APPENDIX C

AIR QUALITY AND CLIMATE

This appendix contains the following:

- Air Quality Methodology 8/1/2022
- NCDAQ concurrence on Methodology (email 08/1/22)
- Coordination and concurrence on Methodology from EPA (email 08/8/22)
- Air Quality and Climate Technical Report

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Landrum & Brown, Incorporated
4445 Lake Forest Dr. Suite 700
Cincinnati, Ohio 45242
513.530.5333

memorandum

Project: Raleigh-Durham International Airport (RDU)
Proposed Runway 5L/23R Replacement Project

To: Michael Lamprecht and Jackie Sweatt-Essick, FAA

From: Gaby Elizondo, Landrum and Brown

Cc: Chris Babb

Date: August 1, 2022

Subject: Air Quality Methodology

This memorandum describes the overall approach and methods to conduct an air quality analysis to demonstrate compliance to the National Environmental Policy Act (NEPA) for the Proposed Runway 5L/23R Replacement Project at the Raleigh-Durham International Airport (RDU). It is intended that this memorandum be coordinated with the U.S. Environmental Protection Agency (USEPA) and the North Carolina Division of Air Quality in an effort to obtain concurrence on procedure and methodology prior to the publication of the anticipated NEPA Environmental Assessment (EA).

The Proposed Action includes relocating Runway 5L/23R west of existing Runway 5L/23R and, after construction is complete, converting the existing Runway 5L/23R to a taxiway. The project also includes use of fill material from Airport borrow sites, use of water from Brier Creek Reservoir, construction of drainage improvements, relocation of a portion of Lumley Road, utility relocations, demolition of four buildings, relocation of aircraft navigational aids, acquisition of property, and removal and/or mitigation of obstacles in accordance with Federal Aviation Administration (FAA) safety standards.

The overall approach to conducting the air quality analysis follows FAA guidelines for preparing NEPA documents, which includes FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures (including the Desk Reference);* FAA Order 5050.4B, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions*; and FAA's *Aviation Emissions and Air Quality Handbook Version 3 Update 1.* In accordance with these orders and guidance documents, the overall approach and goal of the air quality impact analysis is to meet the requirements of NEPA and the Clean Air Act (CAA).

> NEPA: Compliance with NEPA is accomplished by disclosing the potential emissions associated with the Proposed Action. This includes preparation of emission inventories of both construction activities and operational conditions for the Proposed Action, any development alternatives, and the No Action Alternative.
>
> CAA: The CAA requires that project emissions do not cause or contribute to violations of the NAAQS. In nonattainment and maintenance areas, a project's compliance with this requirement can be demonstrated by showing that the project emissions are *de minimis* or that they conform to the State Implementation Plan (SIP) for achieving and maintaining the NAAQS.

The air quality analysis will include an evaluation of potentially affected operational activities for the Existing Conditions (2020); and the Proposed Action and the No Action Alternative for the projected future conditions in 2028 and 2033. The year 2028 was selected because it represents the projected opening year of the proposed runway replacement. In addition, 2033 is used as a basis for analysis, because it represents a condition five years beyond the proposed runway replacement opening year and the periods in between contain construction activities with the demolition of the existing runway and construction of the taxiway. The air quality analysis will also include

Landrum & Brown, Incorporated
4445 Lake Forest Dr. Suite 700
Cincinnati, Ohio 45242
513.530.5333

an evaluation of potential impacts associated with construction activity from 2023 through 2030. In order to report the project's total annual incremental emissions over the entire period of construction, operational emissions will also be reported for the years 2029 and 2030. As a conservative approach, it is assumed aviation activity levels in 2029 and 2030 would not exceed those for 2033. Therefore, for the purpose of this analysis, the 2033 LTOs would be used to estimate operational emissions for 2029 and 2030. Total annual emissions for 2029 and 2030 would include construction activity for that year and operational emissions based on 2033 LTOs.

An emissions inventory will be developed to summarize the total pollutants generated by all active emissions sources that may be affected by the Proposed Action. The emissions inventory will provide the total annual pollutant emissions as tons per year for each analysis year. During the Existing Conditions (2020), the number of aircraft operations at RDU decreased dramatically as compared to the number of aircraft operations in 2019 due to the impacts to aviation associated with the COVID-19 public health emergency. Therefore, the Existing Conditions (2020) are anticipated to be lower than those of normal conditions. However, the Existing Conditions (2020) will be provided for background and context only. The potential emissions due to the implementation of the Proposed Action will be compared to those for the No Action Alternative to disclose the potential increase in emissions caused by the Proposed Action.

Federal Attainment Status

The Airport's location is within North Carolina's Eastern Piedmont Intrastate Air Quality Control Region.[1] The area was previously designated nonattainment for the 1971 standard for carbon monoxide (CO) and was designated in attainment effective September 18, 1995.[2] Additionally, the USEPA has classified Durham and Wake Counties as attainment for CO effective September 18, 2015, ending conformity requirements for CO; therefore, no *de minimis* threshold will be applied for this pollutant in the air quality analysis.[3] The area was designated as nonattainment for the 1997 8-hour ozone standard; however, on December 26, 2007, the USEPA determined the area had reached the 1997 8-hour ozone standard and the region was redesignated to maintenance for these pollutants. As such, the area operates under a maintenance plan for 8-hour ozone.[4] Even though the standard was removed in 2015, the maintenance plan remains in effect and contains future year emissions budgets under which the maintenance area can demonstrate that timely attainment of NAAQS will be achieved. Furthermore, the area is currently in attainment for the 8-hour 2008 and 2015 ozone standards. Regardless, the area continues to operate under the maintenance plan for the 8-hour 1997 ozone standard. For the purpose of this study, the federal *de minimis* threshold for ozone will be applied in the air quality analysis.

