lost firm expansion or relocation, and the costs of point source emission reductions as part of the general conformity requirements. Transportation conformity costs include costs associated with road construction delays, inspection fees, educational programs and the Texas Emissions Reduction Plan (TERP).

Summary of Average Annual Potential Costs of Nonattainment in Corpus Christi MSA (2020 $)

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Permitting Costs	$186,222	$465,556	$186,299	$465,748
Cost of Industrial Project Delays	$10,111,927	$10,111,927	$10,111,927	$10,111,927
Potential Lost Firm Expansion/Relocation	$554,785,332	$1,664,355,997	$554,785,332	$1,664,355,997
Costs of Point Source Emission Reductions	$862,273	$15,282,646	$1,293,409	$22,923,969
Lost GRP due to Road Construction Delays	$20,263,963	$20,291,740	$27,348,016	$27,373,016
Lost GRP due to Inspection Fees	–	–	$5,769,684	$9,281,666
Additional Costs of Educational Programs	$123,474	$123,474	$261,148	$261,148
Additional Costs associated with TERP	$29,655	$29,655	$29,655	$29,655
Total	**$586,362,847**	**$1,710,660,996**	**$599,785,472**	**$1,734,803,126**

The above cost estimates are average costs per year over the window of analysis, which includes the nonattainment and two subsequent 10-year maintaince periods. The cumulative costs over the entire study periods amount to $16 billion–$46 billion in the case of marginal nonattainment, and to $18 billion–$52 billion in the case of moderate nonattainment.

The following table summarizes the distribution of the potential economic losses across the three counties in the Corpus Christi metro area.

Average Annual Potential Costs of Nonattainment by County (2020 $)

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Aransas County	$15,466,449	$45,717,942	$15,876,593	$46,367,817
Nueces County	$505,192,034	$1,477,576,569	$515,041,166	$1,495,117,905
San Patricio County	$65,704,364	$187,366,485	$68,867,713	$193,317,405
MSA Total	**$586,362,847**	**$1,710,660,996**	**$599,785,472**	**$1,734,803,126**

Other than population size, the extent of economic impact on an individual county due to a nonattainment designation to the metro area depends largely on the local economic and industrial landscape, including the locations of major sources of air emissions. A typical resident in the Corpus Christi metro area would incur a potential economic loss of $1,115–$3,299 per year. Residents in Nueces County are expected to each bear at least $1,200 annually. Still, residents in Aransas County—which is relatively far from existing prominent sources of air pollution—are expected to incur at least $560 per year in the case of ozone nonattainment for the entire metro area.

1. INTRODUCTION

This study was initiated by the Coastal Bend Air Quality Partnership (formerly Corpus Christi Air Quality Group) and funded by the Port of Corpus Christi. The objective is to determine the potential economic consequences of a hypothetical scenario of ozone nonattainment designation to the Corpus Christi region. The nonattainment designation refers to an area with air quality worse than the National Ambient Air Quality Standards (NAAQS), as defined in the Clean Air Act of 1970.

Similar studies have been conducted in recent years for the Austin-Round Rock and San Antonio metro areas. In 2015, the Capital Area Council of Governments completed a study on the potential costs of a hypothetical ozone nonattainment designation to the Austin area in Central Texas.[1] A similar study for the San Antonio area was completed in 2017 for the Alamo Area Council of Governments.[2] Following these two studies, this report expressly focuses on the negative consequences of an ozone nonattainment designation on the Corpus Christi economy. The study for San Antonio might has potentially served as a guide to community stakeholders in its Bexar County, which has received a nonattainment designation.

Keep in mind that the objective of the present study is not to assess the risk of ozone nonattainment. Corpus Christi has never been designated as nonattainment. Also, a consensus among community stakeholders holds that the area is currently not on the brink of nonattainment. From these perspectives, the quantitative findings in this report can instead be interpreted as identifiable economic benefits of preemptive actions and policy measures taken in the past or future to maintain the federal air quality attainment status and ultimately the overall quality of life among local residents.

[1] Capital Area Council of Governments, *The Potential Costs of an Ozone Nonattainment Designation to Central Texas*, September 22, 2015.

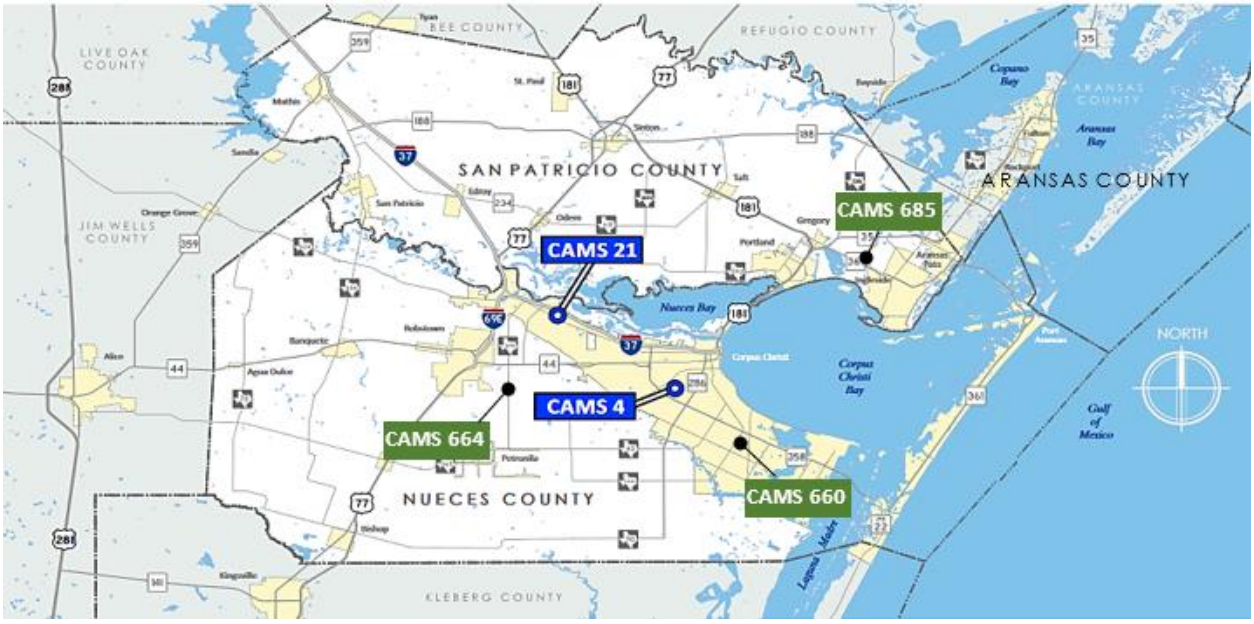
[2] Nivin, Steve, Belinda Roman, and David Turner, *Potential Cost of Nonattainment in the San Antonio Metropolitan Area*, study conducted for Alamo Area Council of Governments, February 21, 2017.

2. BACKGROUND

2.1 Geographic Scope

The geographic scope of this study is the Corpus Christi Metropolitan Statistical Area (MSA), which consists of Aransas, Nueces, and San Patricio Counties. The Corpus Christi Urban Airshed comprises Nueces and San Patricio Counties. The Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) define the Corpus Christi Urban Airshed in which air emissions from sources in both counties interact to influence the level of air pollution in the Corpus Christi community (see Exhibit 2.1). Within a population of slightly more than 24,000 (2019 Census), Aransas County is not part of the Corpus Christi Urban Airshed. However, given the close economic and other interactions among the three counties, particularly the impact of a hypothetical nonattainment status on the Corpus Christi region, this the scope of this study includes Aransas County in addition to the other two counties.

Exhibit 2.1: Map of the Corpus Christi Urban Airshed and Air Quality Monitoring Sites



Source: Corpus Christi Metropolitan Planning Organization.

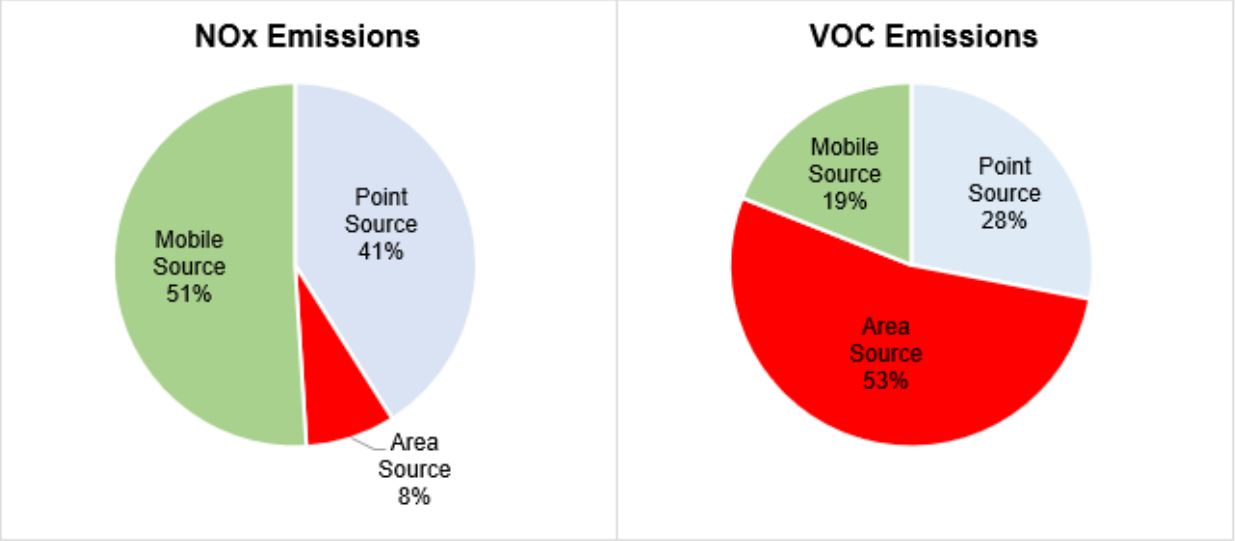
In Corpus Christi, the TCEQ operates two Continuous Air Monitoring Stations (CAMS) that determine the area's airshed's compliance with ozone NAAQS (see Exhibit 2.1 above): (1) CAMS 4 that is located at 902 Airport Road, and (2) CAMS 21 that is located at 9866 La Branch Street. Until recently, three additional ozone monitors were operated for research purposes by Texas A&M University-Kingsville and University of North Texas (CAMS 660, CAMS 664, and CAMS 6850). These monitors have been decommissioned.

2.2 Overview on Air Emissions

The EPA meets its obligations under the Clean Air Act of 1990 by establishing the National Ambient Air Quality Standards (NAAQS). These standards define acceptable ambient, or outdoor, air concentrations for six air pollutants: nitrogen dioxide (NO2), ozone (O3), sulfur dioxide (SO2), carbon monoxide (CO), lead (Pb), and particulate matters (PM10 and PM2.5).[3]

Instead of through direct emissions, ground-level ozone is created indirectly by chemical reactions of NOx and VOC in the presence of sunlight. In addition to natural or biogenic sources of emissions, such as crops, grass and trees, these chemicals are produced by a wide variety of human activities that are broadly classified as point and non-point sources. Point sources include electric power plants, industrial boilers, petroleum refineries, and manufacturing facilities. Non-point sources are further classified as: (1) area sources that are small-scale industrial, commercial and residential sources that generate emissions, and (2) mobile sources that represent a variety of on-road and non-road vehicles and equipment that generate emissions.

Exhibit 2.2: Air Emission Sources in Corpus Christi (Nueces and San Patricio Counties)



Source: TCEQ *Emissions Inventory*, 2019. Accessed online at: https://www.tceq.texas.gov/airquality/areasource/emissions-sources-charts.

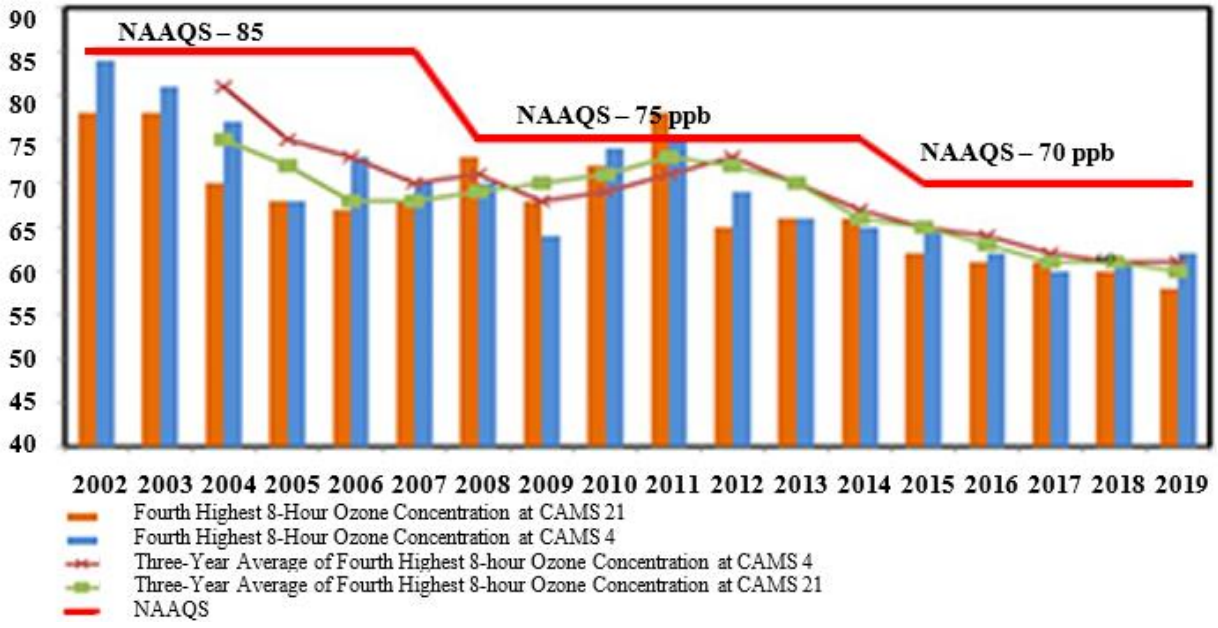
[3] Environmental Protection Agency, *NAAQS Table*. Accessed online at: https://www.epa.gov/criteria-air-pollutants/naaqs-table.

In the Corpus Christi urban airshed, mobile sources are responsible for more than half of the NOx emissions, while area sources account for the majority of VOC emissions (see Exhibit 2.2 above). From these perspectives, it is important to pay as much attention to the impact of vehicle emissions on local air quality as to emissions from large industrial plants.

For ozone, the Clean Air Act establishes nonattainment-area classifications according to the severity of the area's air pollution problem. The NAAQS for ozone is based on an annual fourth highest daily maximum of 8-hour concentration that is averaged over the three past calendar years. In 2008, the ozone NAAQS was revised from previously 85 parts per billion (ppb) to 75 ppb. In 2015, the EPA revised the primary and secondary 8-hour ozone NAAQS for attainment to 70 ppb.

The Corpus Christi metro area has never been designated as a nonattainment area. The city of Corpus Christi is widely known as the "Sparkling City by the Sea." According to readings at the two regulatory monitoring stations (CAMS 4 and CAMS 21), the area's airshed has experienced an overall decreasing trend in ozone concentration since 2011 (see Exhibit 2.3). The fourth highest 8-hour ozone concentration readings between the two stations were around 60 ppb in 2019, about 10 ppb below the NAAQS.

Exhibit 2.3: Corpus Christi Area Ozone Concentration, ppb.



Source: Corpus Christi Air Quality Group, 2019.

Other than technological advances that have raised vehicles' fuel efficiency and the effectiveness of emission controls, the declining trend in ozone concentration in the local airshed was attributable to local efforts spearheaded by the Coastal Bend Air Quality Partnership. This partnership was established in 1995 as Corpus Christi Air Quality Group to address NAAQS ozone attainment issues for the local airshed. Since then, the group has initiated and implemented air quality planning and voluntary emission reduction measures for the area. Participants in this group are representatives of local community stakeholders, such as the City of Corpus Christi, Nueces County, Corpus Christi Metropolitan Planning Organization (MPO), Corpus Christi Regional Transportation Authority (RTA), Port of Corpus Christi Authority and industry, Texas A&M University-Corpus Christi, and Texas A&M University-Kingsville. Since 2006, the group has participated in the EPA's 8-hour Ozone Flex (O3 Flex) program that aims to continue meeting the ozone NAAQS.

Still, there are reasons for the area to be at risk of ozone nonattainment or deterioration in overall air quality. First, given the periodic tightening of the NAAQS, it is conceivable that a new acceptable level for ozone attainment in the future be lowered further to close to 60 ppb. Given the current recorded ozone levels in Corpus Christi, any such revision to NAAQS would make the area at risk of nonattainment. Along with Victoria, Corpus Christi has been classified by the TCEQ as a near nonattainment community.[4]

Second, Corpus Christi has lost state funding for vehicle emissions reduction programs and other air quality programs. In 2017, Governor Abbott vetoed funding that had been approved to support emission reduction programs that assisted communities to remain in attainment. The TERP program was established in 2001 with an aim to reduce emissions from mobile sources, including vehicles and non-road equipment, such as construction equipment, trains, and marine vessels. While local stakeholders have provided interim funding for the area's committed air quality programs, such activities would likely be discontinued in the future without state funding.

Third, the area is poised to continue to expand its industrial sector at a rapid pace. Along with significant growth in energy exports of crude oil and liquefied natural gas (LNG), the Port of Corpus Christi has become the third largest port in the United States by total revenue tonnage. As more petrochemical, plastic, steel and other heavy industrial facilities become operational within the next five years, the amounts and sources of air pollutants would likely increase.

[4] Texas Commission on Environmental Quality, *Texas SIP Revisions*. Assessed online at: https://www.tceq.texas.gov/airquality/sip/sipplans.html.

A recent report by the Environmental Integrity Project indicated two Corpus Christi petrochemical refineries were among the six Texas refineries with benzene levels substantially above the federal action limit (Collier, 2020).[5] Without any offsetting measures, overall air quality in the region may deteriorate as additional large-scale industrial facilities are being built near those petrochemical refineries in "Refinery Row"—an area near Corpus Christi's north end.

The EPA requires each state to monitor ambient air quality and evaluate compliance to the NAAQS. Based on these evaluations, EPA characterizes the air quality within a defined area that ranges in size from portions of a city to a region comprising different counties to a metropolitan statistical area. Areas in attainment have levels of a given criteria air pollutant below the NAAQS, while areas in nonattainment have air quality levels that exceed the NAAQS. Based on the degree exceeding the NAAQS, an ozone nonattainment classification is further defined in Exhibit 2.4 below.

Exhibit 2.4: 8-Hour Design Value for the 2015 Ozone NAAQS

Nonattainment Classification	8-Hour Design Value (ppb)
Marginal	70 to 80
Moderate	81 to 92
Serious	93 to 104
Severe - 15	105 to 110
Severe - 17	111 to 162
Extreme	163 or more

Source: EPA, *NAAQS Table*.

[5] Collier, Kiah, Report 6 State Refineries Exceed Limits for Benzene, *Corpus Christi Caller Times*, February 7, 2020, Page A5.

3. OVERVIEW OF NONATTAINMENT AREA REQUIREMENTS

3.1 State Implementation Plan

The ozone nonattainment classification for an area determines the planning and control requirements that will improve the area's air quality and move the area towards the attainment status. If an area is designated as nonattainment, then the state must develop revisions to its state implementation plan (SIP) that demonstrate the plans that the state will take to bring that area back to attainment.