Pollutants of Concern

As stated above, Wake and Durham counties operate under a maintenance plan for ozone and are in attainment for all other criteria pollutants. The ozone precursor pollutants are volatile organic compounds (VOCs) and nitrogen oxides (NO_x); as such, the only pollutants of concern for this project are VOCs and NO_x. The applicable federal *de minimis* thresholds for this project are 100 tons per year for each of these pollutants. For this analysis, the pollutants of concern will be compared against the federal *de minimis* thresholds to determine if the Proposed Action would conform to the SIP and the CAA or would create any new violation of the NAAQS, delay the attainment of any NAAQS, or increase the frequency or severity of any existing violations of the NAAQS. The

1 Title 40 Protection of the Environment. Code of Federal Regulations (CFR). Chapter 1, Subchapter C, Part 81 Subpart B §81.148 Eastern Piedmont Intrastate Air Quality Control Region.

2 Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants, USEPA Green Book, January 31, 2022. Available on-line: https://www3.epa.gov/airquality/greenbook/anayo_nc.html

3 Letter from the USEPA Region 4 Air, Pesticides, and Toxics Management Division to the Durham-Chapel Hill Carrboro Metropolitan Planning Organization and the Capital Area Metropolitan Planning Organization.

4 Limited Maintenance Plan for the Great Smoky Mountains National Park, Rocky Mount, & Triangle Maintenance Areas for the 1997 8-Hour Ozone NAAQS, North Carolina Department of Environmental Quality, February 2022, Available on-line: https://deq.nc.gov/about/divisions/air-quality/air-quality-planning/state-implementation-plans-sips/limited-maintenance-plan-great-smoky-mountains-national-park-rocky-mount-triangle-maintenance-areas

emissions inventories prepared for the air quality analysis will also provide the emissions estimates for CO, SO_x, PM_{10}, and $PM_{2.5}$ for disclosures purposes only.

Potentially Affected Sources of Emissions

The following sources of emissions will be included in this analysis.

- Aircraft
    - Landing and Takeoff Cycles (Engine Start-Up, Approach, Climb, and Taxi)
- Motor Vehicles
    - Vehicles that may be affected by the relocation of Lumley Road
- Construction Activity
    - On-road activity including construction employee vehicle trips and material delivery/hauling trips
    - Off-road activity including use of construction and demolition equipment such as excavators, graders, and pavers
    - Fugitive dust generated during demolition and construction as well as during clearing and grading activities

Aircraft engine ground run-ups are routine aircraft engine maintenance tests performed to test engines and diagnose engine issues. There would be no change to aircraft engine ground run-ups due to the Proposed Action. The larger jet aircraft use auxiliary power units (APUs) while at the gate to operate the heating, air conditioning, and electric systems. The APUs are also used to 'start up' or restart the aircraft engines before departing from the gate area. Neither the Proposed Action nor the No Action Alternative would affect APU emissions and therefore will not be included in this analysis. In addition, neither the Proposed Action nor the No Action Alternative would affect any natural gas boilers, diesel generators, fuel farms tanks referred to as stationary sources, or the ground support equipment (GSE), such as baggage tractors, belt loaders, catering vehicles, and emergency vehicles, and therefore will not be included in this analysis.

Models to be used in the Analysis

Emissions will be evaluated using the FAA's Aviation Environmental Design Tool (AEDT) Version 3d.[5] AEDT models aircraft performance in space and time to estimate fuel consumption, air quality emissions, and noise consequences at airports. Emission factors for on-road and off-road motor vehicles will be derived from the USEPA's Motor Vehicle Emissions Simulator (MOVES) model version 3. MOVES is an emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants, greenhouse gases, and hazardous air pollutants. The type of construction equipment and potential usage estimates for the project will be developed using the Airport Construction Emissions Inventory Tool (ACEIT). The ACEIT was developed by the Transportation Research Board (TRB) to assist airports and other stakeholders in developing airport construction emissions inventories.

Lead Emissions

Since 1975, lead emissions have been in decline due in part to the introduction of catalyst-equipped vehicles and decline in production of leaded gasoline. The chief source of lead emissions at airports would be the combustion of leaded aviation gasoline (Avgas) in small piston engine general aviation aircraft. Lead is not an ingredient in Jet A fuels that power large commercial service aircraft. In general, an analysis of lead is limited to projects that emit significant quantities of the pollutant (i.e., lead smelters). Some active general aviation airports prepare lead

5 Per FAA memorandum dated September 27, 2017, Guidance on determining which version of the Aviation Environmental Design Tool (AEDT) to use for FAA actions and studies, "The current version of AEDT is required for all noise, fuel burn and emissions modeling for FAA actions where the environmental analysis is initiated on or after the version release date. As noted in the Federal Register and FAA Order 1050.1F, the required model version is the one in effect at the time the "environmental analysis process is underway." AEDT version 3d was the version when this EA was initiated.

Landrum & Brown, Incorporated
4445 Lake Forest Dr. Suite 700
Cincinnati, Ohio 45242
513.530.5333

emissions inventories due to the large quantity of Avgas used. However, a lead inventory analysis will not be conducted as part of this air quality analysis as this project does not include any elements that emits significant quantities of lead and lead is not a criteria pollutant of concern.

Hazardous Air Pollutants

Per FAA guidance, a hazardous air pollutant (HAP) emissions inventory should be considered if the Proposed Action is considered “major” (e.g., new airport, new runway, major runway extension, etc.); if the Proposed Action is located in a nonattainment or maintenance area; and/or if a criteria pollutant emissions inventory is also prepared. Because the Proposed Action includes the construction of a new replacement runway and is located in a maintenance area, a HAPS emissions inventory will be conducted for this air quality analysis. Operational HAPS emissions would be modeled for aircraft and motor vehicles. HAPS from aircraft would be developed using AEDT and HAPS from motor vehicles would be estimated using MOVES3.However, the results will only be provided for disclosure purposes as there are currently no federal standards specifically pertaining to HAPs emissions from aircraft engines or airports.

From:	Bollman, Andrew D
To:	Chris Babb
Cc:	Strait, Randy P; Manning, Tammy; Hartsfield, Taylor; Michael.Lamprecht@faa.gov; jackie.sweatt-essick@faa.gov; kenneth.perry@rdu.com; 5L23REnvoAssessment@rdu.com; Gaby Elizondo
Subject:	RE: [External] RE: RDU EA Air Quality Methodology
Date:	Monday, August 1, 2022 4:34:39 PM

Hi Chris,
Use of 2033 LTO data is a reasonable (and conservative) approach. The DAQ concurs with the updated methodology. Please let me know if you need anything further from us.

Thanks,
Andy

Andy Bollman
Environmental Program Consultant, Division of Air Quality
North Carolina Department of Environmental Quality
919.707.8499 (Office)
919.797.6312 (Mobile)
Andrew.Bollman@ncdenr.gov

From: Chris Babb <Chris.Babb@landrumbrown.com>
Sent: Monday, August 1, 2022 4:07 PM
To: Bollman, Andrew D <andrew.bollman@ncdenr.gov>
Cc: Strait, Randy P <randy.strait@ncdenr.gov>; Manning, Tammy <tammy.manning@ncdenr.gov>; Hartsfield, Taylor <taylor.hartsfield@ncdenr.gov>; Michael.Lamprecht@faa.gov; jackie.sweatt-essick@faa.gov; kenneth.perry@rdu.com; 5L23REnvoAssessment@rdu.com; Gaby Elizondo <Gaby.Elizondo@landrumbrown.com>
Subject: [External] RE: RDU EA Air Quality Methodology

Hello,

Thanks for the comments. We have revised the methodology (attached). We can use the 2033 LTO emissions estimates for 2029 and 2030 as a conservative approach. It is not anticipated that aircraft operations in 2029 or 2030 would exceed that of 2033. Please review and let us know if you concur with the overall approach or if you have additional comments. We have provided the methodology to EPA and have received their concurrence (also attached).

Thanks again,

Chris Babb
Senior Managing Consultant

Landrum & Brown
Global Aviation Planning & Development
T +1 513 530 1275   M +1 513 560 1242
landrumbrown.com

From: Bollman, Andrew D <andrew.bollman@ncdenr.gov>
Sent: Thursday, July 28, 2022 11:28 AM
To: Chris Babb <Chris.Babb@landrumbrown.com>
Cc: Strait, Randy P <randy.strait@ncdenr.gov>; Manning, Tammy <tammy.manning@ncdenr.gov>; Hartsfield, Taylor <taylor.hartsfield@ncdenr.gov>; Michael.Lamprecht@faa.gov; jackie.sweatt-essick@faa.gov; kenneth.perry@rdu.com; 5L23REnvoAssessment@rdu.com
Subject: RDU EA Air Quality Methodology

Hi Chris,
My name is Andy Bollman of North Carolina's Division of Air Quality (DAQ), and I will be responding to the July 7th email you sent to Taylor Hartsfield requesting concurrence on the attached proposed methodology to perform an air quality analysis for the 5L/23R Replacement Project Environmental Assessment. My response is specific to the proposed methods with respect to compliance with General Conformity requirements as the DAQ is not responsible for performing National Environmental Policy Act (NEPA) reviews.