According to the EPA, basic SIP components for nonattainment areas are as follows:[6]

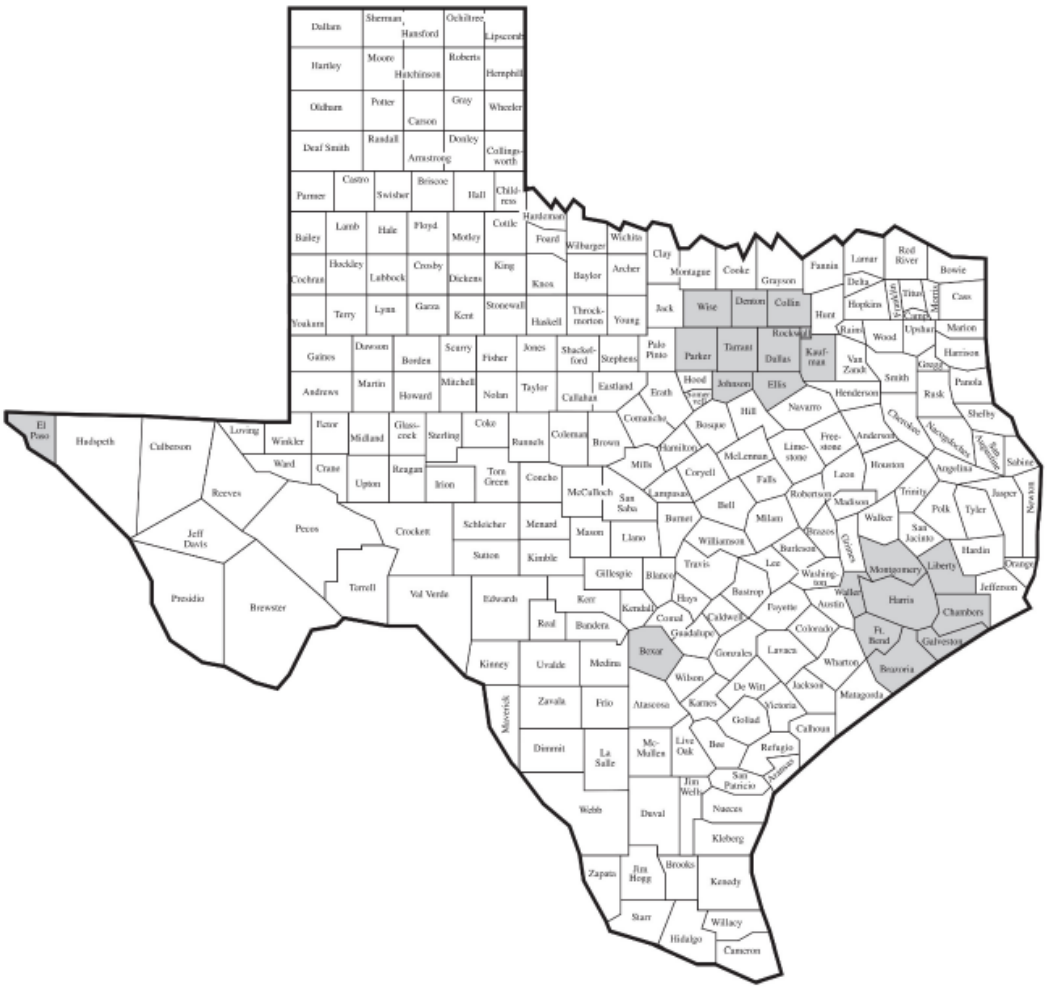
- Emissions inventory and emissions reporting statement rule
- Reasonable further progress (RFP) plan
- Reasonably available control technology (RACT)
- Reasonably available control measure (RACM)
- Attainment demonstration
- Contingency measures
- Nonattainment new source review (NNSR) program
- Motor vehicle emissions budget (MVEB)
- As applicable, a variety of area-wide mobile source and stationary source control programs

In 2015, the EPA revised the primary 8-hour NAAQS for ground-level ozone from the 2008 standard of 75 ppb to 70 ppb. The secondary 8-hour NAAQS for ozone was also revised to the equivalent of the primary standard at 70 ppb. In 2016, the TCEQ issued its recommendations for ozone attainment, nonattainment, or unclassifiable under the new 8-hour NAAQS for all areas within the state. In addition to the 9-county Dallas-Fort Worth and 6-county Houston-Galveston-Brazoria metro areas that had received the ozone "marginal" nonattainment designations for the 2015 8-hour ozone NAAQS, Bexar County in the San Antonio metro area became a new nonattainment area with respect to ozone (see Exhibit 3.1 below).

[6] Environmental Protection Agency, *Implementation of the 2015 National Ambient Air Quality Standards for Ozone: Nonattainment Area Classifications and State Implementation Plan Requirements*, Federal Register, Vol. 81, No. 222. November 17, 2016.

Exhibit 3.1: Texas Nonattainment Areas

Area	Counties
Dallas-Fort Worth Eight-Hour Ground-Level Ozone Nonattainment Area	Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise
Houston-Galveston-Brazoria Eight-Hour Ground-Level Ozone Nonattainment Area	Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller
Bexar County Eight-Hour Ground-Level Ozone Nonattainment Area	Bexar County
City of El Paso Particulate Matter (PM_{10}) Nonattainment Area	El Paso County (for purposes of TERP eligibility, the TCEQ includes the entire county)
Colin County Lead Nonattainment Area	Part of Colin County



Source: TCEQ, *Texas Emission Reduction Plan Biennial Report*, December 2018.

Depending on the level of nonattainment designation, different requirements are imposed with the goal of improving the air quality levels and returning to attainment status. These requirements are established through revisions to the SIP:[7]

Marginal (3 years to attain):

- Baseline emission inventory, followed by periodic updates
- New source review (NSR) program
  - NSR offset ratio 1.1:1
- Major source emission statements
  - Major source threshold 100 tons per year (tpy), and
- Transportation conformity demonstration

Moderate (6 years to attain):

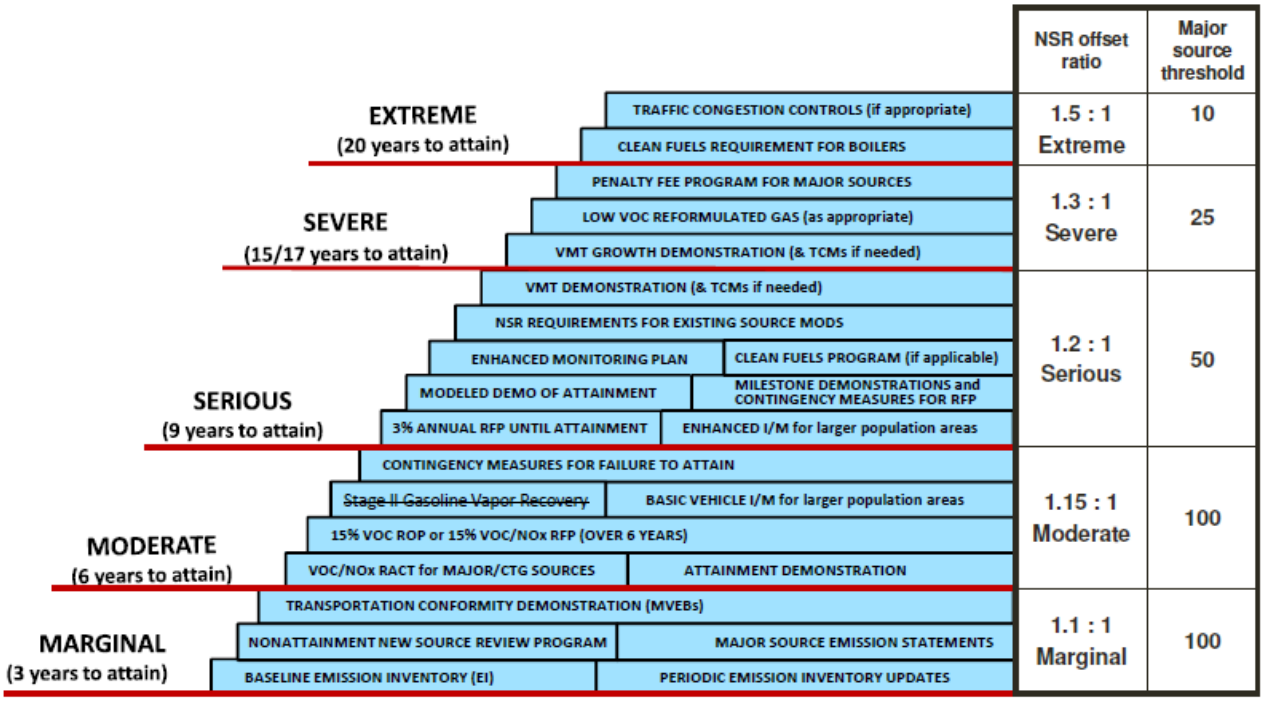
- All requirements for Marginal classification, with
  - Major source threshold 100 tpy
  - NSR offset ratio 1.15:1
- Major source (NOx/VOC) reasonably available control technology (RACT)
- Attainment demonstration
- 15% reasonable further progress (RFP) over 6 years
- Basic vehicle inspection and maintenance (I/M) program
- Contingency measures for failure to attain
- Gasoline vapor recovery (no longer required due to the development of on-board vapor recovery technology)

The "offset" requirements ensure new emissions must be offset so that there is no net increase in emissions in the airshed. New emissions can occur through a new operation or the expansion of an existing emitter in the airshed. The amount of new projected pollutants introduced into the airshed must be offset or neutralized by reducing pollutants elsewhere in the airshed at the same amount, or by purchasing pollutant credits from an airshed emissions trading program.

If the air quality in a nonattainment area improves to meet the NAAQS, the area will be designated as a maintenance area. It is important to consider that even if the regional air quality improves and achieves a designation of maintenance, the requirements will remain in effect until continued NAAQS compliance can be demonstrated. Exhibit 3.2 below shows the general timeline for an area receiving a nonattainment designation.

[7] Ibid.

Exhibit 3.2: Overview of Clean Air Act Ozone Planning and Control Requirements by Classification



Source: EPA, *Implementation of the 2015 National Ambient Air Quality Standards for Ozone: Nonattainment Area Classifications and State Implementation Plan Requirements*, Federal Register, Vol. 81, No. 222, November 17, 2016.

An ozone nonattainment designation for Corpus Christi would likely have 23 or more years of regulatory and economic consequences for the area. The 23-year period assumes that the area is designated as "marginal" nonattainment, so it would take three years for the area's regulatory ozone monitoring data averaged over three years to effectively report ozone attainment levels. The area would then transition into two 10-year maintenance periods beginning immediately after it is re-designated as ozone attainment. The corresponding period for "moderate" nonattainment is 26 years, given the initial six years to receive a nonattainment designation.

3.2 Air Permitting for Stationary Sources

The New Source Review (NSR) is a pre-construction permitting program serving to establish and document air pollution emission limitations from "major" stationary sources of air pollution. NSR includes two primary permitting programs: Prevention of Significant Deterioration (PSD) and Nonattainment NSR (NNSR). These permits apply to new "major" sources of air pollution or existing major sources that are making a "major" modification. PSD applies to attainment areas, while NNSR applies to nonattainment areas.