The DAQ appreciates the opportunity for reviewing the proposed approach and finds that it is a robust methodology that generally meets, and even exceeds, General Conformity requirements (e.g., by including estimation of emissions for pollutants beyond those required). As discussed in the attachment, General Conformity can be demonstrated by showing that the project's emissions are *de minimis,* and given the location of this project, such demonstration would need to show that the project's incremental emissions will not exceed *de minimis* thresholds of 100 tons per year for either volatile organic compounds (VOCs) or nitrogen oxides (NO_x). Our main concern with the methodology is that it appears that the potential for increased aircraft emissions (associated with landing and take-off operations) will only be estimated for two years: 2028 and 2033, while the project's construction emissions will be computed for each year of construction activity (2023-2030). The DAQ's interpretation of Federal General Conformity requirements is that it is necessary to determine the project's <u>total</u> annual incremental emissions over the entire period of construction activity. This would imply a need to have estimates of incremental aircraft VOC and NOx emissions (if any) for each relevant year over the 2023-2030 construction period. From the project background, it appears that this specifically refers to the need to estimate aircraft emissions in 2028-2030 given that 2028 is the projected opening year of the runway replacement. If your understanding contradicts this interpretation, please let us know and we can confirm with EPA how they interpret the requirement for estimating aircraft emissions. If you agree that such emission estimates are needed, then the DAQ suggests that it may be possible to simplify the estimation procedure for additional years. Perhaps it is possible to document that there will be no change in LTOs between 2028 and 2030, or if not, apply total LTO estimates for 2029 and 2030 to interpolated NOx and VOC emission rates for these years from the 2028 and 2033 Aviation Environmental Design Tool (AEDT) results?

Please let us know your response to the DAQ's request for the additional years of annual aircraft VOC and NOx emission estimates. If you have any additional questions, please let me know this as well. The DAQ looks forward to working with you to determine the project's compliance with General Conformity requirements.

Thanks,
Andy Bollman

Andy Bollman
Environmental Program Consultant, Division of Air Quality
North Carolina Department of Environmental Quality
919.707.8499 (Office)
919.797.6312 (Mobile)
Andrew.Bollman@ncdenr.gov

From:	White, Douglas
To:	Chris Babb
Cc:	Michael.Lamprecht@faa.gov; jackie.sweatt-essick@faa.gov; Perry, Kenneth; 5l23REnvoAssessment; Somerville, Amanetta; Kajumba, Ntale; Gaby Elizondo; Dean, Kenneth
Subject:	RE: RDU EA Air Quality Methodology
Date:	Monday, August 8, 2022 6:25:10 PM

Hi Chris,

I concur with the revisions.

V/R

Douglas White
U.S. Environmental Protection Agency / Region 4
Strategic Programs Office / NEPA Section
61 Forsyth Street, SW
Atlanta, GA 30303-8960
404-562-8586

From: Chris Babb <Chris.Babb@landrumbrown.com>
Sent: Monday, August 8, 2022 2:01 PM
To: White, Douglas <White.Douglas@epa.gov>
Cc: Michael.Lamprecht@faa.gov; jackie.sweatt-essick@faa.gov; Perry, Kenneth <kenneth.perry@rdu.com>; 5l23REnvoAssessment <5L23REnvoAssessment@rdu.com>; Somerville, Amanetta <Somerville.Amanetta@epa.gov>; Kajumba, Ntale <Kajumba.Ntale@epa.gov>; Gaby Elizondo <Gaby.Elizondo@landrumbrown.com>
Subject: RE: RDU EA Air Quality Methodology

Hello,

Just wanted to follow up and check to see if you concur with the revised RDU EA Air Quality Methodology based on NCDAQ comments.

Thanks,

Chris Babb
Senior Managing Consultant

Landrum & Brown
Global Aviation Planning & Development

T +1 513 530 1275 M +1 513 560 1242

landrumbrown.com

From: Chris Babb
Sent: Tuesday, August 2, 2022 12:52 PM
To: White, Douglas <White.Douglas@epa.gov>

Cc: Michael.Lamprecht@faa.gov; jackie.sweatt-essick@faa.gov; Perry, Kenneth <kenneth.perry@rdu.com>; 5l23REnvoAssessment <5L23REnvoAssessment@rdu.com>; Somerville, Amanetta <Somerville.Amanetta@epa.gov>; Kajumba, Ntale <Kajumba.Ntale@epa.gov>; Gaby Elizondo <Gaby.Elizondo@landrumbrown.com>
Subject: RE: RDU EA Air Quality Methodology

Hello,

We received comments from the North Carolina Division of Air Quality on the RDU EA Air Quality Methodology. They requested we provide an estimate of aircraft emissions in the years 2029 and 2030 as well. We proposed to use the 2033 LTO emissions estimates for 2029 and 2030 as a conservative approach. It is not anticipated that aircraft operations in 2029 or 2030 would exceed that of 2033. They concurred with this approach. The revised methodology is attached. Please let us know if you have any issues with the revised approach.

Thanks,

Chris Babb
Senior Managing Consultant

Landrum & Brown
Global Aviation Planning & Development

T +1 513 530 1275 M +1 513 560 1242

landrumbrown.com

From: Chris Babb
Sent: Wednesday, July 20, 2022 3:16 PM
To: White, Douglas <White.Douglas@epa.gov>
Cc: Michael.Lamprecht@faa.gov; jackie.sweatt-essick@faa.gov; Perry, Kenneth <kenneth.perry@rdu.com>; 5l23REnvoAssessment <5L23REnvoAssessment@rdu.com>; Somerville, Amanetta <Somerville.Amanetta@epa.gov>; Kajumba, Ntale <Kajumba.Ntale@epa.gov>; Gaby Elizondo <Gaby.Elizondo@landrumbrown.com>
Subject: RE: RDU EA Air Quality Methodology

Hello,

The HAPs inventory would be conducted for the following:

- Future (2028) No Action Alternative
- Future (2028) Proposed Action

And the

- Future (2033) No Action Alternative
- Future (2033) Proposed Action

Thanks,

Chris Babb
Senior Managing Consultant

Landrum & Brown
Global Aviation Planning & Development

T +1 513 530 1275   M +1 513 560 1242

landrumbrown.com

From: White, Douglas <White.Douglas@epa.gov>
Sent: Wednesday, July 20, 2022 3:01 PM
To: Chris Babb <Chris.Babb@landrumbrown.com>
Cc: Michael.Lamprecht@faa.gov; jackie.sweatt-essick@faa.gov; Perry, Kenneth <kenneth.perry@rdu.com>; 5l23REnvoAssessment <5L23REnvoAssessment@rdu.com>; Somerville, Amanetta <Somerville.Amanetta@epa.gov>; Kajumba, Ntale <Kajumba.Ntale@epa.gov>
Subject: RE: RDU EA Air Quality Methodology

Hi Chris,

The methodology is sufficient.
What stage(s) of the project will the HAP inventory be completed for?

Doug

Douglas White
U.S. Environmental Protection Agency / Region 4
Strategic Programs Office / NEPA Section
61 Forsyth Street, SW
Atlanta, GA 30303-8960
404-562-8586

From: Chris Babb <Chris.Babb@landrumbrown.com>
Sent: Tuesday, July 19, 2022 8:10 AM
To: Kajumba, Ntale <Kajumba.Ntale@epa.gov>; White, Douglas <White.Douglas@epa.gov>
Cc: Michael.Lamprecht@faa.gov; jackie.sweatt-essick@faa.gov; Perry, Kenneth <kenneth.perry@rdu.com>; 5l23REnvoAssessment <5L23REnvoAssessment@rdu.com>
Subject: RE: RDU EA Air Quality Methodology

Hello,

Just wanted to follow up and check to see if you had any comments on the RDU EA Air Quality Methodology.

Thanks,

Chris Babb
Senior Managing Consultant

Landrum & Brown
Global Aviation Planning & Development
T +1 513 530 1275   M +1 513 560 1242
landrumbrown.com

From: Chris Babb
Sent: Tuesday, July 5, 2022 3:24 PM
To: Kajumba, Ntale <Kajumba.Ntale@epa.gov>; White, Douglas <White.Douglas@epa.gov>
Cc: Michael.Lamprecht@faa.gov; jackie.Sweatt-Essick@FAA.gov; Perry, Kenneth <kenneth.perry@rdu.com>; 5l23REnvoAssessment <5L23REnvoAssessment@rdu.com>
Subject: RDU EA Air Quality Methodology

Hello,

Please find attached the proposed methodology to conduct the air quality analysis for the Runway 5L/23R Replacement Project Environmental Assessment. The FAA is seeking your concurrence on the methodology. Let us know any questions or comments.

Thanks,

Chris Babb
Senior Managing Consultant

Landrum & Brown
Global Aviation Planning & Development
T +1 513 530 1275   M +1 513 560 1242
landrumbrown.com

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Air Quality and Climate Technical Report

Raleigh-Durham International Airport

August 26, 2022

PREPARED FOR
Raleigh-Durham Airport Authority

PRESENTED BY
Landrum & Brown, Incorporated

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1 Introduction

The purpose of this Air Quality and Climate Technical Report is to provide supporting documentation for the Environmental Assessment (EA) being prepared for the Proposed Runway 5L/23R Replacement Project at the Raleigh-Durham International Airport (RDU or Airport). This document describes the overall approach, methods, and results of the air quality and climate analysis to demonstrate compliance with the National Environmental Policy Act (NEPA) and the Clean Air Act (CAA). The approach, methods, and models used in the technical report were approved by the U.S. Environmental Protection Agency (USEPA) and the North Carolina Division of Air Quality (NCDAQ). The Air Quality and Climate Technical Report is organized in the following manner:

- **Air quality** is provided in Sections 2 through 10 which includes the regulatory setting, methodology, emissions inventories, and summary of impacts for criteria pollutants.
- **Climate** is provided in Section 11 through 19 which includes the regulatory setting, methodology, emissions inventories, and summary of impacts for greenhouse gases.
- Due to the size of several tables that substantiate the analysis, they are provided at the end of this technical report as **Attachments,** which are organized in the following order.

  Attachment 1, Hazardous Air Pollutants
  Attachment 2, Construction
  Attachment 3, Motor Vehicles

1.1 Description of the Proposed Action

All elements of the Proposed Action are described in detail in the EA. The Proposed Action includes relocating Runway 5L/23R northwest of existing Runway 5L/23R and, after construction is complete, converting the existing Runway 5L/23R to a taxiway. The project also includes use of fill material from Airport borrow sites, use of water from Brier Creek Reservoir, construction of drainage improvements, relocation of a portion of Lumley Road, utility relocations, demolition of four buildings, relocation of aircraft navigational aids, acquisition of property, and removal and/or mitigation of obstacles in accordance with Federal Aviation Administration (FAA) safety standards.