For NNSR permitting in a marginal or moderate ozone nonattainment area, a "major" source is defined as a facility that has the potential to emit at least 100 tons per year (tpy) of either NOx or VOC, and a "major" modification is a physical modification or change in operations that would raise emissions of NOx or VOC by at least 40 tpy.[8] According to the EPA, all NNSR programs have to require: (1) the installation of the lowest achievable emission rate (LAER),(2) emission offsets, and (3) opportunity of public involvement.[9]

The LAER requirements can be achieved in different ways, including changes to raw materials, process modifications, and add-on controls. These methods will likely increase the cost of building a new facility as a major source or the cost of expanding operations of an existing major source. In addition, a typical NNSR involves permitting fees that are higher than the typical NSR or PSD permits, as well as an extensive review process.[10] According to the TCEQ, the target time frame for NNSR permit issuance is 365 days, significantly longer than the target of 285 days for NSR permits.[11]

3.3 Conformity

Under the Clean Air Act, "conformity" is a provision that mandates all federal activities to conform, or meet, the requirements of an approved SIP in nonattainment and maintenance areas. Essentially, conforming activities should not cause or contribute to new violations, increase the frequency or severity of existing violations, or delay timely attainment of any emission reductions. Conformity regulations are categorized as transportation conformity and general conformity.

Transportation Conformity

Transportation conformity requirements apply to transportation-related plans and programs, including projects funded or approved by federal transportation agencies such as Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA). As a nonattainment area, the transportation conformity process involves the revision of the long-term metropolitan transportation plan

[8] Environmental Protection Agency, *Infrastructure SIP Requirements*. Accessed online at: https://www3.epa.gov/airquality/urbanair/sipstatus/infrastructure.html.

[9] Environmental Protection Agency, *Nonattainment NSR Basic Information*. Accessed online at: https://www.epa.gov/nsr/nonattainment-nsr-basic-information.

[10] Environmental Protection Agency, *Status of SIP Requirements for Designated Areas*. Accessed online at: https://www3.epa.gov/airquality/urbanair/sipstatus/reports/tx_elembypoll.html#ozone-8hr_2008_1404.

[11] Texas Commission on Environmental Quality, *Texas Commission on Environmental Quality Fact Sheet - Air Permitting.*

(MTP) and shorter-term transportations improvement programs (TIPs) by including an analysis of the potential impact of the plans on local air quality in order to demonstrate that the activities conform to the SIP. The SIP must conform to the motor vehicle emission budget (MVEB), which is a representation of the area's projected local on-road mobile source emissions for NAAQS specific pollutants. For the ozone NAAQS, the EPA's determination of transportation conformity is based on evaluating the area's impact of MTP and TIP on future emissions of NOx and VOC as ozone precursors against the MVEB in the SIP. With a one-year grace period, an area that has received nonattainment designation enters a conformity "lapse" if it fails to demonstrate transportation conformity. A lapse results in restrictions in federal funding for highway and transit improvement projects.

For the Corpus Christi region, the Corpus Christi Metropolitan Planning Organization (MPO) provides direction for the allocation of federal funds for urban transportation planning through its development of MTP and TIPs. Should the area be designated as ozone nonattainment, the MPO would be the primary agency for demonstrating transportation conformity.

General Conformity

In a nonattainment or maintenance area, general conformity is determined on a project-by-project basis. This federal requirement applies to activities that are federally funded or approved and they are not covered by transportation conformity regulations. Under general conformity, the EPA requires that the federal agency proposing a project work with state and local governments to evaluate whether the potential impact of the project on air quality would conform to the SIP.

The military and various divisions of Department of Defense together play a key role in the Corpus Christi economy. The military installation of Naval Air Station Corpus Christi, including Corpus Christi Army Depot, is the largest single employer in the region.[12] A nonattainment designation will impact this military base's operations due to additional regulations on air emissions.

One key criterion for general conformity determinations is the *de minimis* level that the total direct and indirect emissions associated with a proposed project must fall below. For marginal and moderate nonattainment areas respect to ozone, the *de minimis* level is 100 tpy of NOx or VOC.

[12] Texas Comptroller of Public Accounts, *Naval Air Station Corpus Christi, Estimated Contribution to the Texas Economy, 2015*. Accessed online at: https://comptroller.texas.gov/economy/economic-data/military/2015/nas-corpus.php.

If the proposing federal agency fails to demonstrate general conformity of the project, then it may obtain emission offsets in order to ensure that there is no net increase in emissions for the area. Offsets must occur during the same calendar year as any emissions increase from the proposed project; otherwise, offsets must exceed a 1.1-to-1 ratio of projected emissions for marginal nonattainment areas and 1.15-to-1 ratio for moderate nonattainment areas (recall Exhibit 3.2).

The general conformity requirements affect both large and small businesses. Small businesses, from bakeries and dry cleaners to gas stations and auto body shops, may not be major sources of air emissions but can also be affected when operating in a non-attainment community. TCEQ requires that any business that emits pollutants into the air either file for a permit or maintain extensive reports to prove that they are exempt from permitting. The additional documentation needed for permitting and reporting can be expensive and challenging particularly for small businesses that do not have an environmental staff to assist with managing the new requirements.

3.4 Reasonably Available Control Technology

If an area is designated as moderate or more severe nonattainment with respect to ozone, then sources of emissions within the area must demonstrate that they have implemented Reasonably Available Control Technology (RACT). The EPA defines RACT as the lowest emission limitation that a given source is capable of meeting by the application of control technology at that is reasonably available based on technological and economic feasibility (EPA, 2016g).[13] Existing facilities would need to be retrofitted with pollution control technology. In Texas, TCEQ establishes RACT requirements for ozone based on NOx and VOC emissions.

3.5 Attainment Demonstration

If an area is classified as moderate or more severe nonattainment with respect to ozone, then the area is required to demonstrate that it will be able to achieve attainment by the attainment date. The demonstration must include evidence that the state has implemented reasonably available control measures necessary to advance attainment as well as any additional measures that will be

[13] Environmental Protection Agency, *Implementing Reasonably Available Control Technology Requirements for Sources Covered by the 2016 Control Techniques Guidelines for the Oil and Natural Gas Industry*. Accessed online at: https://www.epa.gov/nsr/nonattainment-nsr-basic-information.

implemented in the case of failing to achieve attainment by the pre-specified date.

3.6 Reasonable Further Progress

If an area is classified as moderate or more severe nonattainment with respect to ozone, then the Clean Air Act requires its state to submit plans to show reasonable further progress (RFP) towards achieving attainment. In Texas, the TCEQ would be required to submit an RFP analysis as a revision to its SIP for the nonattainment area within three years of the nonattainment designation. The SIP revision would involve reducing ozone precursor emissions at annual increments between the baseline year and the attainment year.

3.7 Vehicle Inspection and Maintenance Programs

The Inspection and Maintenance (I/M) programs aim to improve air quality by identifying cars and trucks that may need repairs due to high emissions. Areas designated as moderate or more severe nonattainment with respect to ozone are required to implement I/M programs. The SIP must be revised to include the implementation of a basic I/M program. In Texas, the I/M programs in nonattainment areas are integrated with the annual safety inspection program run by the Texas Department of Public Safety (DPS) in conjunction with the TCEQ.[14]

[14] Texas Commission on Environmental Quality, *Vehicle Emissions Inspections in Texas: Program Overview of the Vehicle Inspection and Maintenance (I/M) Program in Texas*. Accessed online at: https://tceq.state.tx.us/airquality/mobilesource/vim/overview.html.

4. OVERVIEW OF METHODOLOGY

The overall methodology of this study draws on the related economic impact studies for the Austin and San Antonio regions in the case of ozone nonattainment. The Austin study was completed by the Capital Area Council of Governments.[15] The San Antonio study was prepared for the Alamo Area Council of Governments.[16] Both studies were financed through grants from the TCEQ. By following the general approach of these two reports, we can compare the estimated potential costs of nonattainment against these regions within Texas. A comparison across the three regions also highlights unique characteristics of the Corpus Christi that contribute to its economic consequences of ozone nonattainment.

As in the studies for Austin and San Antonio metro areas, this report focuses on the alternative hypothetical scenarios of marginal and moderate nonattainment with respect to ozone. The EPA imposes substantially more stringent statutory and regulatory requirements for the serious, severe, and extreme nonattainment classifications.

4.1 Economic Impact Measures

Consistent with the common practice and the economic methodology of related studies for Austin and San Antonio, estimates of economic impacts are captured by projected changes in gross regional product (GRP), or value added, in the Corpus Christi metro area as well as its three individual counties. Gross regional product is a comprehensive measure of the size of a regional economy. Other key measures of economic impacts are employment (full-time-equivalent job positions), wage incomes including benefits, and gross business sales (revenues or output).

4.2 Multiplier Effects

This report documents not only the "direct" impacts of a nonattainment designation on local economic activity, but also the "secondary" impacts that are associated with the direct economic impacts. For instance, a delay in an industrial facility's expansion due to a longer building permit process will result in economic losses beyond the direct loss of the economic activity in that facility. This delay also affects the company's suppliers and employees, as well as all other local businesses and their workers that rely on purchases from those suppliers and

[15] Capital Area Council of Governments, *The Potential Costs of an Ozone Nonattainment Designation to Central Texas*, September 22, 2015.

[16] Nivin, Steve, Belinda Roman, and David Turner, *Potential Cost of Nonattainment in the San Antonio Metropolitan Area*, study conducted for Alamo Area Council of Governments, February 21, 2017.

employees. These secondary impacts are also known as the multiplier effects, which capture all changes in the local economy as a result direct changes in economic activity.

We calculate the "total" economic impacts in terms of changes in GRP using the Economic Modeling Specialists International (EMSI) model. This model applies the IMPLAN input-output multiplier data to the Corpus Christi metro area. This approach allows us to directly compare our economic impact estimates with those in the Austin and San Antonio studies that apply the same economic methodology.

4.3 Key Assumptions

For economic analysis of hypothetical or counterfactual scenarios, it is necessary to first make assumptions about specifics of the scenarios and future conditions in the Corpus Christi area. The following lists some general assumptions followed in this study. Other assumptions will be described in the next section for economic analysis.

- The entire time span of this study is 27 years for the case of marginal nonattainment, and 30 years for the case of moderate nonattainment. These windows cover the two 10-year maintenance periods and the time to attain nonattainment designation.
- All dollar values are in 2020 dollars.
- The economic structure (e.g., distribution of businesses and jobs) of the three individual counties in the Corpus Christi metro area as well as their population shares remain unchanged in the future
- To allocate the economic costs across the three counties, the counties' shares of the area population, employment or GRP are used, depending on the analysis (see Exhibit 4.1):

Exhibit 4.1: County Shares of Corpus Christi MSA

	Population	Employment	GRP
Aransas County	5.3%	4.9%	2.7%
Nueces County	80.0%	80.6%	86.7%
San Patricio County	14.8%	14.5%	10.6%

Sources: Bureau of Census (2019), Bureau of Labor Statistics (2019), Bureau of Economic Analysis (2018).