2 Regulatory Setting for Air Quality

NEPA provides for an environmental review process to disclose the potential impacts, including air quality, from a proposed federal action on the human environment. Per the United States Environmental Protection Agency (USEPA), NEPA's basic policy is to assure that all branches of government give proper consideration to the environment prior to undertaking any major federal action that significantly affects the environment. On a federal level, air quality is governed by CAA and administered and regulated by the USEPA in coordination with state and local governments. Additionally, air quality in North Carolina is governed by regulations under the North Carolina Department of Environmental Quality (NCDEQ).

2.1 National Ambient Air Quality Standards

The USEPA is the primary federal agency responsible for regulating air quality. The USEPA implements the provisions of the CAA. The CAA, including the 1990 Amendments, provides the establishment of standards and programs to evaluate, achieve, and maintain acceptable air quality in the United States. Under the CAA, the USEPA established a set of standards, or criteria, for six pollutants determined to be potentially harmful to human health and welfare.[1]

The USEPA considers the presence of the following six criteria pollutants to be indicators of air quality:

- Carbon monoxide (CO);
- Ozone (O_3);
- Nitrogen dioxide (NO_2);
- Sulfur dioxide (SO_2).
- Particulate matter (PM_{10} and $PM_{2.5}$); and,
- Lead (Pb).

For each of the criteria pollutants, the USEPA established primary standards intended to protect public health, and secondary standards for the protection of public welfare, which captures factors such as preventing materials damage, preventing crop and vegetation damage, and assuring good visibility. The National Ambient Air Quality Standards for the criteria pollutants, known as the NAAQS, are provided in **Table 2-1**. Areas of the country where air pollution levels consistently exceed these standards may be designated nonattainment by the USEPA.

A nonattainment area is a homogeneous geographical area (usually referred to as an air quality control region or airshed) that is in violation of one or more NAAQS and has been designated as nonattainment by the USEPA as provided for under the CAA. Each nonattainment area is required to have a State Implementation Plan (SIP), developed by the state that quantifies current conditions, projects future conditions through the date of prescribed attainment, and identifies mitigation measures that are to be used to bring the area back into attainment.

A maintenance area describes the air quality designation of an area previously designated nonattainment by the USEPA that subsequently meets attainment after emissions are reduced. Such an area remains designated as maintenance for a period up to 20 years at which time the state can apply for re-designation to attainment, provided that the NAAQS remained in attainment throughout the maintenance period.

The CAA conformity regulations (40 CFR Part 93) apply only to areas designated as nonattainment or maintenance. Under these rules, a federal agency shall not support, permit, or approve any action, which does not conform to an approved SIP.

---

[1] USEPA, C.F.R. Title 40, Part 50 (40 C.F.R. Part 50) National Primary and Secondary Ambient Air Quality Standards (NAAQS), July 2011.

TABLE 2-1, NATIONAL AMBIENT AIR QUALITY STANDARDS

POLLUTANT		PRIMARY/ SECONDARY	AVERAGING TIME	LEVEL	FORM
Carbon Monoxide		Primary	8 hour	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead		Primary and Secondary	Rolling 3-month average	0.15 μg/m3 (1)	Not to be exceeded
Nitrogen Dioxide		Primary	1 hour	100 ppb	98^{th} percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and Secondary	1 year	53 ppb (2)	Annual Mean
Ozone		Primary and Secondary	8 hour	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particulate Matter	$PM_{2.5}$	Primary	1 year	12.0 $\mu g/m^3$	Annual mean, averaged over 3 years
		Secondary	1 year	15.0 $\mu g/m^3$	Annual mean, averaged over 3 years
		Primary and Secondary	24 hour	35 $\mu g/m^3$	98^{th} percentile, averaged over 3 years
	PM_{10}	Primary and Secondary	24 hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		Primary	1 hour	75 ppb (4)	99^{th} percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3 hour	0.5 ppm	Not to be exceeded more than once per year

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 μg/m3 as a calendar quarter average) also remain in effect.

(2) The level of the annual NO2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards are not revoked and remain in effect for designated areas. Additionally, some areas may have certain continuing implementation obligations under the prior revoked 1-hour (1979) and 8-hour (1997) O3 standards.

(4) The previous SO2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO2 standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Notes: ppm is parts per million; ppb is parts per billion, and μg/m3 is micrograms per cubic meter.

Source: USEPA, https://www.epa.gov/criteria-air-pollutants/naaqs-table Accessed January 2022

2.2 Conformity

2.2.1 General Conformity

The General Conformity Rule under the CAA is conducted in three phases, depending on the extent of the proposed federal action: (1) applicability, (2) evaluation, and (3) determination. The General Conformity Rule establishes minimum values, referred to as the *de minimis* thresholds, for the criteria and precursor pollutants[2] for the purpose of:

- Identifying federal actions with project-related emissions that are clearly negligible (*de minimis*);
- Avoiding unreasonable administrative burdens on the sponsoring agency; and,
- Focusing efforts on key actions that would have potential for significant air quality impacts.[3]

The federal *de minimis* thresholds established under the CAA are provided in **Table 2-2**. The *de minimis* thresholds are expressed as tons per year, which represent the total amount of pollutants released into the atmosphere. The NAAQS are defined as parts per million/billion or micrograms per cubic meter, which represent the acceptable concentration of the pollutants in the air, or the level of air pollution that we breathe in order to maintain public health and public welfare. An emissions inventory, expressed in tons per year, is a summary of the total pollutants generated by potentially affected sources evaluated in the study and cannot be compared directly to the NAAQS. A dispersion analysis would be required to determine the potential pollutant concentrations in the air and where the pollutants would go. The *de minimis* thresholds are used to determine if a more in-depth analysis is needed.