5. ANALYSIS OF ECONOMIC CONSEQUENCES

We present our estimates of potential economic impacts under the following broad categories:

- Impact on local industry's expansion and operations
  The impacts are measured in terms of the costs associated with nonattainment new source review (NNSR) permitting rules, economic consequences of construction project delays, potential losses in firm expansion or relocation, and the costs of point source reductions in NOx and VOC. These impacts include general conformity costs.

- Transportation conformity costs
  The impacts are measured in terms of economic losses due to federally funded road construction delays and the costs associated with vehicle inspection fees and repair costs.

- Additional costs of educational programs and voluntary control measures
  These are costs associated with additional educational programs and the additional costs in the Texas Emissions Reduction Plan (TERP) beyond those voluntary programs already taken. Such costs are considered economic "losses," or waste to society, in the sense that the new programs might otherwise be unnecessary if local air quality is not a critical community issue and thus resources associated with those costs would otherwise be allocated to other activities, including leisure.

5.1 Impact on Local Industry

Nonattainment New Source Review Permitting Costs

Under the new point source review requirements in a nonattainment area, firms that plan to expand its operations or relocate a new facility in the area may be required to conduct a conformity analysis. According to the TCEQ, the potential costs of conducting conformity analysis for a construction permit are between $100,000 and $250,000.[17]

[17] Texas Commission on Environmental Quality, *Texas Commission on Environmental Quality Fact Sheet - Air Permitting.*

To determine the potential number of permits to be filed in the future, we derived data on the construction permits filed with TCEQ since 1995. The average number of permits per year was 50 for the Corpus Christi metro area. About 66% of all construction permits were filed in Nueces County, 27% in San Patricio County, and 7% in Aransas County.

The total costs of permitting per year equal the historical average number of permits times the alternative estimates of permitting costs. The low and high estimates correspond, respectively, to the low and high estimated dollar costs of a conformity analysis. In line with the San Antonio report, the total NNSR permitting cost is assumed to be 13% higher for moderate nonattainment than for marginal nonattainment. The total costs of permitting under a nonattainment designation ranges from about $5 million to nearly $14 million per year. The exhibit below lists the estimates by county and by level of nonattainment (see Exhibit 5.1).

Exhibit 5.1: Annual Costs of Nonattainment New Source Review Permitting by County (2020 $)

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Aransas County	$336,000	$840,000	$373,488	$933,719
Nueces County	$3,336,000	$8,340,000	$3,708,198	$9,270,496
San Patricio County	$1,356,000	$3,390,000	$1,507,289	$3,768,223
MSA Total	**$5,028,000**	**$12,570,000**	**$5,588,975**	**$13,972,438**

Consequences of Construction Project Delays

A more lengthy and stringent permitting process for the nonattainment designation results in losses in economic activity associated with construction delays. Since a new source review permit could take up to 365 days, this delay potentially results in one year of lost business and wage earnings associated with the operation of the new facility.

The numbers of firms directly affected by construction delays are determined by the distribution of TCEQ permits by industry. The impact of construction delays in a given industry on RGP is calculated by multiplying the average firm size, as measured by gross sales, by the yearly number of permits in its respective industry. Essentially, the estimated reductions in GRP represent the impacts of a one-year delay in the construction project of a typical firm in different industries.

As shown in Exhibit 5.2 below, construction project delays are projected to result in a total loss of $273 million annually in the metro area's GRP under a marginal nonattainment designation. The corresponding reduction in GRP increases to $303 million under a moderate nonattainment designation.

Exhibit 5.2: Annual Reductions in GRP due to Construction Project Delays (2020 dollars)

	Marginal Nonattainment	Moderate Nonattainment
Aransas County	$7,439,110	$8,265,677
Nueces County	$236,731,564	$263,035,071
San Patricio County	$28,851,359	$32,057,065
MSA Total	**$273,022,032**	**$303,357,813**

Potential Loss of Firm Expansion or Relocation

When an area is designated as nonattainment, many local firms are required to install new emission control systems or engage in other activities to reduce emissions. Emissions control systems may cost more than $1 million to install and additional staff to maintain. In addition, offsets may be prohibitively expensive for many firms to purchase, even if they are available. All these additional costs may affect firms' decision to expand or relocate in a nonattainment area.

Since 2010, the Corpus Christi metro area has received more than $52 billion in capital expenditures. The following exhibit is a list of announced construction projects with a capital cost about $1 billion or more (see Exhibit 5.3).

Exhibit 5.3: Major Construction Projects in Corpus Christi Beginning 2010

	Year Start	Year End	$ Millions	Industry
TPCO	2011	2016	$1,200	steel
M&G	2014	2016	$1,100	plastics
voestalpine	2014	2016	$1,000	steel
Cheniere	2015	2018	$15,000	natural gas
OxyChem	2015	2017	$1,000	petrochemical
ExxonMobil/SABIC	2019	2022	$11,000	plastics
Steel Dynamics	2020	2021	$1,800	steel
Total			**$32,100**	

Corpus Christi's attainment status has been touted as one advantage for at least some of those corporate decisions to build industrial facilities in the area, as

opposed to other nonattainment areas, such as Houston. It is therefore conceivable that some of those facilities would not have occurred in the current locations in Nueces or San Patricio County if the area were designated as nonattainment.

We consider losses from potential firm expansion and relocation in three industries with major point sources of air emissions: oil and gas extraction, petrochemical manufacturing, and steel and fabricated pipe manufacturing. As evident in Exhibit 5.3 above, these industries account for the majority of new capital construction in the area during the past decade. The utilities industry, which includes electric power generation, is also a major air pollution source, but public utilities are most likely not to relocate or expand due to a nonattainment designation.

As in the San Antonio study, we first consider the potential loss of one average-sized firm in each of those three industries. The "direct" effects in terms of employment, wage income, GRP, and gross sales in a particular industry are measured by dividing their corresponding industry totals by the number of firms in that industry. As explained above, the loss of one industrial plant not only results in a direct loss of economic activity in that particular facility, but also losses of economic activity that ripple across the region. We used ESMI input-output model for the Corpus Christi area to project the alternative measures of total (including direct and secondary) economic impacts.

In addition to new construction, it is also probable that additional permitting and construction costs due to nonattainment will prevent some existing industrial plants from expanding in the future. In this scenario, we assume that the potential loss from firm expansion in a particular industry is equivalent to one-third of the average firm capacity. Our estimated potential losses from firms not expanding represents the low end of the range, while the estimated potential losses from firms relocating elsewhere represents the high end of the range.

The following two tables (Exhibits 5.4 and 5.5) show the low and high annual impact estimates by county due to firm expansion and relocation, respectively. A nonattainment designation for the Corpus Christi metro area would result in potential losses of 657 to 1,970 jobs, $555 million to $1.66 billion in GRP, and $1.3 billion to $4 billion in annual business revenues.

Exhibit 5.4: Low Estimates of Annual Impacts of Average Firm Expansion by Industry

Industry	Employment	Wage Income	GRP	Sales
Oil and Gas Extraction				
Aransas County	0	$36,953	$322,567	$602,291
Nueces County	7	$611,223	$10,264,925	$19,166,437
San Patricio County	1	$110,064	$1,251,025	$2,335,885
MSA Total	**9**	**$758,240**	**$11,838,517**	**$22,104,613**
Petrochemical Manufacturing				
Aransas County	31	$4,047,630	$14,766,935	$35,426,216
Nueces County	513	$66,949,950	$469,921,778	$1,127,353,110
San Patricio County	92	$12,055,820	$57,271,120	$137,394,729
MSA Total	**637**	**$83,053,400**	**$541,959,833**	**$1,300,174,056**
Steel and Pipe Manufacturing				
Aransas County	1	$34,400	$26,893	$53,323
Nueces County	9	$568,993	$855,791	$1,696,868
San Patricio County	2	$102,460	$104,298	$206,804
MSA Total	**11**	**$705,853**	**$986,982**	**$1,956,994**
Area Total				
Aransas County	32	$4,118,983	$15,116,395	$36,081,829
Nueces County	529	$68,130,166	$481,042,494	$1,148,216,415
San Patricio County	95	$12,268,344	$58,626,443	$139,937,418
MSA Total	**657**	**$84,517,493**	**$554,785,332**	**$1,324,235,662**

Exhibit 5.5: High Estimates of Annual Impacts of Average Firm Expansion by Industry

Industry	Employment	Wage Income	GRP	Sales
Oil and Gas Extraction				
Aransas County	1	$110,859	$967,702	$1,806,872
Nueces County	21	$1,833,669	$30,794,774	$57,499,310
San Patricio County	4	$330,193	$3,753,074	$7,007,655
MSA Total	**26**	**$2,274,720**	**$35,515,551**	**$66,313,838**
Petrochemical Manufacturing				
Aransas County	93	$12,142,891	$44,300,806	$106,278,648
Nueces County	1,540	$200,849,850	$1,409,765,334	$3,382,059,331
San Patricio County	277	$36,167,459	$171,813,361	$412,184,188
MSA Total	**1,911**	**$249,160,200**	**$1,625,879,500**	**$3,900,522,167**
Steel and Pipe Manufacturing				
Aransas County	2	$103,200	$80,678	$159,968
Nueces County	26	$1,706,979	$2,567,373	$5,090,604
San Patricio County	5	$307,379	$312,895	$620,411
MSA Total	**32**	**$2,117,559**	**$2,960,946**	**$5,870,983**
Area Total				
Aransas County	96	$12,356,950	$45,349,186	$108,245,488
Nueces County	1,588	$204,390,498	$1,443,127,481	$3,444,649,245
San Patricio County	286	$36,805,031	$175,879,330	$419,812,254
MSA Total	**1,970**	**$253,552,479**	**$1,664,355,997**	**$3,972,706,987**

Costs of Point Source Emission Reductions

An area designated as nonattainment with respect to ozone is required to perform specific types of NOx and VOC emission reductions. In particular, federally funded projects may obtain emission offsets to ensure there is no net increase in emissions for the area. The offset ratios are 1.1 to 1 for marginal nonattainment and 1.15 to 1 for moderate nonattainment (recall Exhibit 3.2).