The NAAQS are also provided for a specific criteria pollutant such as NO_2 or SO_2. However, the *de minimis* thresholds are provided for pollutants referred to as sulfur oxides (SO_x) and nitrogen oxides (NO_x). SO_2 is a colorless gas that is typically identified as having a strong odor and is formed when the fuel containing sulfur, like coal, oil, and jet fuel, is burned. SO_x constitutes a class of compounds of which sulfur dioxide (SO_2) and sulfur trioxide (SO_3) are of greatest importance. While the NAAQS only addresses SO_2, SO_x is the total group of sulfur oxides.

Similarly, nitrogen gas, at high temperatures (i.e., in the combustion process) and under certain other conditions can combine with oxygen, forming several different gaseous compounds collectively called NO_x. Nitric oxide (NO) and nitrogen dioxide (NO_2) are the two most important compounds. While the NAAQS only addresses NO_2, NO and the total group of nitrogen oxides is of concern. NO and NO_2 are both precursors in the formation of ozone and secondary particulate matter. Because of this and that NO emissions largely convert to NO_2, NO_x emissions are typically examined when assessing potential air quality impacts.

2 Precursor pollutants are pollutants that are involved in the chemical reactions that form the resultant pollutant. Ozone precursor pollutants are NO_x and VOC, whereas $PM_{2.5}$ precursor pollutants include NO_x, VOC, SO_2, and ammonia (NH_3)

3 40 CFR Part 93

TABLE 2-2, FEDERAL *DE MINIMIS* THRESHOLDS

CRITERIA AND PRECURSOR POLLUTANTS	TYPE AND SEVERITY OF NONATTAINMENT AREA	TONS PER YEAR THRESHOLD
Ozone (VOC or NO_x)[1]	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (NO_x)[1]	Marginal and moderate nonattainment inside an ozone transport regions[2]	100
	Maintenance	100
Ozone (VOC)[1]	Marginal and moderate nonattainment inside an ozone transport region[2]	50
	Maintenance within an ozone transport region[2]	50
	Maintenance outside an ozone transport region[2]	100
Carbon monoxide (CO)	All nonattainment & maintenance	100
Sulfur dioxide (SO_2)	All nonattainment & maintenance	100
Nitrogen dioxide (NO_2)	All nonattainment & maintenance	100
Coarse particulate matter (PM_{10})	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
Fine particulate matter ($PM_{2.5}$) (VOC, NO_x, NH_3, and SO_x)[3]	All nonattainment and maintenance	100
Lead (Pb)	All nonattainment and maintenance	25

1 The rate of increase of ozone emissions is not evaluated for a project-level environmental review because the formation of ozone occurs on a regional level and is the result of the photochemical reaction of NO_x and VOC in the presence of abundant sunlight and heat. Therefore, USEPA considers the increasing rates of NO_x and VOC emissions to reflect the likelihood of ozone formation on a project level.

2 An OTR is a single transport region for ozone, comprised of the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and the Consolidated Metropolitan Statistical Area that includes the District of Columbia.

3 For the purposes of General Conformity applicability, VOCs and NH3 emissions are only considered PM2.5 precursors in nonattainment areas where either a state or USEPA has made a finding that the pollutants significantly contribute to the PM2.5 problem in the area. In addition, NO_x emissions are always considered a PM2.5 precursor unless the state and USEPA make a finding that NO_x emissions from sources in the state do not significantly contribute to PM2.5 in the area. Refer to 74 FR 17003, April 5, 2006.

Notes: CFR Title 40, Protection of the Environment Part 93.153
USEPA defines de minimis as emissions that are so low as to be considered insignificant and negligible. Volatile organic compounds (VOC); Nitrogen oxides (NO_x); Ammonia (NH_3); Sulfur oxides (SO_x).

Sources: USEPA, 40 C.F.R. Part 93.153(b)(1) & (2).

The *de minimis* rates vary depending on the severity of the nonattainment area and further depend on whether the general federal action is located inside an ozone transport region[4]. An evaluation relative to the General Conformity Rule (the Rule), published under 40 CFR Part 93,[5] is applicable to general federal actions that would cause emissions of the criteria or precursor pollutants, and are:

- Federally-funded or federally-approved;
- Not a highway or transit project[6];
- Not identified as an exempt project[7] under the CAA;
- Not a project identified on the approving federal agency's Presumed to Conform list[8]; and,
- Located within a nonattainment or maintenance area.

When an action requires evaluation under the General Conformity regulations, the net total direct and indirect emissions due to the federal action may not equal or exceed the relevant *de minimis* thresholds unless:

- An analytical demonstration is provided that shows the emissions would not exceed the NAAQS; or
- Net emissions are accounted for in the State Implementation Plan (SIP) planning emissions budget; or
- Net emissions are otherwise accounted for by applying a solution prescribed under 40 CFR Part 93.158.