In Corpus Christi, power plants and petroleum refineries are key industrial sources of ozone precursors. For marginal and moderate ozone nonattainment areas, a major source in the NNSR program is a facility with 100 tons per year (tpy) emissions of ozone precursors. The following exhibit displays the total amount of NOx and VOC emissions from the area's major sources in the electric power and petroleum refining industries (see Exhibit 5.6). The electric power industry includes the Barney M. Davis and Nueces Bay power plants now operated by Talen Energy, and the Calpine's Corpus Christi Energy Center. The petroleum refineries, located in so-called "refinery row" near the Corpus Christi ship channel, are facilities operated by Citgo, Flint Hills Resources and Valero.

Exhibit 5.6: NOx and VOC Emissions of Major Power Plants and Petroleum Refineries in Corpus Christi

	NOx Emissions (TPY)	VOC Emissions (TPY)
Power Plants	703	239
Petroleum Refineries	3,766	2,478
Total	**4,469**	**2,477**

Source: EPA, *Comprehensive Data Collected from the Petroleum Refining Sector*, accessed online at: https://www.epa.gov/stationary-sources-air-pollution/comprehensive-data-collected-petroleum-refining-sector; EPA, *Power Plant Emission Trends*, 2019, accessed online at: https://www.epa.gov/airmarkets/power-plant-emission-trends; and author's estimates.

The cost estimates for air emission reductions in 2020 dollars draw from the EPA's Regulatory Impact Analyses (RIAs). Depending on the emission sources, the average cost of NOx controls ranges between $1,200 to $19,000 per ton, and the average cost of VOC controls ranges between $1,200 to $25,000 per ton. These costs apply to a typical area with the ozone NAAQS of 70 ppb or lower.[18] The estimates are comparable to the historical Emission Reduction Credit Trade Data for the Dallas-Fort Worth area, but they are substantially lower than the trade costs for the Houston-Galveston-Brazoria metro area with fewer trades. As pointed out in Section 3.1, a non-attainment area can meet the "offset"

[18] Environmental Protection Agency, Office of Air Quality Planning and Standards, *Regulatory Impact Analysis of the Final Revisions to the National Ambient Air Quality Standards for Ground- Level Ozone*. September 2015. EPA-452/P-15-007.

requirements by implementing an emissions trading program, as in the Dallas and Houston metro areas.

The following exhibit shows estimates of the annual potential costs of point source emission reductions by county (see Exhibit 5.7). The low and high cost estimates correspond to the low and high ends of EPA estimates for emission control costs.[19] In line with the required offset ratios for ozone nonattainment, estimates for the scenario of marginal nonattainment represent the total costs of an 10% reduction in both NOx and VOC emissions, and estimates for the scenario of moderate nonattainment represent the total costs of a 15% reduction in both NOx and VOC emissions. The distribution of costs across the three counties is proportional to their shares of point source emissions. While most power plants and petroleum refineries are located in Nueces County, the majority of industrial manufacturing plants that has recently been built or under construction are in San Patricio County. These newly developed industrial sites are poised to contribute to major air pollutant sources in the future. In light of locations of these new industrial facilities along with the existing power plants and refineries, the allocations of the emission reduction cost estimates are assumed to be 70% and 30% for Nueces and San Patricio Counties, respectively.

Exhibit 5.7: Annual Potential Costs of Point Source Emission Reductions by County (2020 $)

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Aransas County	$0	$0	$0	$0
Nueces County	$603,591	$10,697,852	$905,387	$16,046,778
San Patricio County	$258,682	$4,584,794	$388,023	$6,877,191
MSA Total	**$862,273**	**$15,282,646**	**$1,293,409**	**$22,923,969**

Overall Impact on Local Industry

The following exhibit summarizes the annual impact on Corpus Christi's local industry associated with projected losses in future firm decisions to expand or relocate in the area as well as operations of existing firms due to a nonattainment designation (see Exhibit 5.7). The range of potential costs on local industry is between $0.56 million and $1.69 million each year. Reductions in economic activity, or GRP, due to a potential loss of industrial construction and expansion

[19] Environmental Protection Agency, *Regulatory Impact Analyses for Air Pollution Regulations: Economic Impact Analyses and Industry Profiles by Sector*. Available online at: https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/regulatory-impact-analyses-air-pollution.

opportunities contribute to the bulk of the nonattainment designation's impacts on Corpus Christi's industry sector.

Exhibit 5.7: Average Annual Potential Costs of Nonattainment on Corpus Christi MSA Industry (2020 $)

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Cost of NNSR Permitting	$186,222	$465,556	$186,299	$465,748
Cost of Industrial Project Delays	$10,111,927	$10,111,927	$10,111,927	$10,111,927
Lost Firm Expansion/Relocation	$554,785,332	$1,664,355,997	$554,785,332	$1,664,355,997
Costs of Point Source Reduction	$862,273	$15,282,646	$1,293,409	$22,923,969
Total	**$565,945,755**	**$1,690,216,126**	**$566,376,968**	**$1,697,857,641**

5.2 Transportation Conformity Costs

From the perspective of transportation conformity, the economic costs of ozone nonattainment arise largely from traffic congestion in the urban area that contributes to ozone as a result of vehicle idling. As indicated in Section 2 above, vehicles are major sources of NOx and VOC emissions. An ozone nonattainment designation would result in additional requirements in terms of environmental assessments for federally funded transportation projects. According to the Capital Area Council of Governments (2015), the additional cost of completing such analyses ranges between $100,000 and $250,000 per project. [20] A lapse in conformity to the federal regulations would result in a loss of federal funding for the area's road works altogether.

The following exhibit is a sample of the major planned road construction projects in Corpus Christi MPO's region, including a proposed new 4-lane regional parkway in the south side of the city of Corpus Christi (see Exhibit 5.8).

Exhibit 5.8 : Major Road Construction Projects in Corpus Christi MPO 2020-2045 MTP

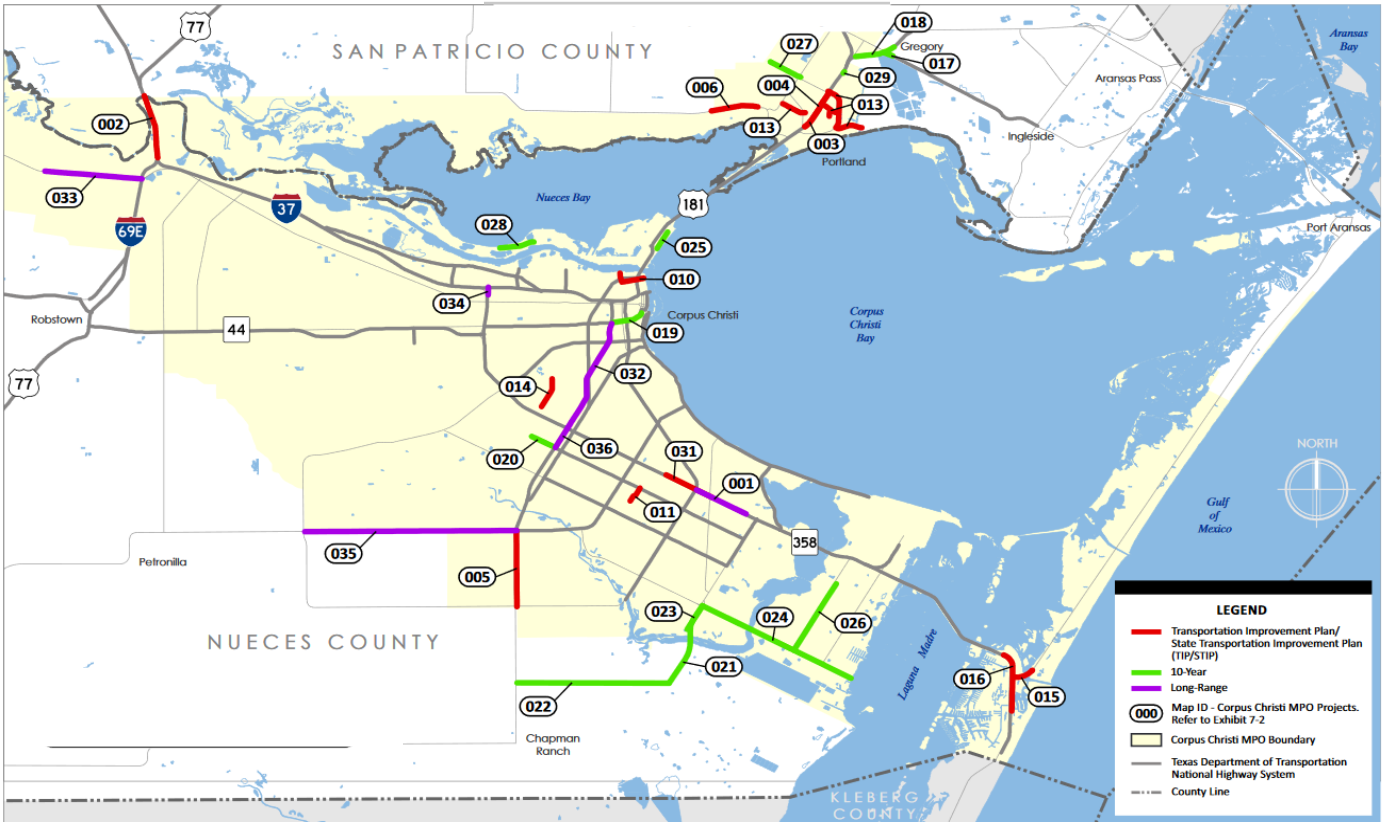
Project Description	Construction Cost
Plan to build a 4-lane regional parkway	$416,608,000
SH 286 (Crosstown) expansion and improvements	$219,916,800
Park Road 22 Improvements	$74,015,004
I-37 Expansion and Improvements	$289,475,200
US 181 Improvements	$123,914,880
Sample Total	**$1,123,929,884**

Source: Corpus Christi Metropolitan Planning Organization, 2020-2045 Metropolitan Transportation Plan (MTP), February 2020.

[20] Capital Area Council of Governments, *The Potential Costs of an Ozone Nonattainment Designation to Central Texas*, September 22, 2015.

The list of road construction and improvement projects in Exhibit 5.8 above is part of the Corpus Christi MPO's 2020-2045 Metropolitan Transportation Plan (MTP) for short- and long-range projects. The following exhibit is a map of these projects (see Exhibit 5.9). The total construction costs of these projects in the 2020-2045 MTP total $1.83 billion.[21]

Exhibit 5.9: Map of Corpus Christi MPO 2020-2045 MTP



These traffic improvement and roadway projects will enhance flows in the Corpus Christi urban area. When one of these projects is completed, the typical travel time will reduce. The time savings for drivers translate into additional time for other activities. Reducing vehicle idling time that would otherwise occur in congestion also results in less air pollution. From these perspectives, potential delays in federally funded road improvement projects due to ozone nonattainment will involve losses in potential economic benefits.

[21] Corpus Christi Metropolitan Planning Organization, *2020-2045 Metropolitan Transportation Plan, Chapter 7: Implementation Plan*. Accessed online at: http://www.corpuschristi-mpo.org/01_mtp.html.

Costs Associated with Road Construction Delays

As for pre-construction delays in building new industrial facilities (see Section 5.1 above), any delay in starting a road improvement or construction project would result in a potential loss of local economic activity or business that relies on a timely completion of that project.

To calculate potential losses due to pre-construction delays in road improvement projects, we draw on a recent study by Texas A&M Transportation Institute (TTI).[22] Exhibit 5.10 below shows estimates of monthly costs of delay based on the sizes of the projects. All of the roadworks shown in Exhibit 5.9 above belong to "large" projects according to the TTI classification. The total economic costs include: (1) direct costs to travelers due to additional travel time, (2) increases in construction costs due to a delay, and (3) impact on economic activity due to a delay.

Exhibit 5.10: Monthly Costs of Road Construction Project Delays (2020 $)

	Small Projects	Large Projects	Total
Project Total Costs	$702,958,429	$1,123,929,884	**$1,826,888,313**
Direct Cost to Travelers per Month	$1,419,313	$1,427,272	**$2,846,585**
Construction Cost Increase per Month	$3,664,668	$14,530,263	**$18,194,931**
Impact on Economic Activity per Month	$665,556	$1,069,053	**$1,734,608**
Total Costs of Delay per Month	**$5,749,537**	**$17,026,588**	**$22,776,125**

Sources: Beaty et al. (2015), and author's calculations.

According to the TTI's 2019 *Urban Mobility Report*, the average "economic" value of time for Corpus Christi travelers is $18.12 per hour.[23] From the perspective of all future projects in the Corpus Christi MPO's 2020-2045 MTP, a one-month delay would result in a total of slightly less than $3 million worth of local traveling time per month.

The TTI estimates that each month of pre-construction delay in road projects results in a 0.5% increase in construction costs for small projects and a 1.3% increase for large projects. Accordingly, construction costs are projected to

[22] Curtis Beaty, David Ellis, Brianne Glover, and Bill Stockton, *Assessing the Costs Attributed to Project Delay During Project Pre-Construction Stages*, Texas A&M Transportation Institute, March 2016.

[23] Texas A&M Transportation Institute, Urban Mobility Report, 2019. Accessed online at: https://tti.tamu.edu/conferences/tsc11/program/presentations/construction-2/ellis.pdf.

increase by $17 million if all those planned road projects for Corpus Christi are delayed by one month.

The last type of economic costs due to road construction delay is the indirect impact on local economic activity. Any delay in roadworks necessarily means a delay in employing construction workers. Other economic costs are associated with excess fuel consumed and additional CO2 emissions due to vehicle idling during traffic congestion that likely occurs before the construction project is complete. The EPA estimates 8.887 grams of CO2 emissions from a gallon of gasoline consumption and $40 per ton of pollution cost.[24] According to the U.S. Office of Management and Budget, $1 in reduced air emissions from mobile sources would generate $9 in economic benefits.[25] This ratio can also be interpreted as the potential costs of any delay in road improvement projects.

The following exhibit lists the total economic impact on the three individual counties in the metro area (see Exhibit 5.11). Following the San Antonio report, we assume that transportation conformity analyses under the alternative marginal and moderate nonattainment designations would respectively result in 2-year and 3-year delays in federally funded road projects. Accordingly, we multiply the corresponding monthly economic costs due to road project delays by 24 and 36 to arrive at the respective 2-year and 3-year cumulative estimates. The total impact also includes the costs of conducting transportation conformity analyses. Given the five major projects listed in Exhibit 5.9 above, the low estimates are based on a cost of $100,000 per conformity analysis and the high estimates are based on a cost of $250,000 per conformity analysis.

Exhibit 5.11: Cumulative Total of Reduced GRP due to Transportation Conformity by County (2020 $)

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Aransas County	$700,547	$701,507	$1,050,500	$1,051,460
Nueces County	$393,006,713	$393,545,446	$589,330,493	$589,869,225
San Patricio County	$153,419,733	$153,630,040	$230,059,497	$230,269,804
MSA Total	**$547,126,993**	**$547,876,993**	**$820,440,490**	**$821,190,490**

[24] Environmental Protection Agency, Greenhouse Gas Emissions from a Typical Passenger Vehicle. Available online at: https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle.

[25] Capital Area Council of Governments, *The Potential Costs of an Ozone Nonattainment Designation to Central Texas*, September 2015.

The *cumulative* impact on the metro area economy over the entire study period is projected to exceed $547 million for marginal nonattainment and $820 million for moderate nonattainment. The distribution of estimated reductions in GRP among the three counties is proportional to the counties' shares of area-wide road construction employment.

5.3 Vehicle Inspection and Repair Costs

An area of moderate nonattainment is required to implement the basic vehicle inspection and maintenance (I/M) program. In this program, vehicles that are 2 to 24 years old with light or medium duty engines are required to get an on-board diagnostic emission inspection each year. In Texas, the current inspection fees are between $11.5 per vehicle in El Paso and $18.5 in the Dallas-Fort Worth and Houston areas.

The following exhibit shows the average annual reductions in GRP due to the vehicle inspection requirement (see Exhibit 5.12). To arrive at the estimates in the table, we first collected data on the total number of registered vehicles in each county from the Texas Department of Motor Vehicles. Next, we extrapolated those numbers with a projected population growth rate of 1% per year for the next 30 years (the window of this study). Assuming the inspection fees to remain the same for the entire 30-year period, the low estimates correspond to $11.5 per vehicle and the high estimates correspond to $18.5 per vehicle.

The total impact on the local economies in terms of RGP includes the multiplier, or spillover, effects on local economic activity associated with corresponding reductions in households' disposable income for purchasing other local goods and services after paying for vehicle inspections. The EMSI input-output models for the individual counties are used to project the multiplier effects due to corresponding reductions in household disposable incomes.

Exhibit 5.12 Annual Lost GRP due to Inspection Fees by County Under Moderate Nonattainment (2020 $)

	Low Estimate	High Estimate
Aransas County	$393,836	$633,563
Nueces County	$4,348,630	$6,995,622
San Patricio County	$1,027,218	$1,652,481
MSA Total	**$5,769,684**	**$9,281,666**

As shown in the above exhibit, the requirement for vehicle inspections in the Corpus Christi metro area would result in a reduction in GRP between $5.8 million and $9.3 million each year. According to the historical data of Dallas-Fort Worth and Houston areas, about 4% of vehicles fail initial inspections and the typical repair cost of those vehicles was between $200 and $300 per vehicle. For the Corpus Christi metro area, this would result in about $4.4 million annually in repair costs due to inspections. However, such costs are not included in this report because vehicle repairs represent economic activity and thus income transfers from vehicle owners to auto repair shops.

5.4 Educational and Outreach Programs

As indicated above, the Coastal Bend Air Quality Partnership is at the forefront to address NAAQS ozone attainment issues for the Corpus Christi metro area. Participants in this group include municipal and county government agencies in the area, the Port Authority and port industry, the MPO, universities, the military sector, and the news media across the region.

One strategy spearheaded by this alliance is participation in the EPA's Ozone Advance Program. Through this program, a diverse group of local community stakeholders have been participating in the following Path Forward activities:[26]

- Air quality education and outreach programs
- Grade school air quality curricula
- Additional air quality monitoring and research with CAMS 660, CMAS 664, and CMAS 685 (recently discontinued)
- Pollution Prevention Partnership's Clean Fleet program for voluntary vehicle emission testing and repairs (AutoCheck)
- Detection of fugitive emissions by infrared cameras
- Corpus Christi Army Depot Ozone Action Day for pollution reduction and prevention actions
- Operation of public use Compressed Natural Gas (CNG) fueling facilities
- RTA's replacement of the existing fleet with CNG and electric vehicles
- MPO's bicycle mobility planning in roadway projects
- Bike Share program in Corpus Christi downtown
- RTA Van Share and community shuttle programs
- Local home builders' Coastal Bend GreenBuilt initiative for "green" building

[26] Corpus Christi Air Quality Group, *Corpus Christi Urban Airshed Annual Ozone Advance Report*, May 2019.

An ozone nonattainment designation would necessitate more promotion and outreach activities beyond those in the existing Ozone Advance Program. Its total budget, which includes costs for vehicle emission reductions and air monitoring programs, currently exceeds $200,000 annually. The following exhibit lists estimates for the average additional annual costs of air quality educational and outreach programs by county (see Exhibit 5.13). As discussed above, such educational and outreach activities represent economic "costs" in the sense that their associated resources might otherwise be allocated to other economic activities, including leisure, if air quality is not a critical community issue.

Exhibit 5.13: Costs of Additional Educational Programs by County per Year (2020 $)

	Marginal Nonattainment	Moderate Nonattainment
Aransas County	$6,061	$12,820
Nueces County	$92,293	$195,200
San Patricio County	$17,042	$36,044
MSA Total	**$115,397**	**$244,064**

The estimates for moderate nonattainment are based on a per capita cost of $0.48, which is the inflation-adjusted per capita cost of $0.45 for the Commute Solutions programs in the Houston metro area in 2016, as funded by the Texas Department of Transportation (TxDOT). The projected cost for each county in a given year equals the projected local population of that year times the per capita cost. Consistent with historical trends, we assume a 1% population growth rate per year for each of the three counties. Under the moderate nonattainment designation, the Corpus Christi metro area would potentially incur an additional $244,064 each year in air quality educational programs. This amount exceeds the total costs of major programs currently conducted by the Coastal Bend Air Quality Partnership participants.

The Houston area has been in moderate nonattainment. For the hypothetical scenario of marginal nonattainment designation, we follow the San Antonio study and assume the additional educational costs to be half of the full projected costs for moderate nonattainment. Over the period of marginal nonattainment, the Corpus Christi metro area is projected to incur $115,397 each year in air quality educational programs, or more than half of the current budget of the Coastal Bend Air Quality Partnership programs.

5.5 Costs of Voluntary Control Measures

Under the Texas Emissions Reduction Plan (TERP), communities can apply for funding to pay for programs that reduce emissions from vehicles in the area. These programs include the Diesel Emission Reduction Incentive (DERI), Texas Clean Fleet (TCFP) Program, Texas Natural Gas Vehicle Grant Program (TNGVGP), and Drayage Truck Incentive Program (DTIP).

The following exhibit lists the two TERP programs in which Corpus Christi has participated and the average annual amount of grants the area received over the 2001-2018 period. According to the TCEQ, the area received an annual average of slightly less than $500,000 through the DERI program and about $18,000 through the TNVGP program.[27]

Exhibit 5.14: TERP Programs for Corpus Christi, 2001-2018

	Annual Average
Diesel Emissions Reduction Incentive Program	$546,385
Texas Clean Fleet Program	—
Texas Natural Gas Vehicle Grant Program	$18,189
Drayage Truck Incentive Program	—
TERP Programs Total	**$564,575**

Source: TCEQ, *Texas Emissions Reduction Plan, Biennial Report (2017-2018),* December 2018.

We assume that the Corpus Christi community will continue to participate in these programs and receive funding for the same amounts (2020 dollars) on average every year. However, these programs have covered only two of the three counties of the metro area. Under a nonattainment designation, we assume Aransas County will begin participating in these programs along with the other two counties. The projected costs of those two TERP programs for Aransas County in the future are calculated as the projected county population (see Section 5.4 above) times the per capita estimates of the program total costs listed in Exhibit 5.14 above.

The following exhibit lists the additional costs of the TERP programs cumulated over the entire windows of marginal and moderate nonattainment designation, respectively (see exhibit 5.15). In total, a nonattainment designation would potentially result more than $800,000 in costs for the area beyond the existing TERP programs.

[27] Texas Commission on Environmental Quality, *Texas Emissions Reduction Plan, Biennial Report (2017-2018),* December 2018.

Exhibit 5.15: Cumulative Additional Costs of TERP Programs by County (2020 $)

	Marginal Nonattainment	Moderate Nonattainment
Aransas County	$800,692	$889,658
Nueces County	—	—
San Patricio County	—	—
MSA Total	**$800,692**	**$889,658**

6. OVERALL FINDINGS

6.1 Overall Economic Losses

We have estimated the potential costs of an ozone nonattainment designation for Corpus Christi in terms of the local economic impacts from potential losses of industry expansion, delays in construction projects, including industrial projects and federally funded road works, additional vehicle inspection costs, additional educational and outreach program costs, and additional costs of voluntary emission control measures. It is important to note that these costs affect not only businesses, both big and small, but also individuals within the nonattainment community.

The following exhibit summarizes the annual average of potential economic costs of nonattainment for the Corpus Christi metro area (see Exhibit 6.1). In total, the area is projected to incur a total economic loss between $586 million and $1.7 billion annually, depending on different hypothetical scenarios of nonattainment and cost assumptions. The low range of the cost estimates is equivalent to 2.4% of the metro area GRP, and the high range of the cost estimates is equivalent to 7.1% of the metro area GRP.

Exhibit 6.1: Average Annual Potential Costs of Nonattainment in the Corpus Christi MSA (2020 $)

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Impact on Local Industry	$565,945,755	$1,690,216,126	$566,376,968	$1,697,857,641
Losses due to Road Construction Delays	$20,263,963	$20,291,740	$27,348,016	$27,373,016
Vehicle Inspection Costs	–	–	$5,769,684	$9,281,666
Educational/Outreach Program Costs	$123,474	$123,474	$261,148	$261,148
Costs of Voluntary Control Measures	$29,655	$29,655	$29,655	$29,655
Total	**$586,362,847**	**$1,710,660,996**	**$599,785,472**	**$1,734,803,126**

Within the Corpus Christi metro area, Nueces County is the most populated county with nearly 80% of the regional population. This county is projected to incur between $0.5 billion and roughly $1.5 billion each year if the metro area as a whole receives an ozone nonattainment designation.

For each of three counties in the metro area, the following exhibit displays the corresponding annual cost estimates per capita by dividing the total cost estimates for the county by its projected average county population over the period of study. The estimates essentially represent the burden on each local resident should the metro area fails to maintain the ozone attainment status.

Exhibit 6.2: Average Annual Potential Costs of Nonattainment per County Resident (2020 $)

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Aransas County	$560	$1,655	$575	$1,679
Nueces County	$1,201	$3,514	$1,225	$3,555
San Patricio County	$846	$2,413	$887	$2,490
MSA	**$1,115**	**$3,253**	**$1,141**	**$3,299**

According to Exhibit 6.2 above, the burden from the nonattainment designation is the highest for residents in Nueces County due in part to the county's relatively more employment and business opportunities that might potentially be lost. However, even though most existing industrial activity that contributes to major air pollution sources occurs in Nueces and San Patricio Counties, a typical resident in Aransas County would still experience economic losses between $560 and $1,679 each year.

Our analyses cover a period of 27 years in the case of marginal nonattainment designation, and 30 years in the case of moderate nonattainment. For the Corpus Christi metro area as a whole, the projected cumulative costs therefore amount to $16 billion-$46 billion under marginal nonattainment, and $18 billion-$52 billion under moderate nonattainment.

6.2 Comparisons with Other Areas

While our cost measures seem significant in comparison of the size of the Corpus Christi economy, it is instructive to compare such estimates with those in the corresponding studies for San Antonio and Austin metro areas. The following exhibits lists the estimates for San Antonio corresponding to our broad classifications (see Exhibit 6.3).[28]

Exhibit 6.3: Average Annual Potential Costs of Nonattainment in the San Antonio MSA

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Impact on Local Industry	$95,302,311	$997,059,928	$95,094,903	$996,763,631
Losses due to Road Construction Delays	$21,133,273	$21,133,273	$28,529,919	$28,529,919
Vehicle Inspection Costs	–	–	$112,533,112	$181,031,510
Educational/Outreach Program Costs	$545,755	$545,755	$1,108,899	$1,108,899
Costs of Voluntary Control Measures	$318,460	$318,460	$318,460	$318,460
Total	**$117,299,799**	**$1,019,057,416**	**$237,585,294**	**$1,207,752,419**

[28] Nivin, Steve, Belinda Roman, and David Turner, *Potential Cost of Nonattainment in the San Antonio Metropolitan Area*, study conducted for Alamo Area Council of Governments, February 21, 2017.

For the Austin study, there are no estimates for costs associated with vehicle inspection, educational programs, and voluntary control measures. On the other hand, there are more detailed costs associated with general conformity requirements.[29]

Exhibit 6.4: Average Annual Potential Costs of Nonattainment in the Austin-Round Rock MSA

	Marginal/Moderate Nonattainment	
	Low Estimate	**High Estimate**
Impact on Local Industry	$806,604,694	$1,375,725,114
General & Transportation Conformity Costs	$3,379,474	$9,179,770
Vehicle Inspection Costs	–	–
Educational/Outreach Program Costs	–	–
Costs of Voluntary Control Measures	–	–
Total	**$809,984,168**	**$1,384,904,884**

There are two major observations in comparing the cost estimates across the three metro areas. First, even though the current size of population in the Corpus Christi metro area is less than 20% of that in the San Antonio metro area, the estimated annual economic impact from nonattainment is higher in Corpus Christi than in San Antonio. By comparison, the Austin-Round Rock metro area is projected to incur the highest overall economic cost that are nearly seven times of its San Antonio counterpart, despite a similar population size.

Second, estimates for the economic consequences from potential losses of firm expansion or relocation dominate variations in estimated economic impacts across the three metro areas. In the case of the Austin-Round Rock metro area in Central Texas, the report considers the potential impact of a nonattainment designation on prospective capital investments, such as an expansion for the existing Samsung semiconductor manufacturing facility in Travis County. According to the report, forgiving this capital investment project alone would result in a cumulative economic impact up to $3.7 billion.

Likewise, given the outsized economic significance of recent growth in the industrial manufacturing sector to Corpus Christi, the region's "opportunity" costs of potential firm expansion and relocation are expected to be substantial as well. Our estimates based on the average-sized firms in various industries today generate only conservative projections. Still, as a result of the relative size of the industrial sector in Corpus Christi that is similar to that in Austin, our estimates for the impact on local industry and thus the overall economic consequences of

[29] Capital Area Council of Governments, *The Potential Costs of an Ozone Nonattainment Designation to Central Texas*, September 22, 2015.

nonattainment are much more comparable to the corresponding estimates for Austin than for San Antonio. The corresponding estimates for potential economic losses in Corpus Christi would even be greater should we instead consider the possibility of losing any of the newly built manufacturing plants near the Port of Corpus Christi, including the ExxonMobil plastics plant and the Steel Dynamics facility currently under construction.

One drawback of all these related studies is the high level of uncertainty involving the projections for the potential economic losses from firms' decision to expand or build a new facility in an area. From this perspective, we follow the San Antonio study and focus on the "hard" costs of nonattainment alternatively. These "hard" costs, which can be estimated with high levels of confidence, consist of the costs of nonattainment new source review (NNSR) permitting, the impact on local economic activity due to industrial construction project delays and road construction delays, as well as losses associated with the requirement for vehicle inspection. The costs of NNSR permitting and losses due to industrial project delays are parts of the estimated impact on local industry (section 5.1). The estimated losses from road construction delays and vehicle inspection represent costs related to transportation conformity (section 5.2).

Exhibit 6.5: Average Annual Potential "Hard" Costs of Nonattainment in the Corpus Christi MSA (2020 $)

	Marginal Nonattainment		Moderate Nonattainment	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Cost of NNSR Permitting	$186,222	$465,556	$186,299	$465,748
Cost of Industrial Project Delays	$10,111,927	$10,111,927	$10,111,927	$10,111,927
Losses due to Road Construction Delays	$20,263,963	$20,291,740	$27,348,016	$27,373,016
Vehicle Inspection Costs	$0	$0	$5,769,684	$9,281,666
Total	**$30,562,112**	**$30,869,223**	**$43,415,927**	**$47,232,357**

With a focus on the "hard" costs, a nonattainment designation for the Corpus Christi metro area is projected to generate an annual impact of $30 million–$47 million. While the cost estimates in total are substantially smaller than the corresponding overall estimates in Exhibit 6.1 above, they nevertheless highlight the importance, or economic benefits, of maintaining clean air quality to local residents.

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