Conformity to the *de minimis* thresholds is relevant only with regard to those pollutants and the precursor pollutants for which the area is designated nonattainment or maintenance. Notably, there are no *de minimis* thresholds to which a federal agency would compare ozone emissions. This is because ozone is not directly emitted from a source. Rather, ozone is formed through photochemical reactions involving emissions of the precursor pollutants, nitrogen oxides (NO_x) and volatile organic compounds (VOC), in the presence of abundant sunlight and heat. Therefore, emissions of ozone on a project level are evaluated based on the rate of emissions of the ozone precursor pollutants, NO_x and VOC.

If the General Conformity evaluation for this air quality analysis were to show that any of the applicable thresholds were equaled or exceeded, further, more detailed analysis to demonstrate conformity would be required, which is referred to as a General Conformity Determination. Conversely, if the General Conformity evaluation were to show that none of the relevant thresholds were equaled or exceeded, the project would be presumed to conform to the applicable North Carolina SIPs and no further analysis would be required under NEPA or the CAA.

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4 The ozone transport region is a single transport region for ozone (within the meaning of Section 176A(a) of the CAA), comprised of the States of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and the Consolidated Metropolitan Statistical Area that includes the District of Columbia, as given at Section 184 of the CAA.

5 EPA, 40 C.F.R. Part 93, Subpart B, Determining Conformity of General Federal Actions to state or Federal Implementation Plans, July 1, 2006.

6 Highway and transit projects are defined under Title 23 United States Code and the Federal Transit Act.

7 The Proposed Project is not listed as an action exempt from a conformity determination pursuant to 40 C.F.R. § 93.153(c). An exempt project is one that the USEPA has determined would clearly have no impact on air quality at the facility, and any net increase in emissions would be so small as to be considered negligible.

8 The provisions of the CAA allow a federal agency to submit a list of actions demonstrated to have low emissions that would have no potential to cause an exceedance of the NAAQS and are presumed to conform to the CAA conformity regulations. This list would be referred to as the "Presumed to Conform" list. The FAA Presumed to Conform list was published in the Federal Register on February 12, 2007 (72 FR 6641-6656) and includes airport projects that would not require evaluation under the General Conformity regulations.

2.2.2 Transportation Conformity

Although airport improvement projects are usually considered under the General Conformity regulations, there can be elements of a federal action or its alternatives that may require an analysis to demonstrate Transportation Conformity, such as actions relating to transportation plans, programs, projects developed, funded, or approved under Title 23 United States Code (U.S.C.) or the Federal Transit Act (FTA),[9] or involve federal highways. In such cases, the sponsoring federal agency would be required to coordinate with the Federal Highway Administration (FHWA), the state Department of Transportation (DOT), and the local Metropolitan Planning Organization (MPO) to assist in completing a Transportation Conformity evaluation. Furthermore, as with General Conformity, Transportation Conformity regulations apply only to federal actions located within a nonattainment or maintenance area. The Proposed Action under consideration at RDU would not be developed, funded, or approved by the FHWA or FTA. Therefore, the Transportation Conformity regulations would not apply.

2.2.3 Indirect Source Review

Some states require an air quality review when a federal action has the potential to cause an increase in net emissions from indirect sources. Indirect sources cause emissions that occur later in time or are farther removed from the federal action. Depending on the state, indirect sources may be identified as motor vehicles on highways, parking at sports and entertainment facilities, or an increase in aircraft operations. The state requirement may be referred to as the indirect source review (ISR) and each state requiring an ISR sets thresholds for increased operation of the indirect sources. When a federal action has the potential to exceed these thresholds, an air quality review is required to assess the character and impact of the additional emissions and determine whether a permit is required, which is separate from the analyses required under NEPA or the CAA.

The state of North Carolina did have indirect source review thresholds known as the Transportation Facility Permitting (TFP) regulations; however, these regulations were repealed by the North Carolina Division of Air Quality effective January 1, 2015.[10]

2.3 Federal Attainment Status

The Airport's location is within North Carolina's Eastern Piedmont Intrastate Air Quality Control Region.[11] The area was previously designated nonattainment for the 1971 CO standard and was designated in attainment effective September 18, 1995.[12] Additionally, the USEPA has classified Durham and Wake Counties as attainment for CO effective September 18, 2015, ending conformity requirements for CO; therefore, no *de minimis* threshold will be applied for this pollutant in the air quality analysis.[13] The area was designated as nonattainment for the 1997 8-hour ozone standard; however, on December 26, 2007, the USEPA determined the area had reached the 1997 8-hour ozone standard and the region was redesignated to maintenance for these pollutants. As such, the area operates under a maintenance plan for 8-hour ozone. Even though the standard was revoked in 2015, the maintenance plan remains in effect and contains future year emissions budgets under which the

9 USEPA, 40 CFR Part 93.153, Applicability, July 1, 2006.

10 North Carolina Air Quality Rules Subchapter 2Q Air Quality Permit Procedures Section 0600 Transportation Facility Procedures.

11 Title 40 Protection of the Environment. CFR. Chapter 1, Subchapter C, Part 81 Subpart B §81.148 Eastern Piedmont Intrastate Air Quality Control Region.

12 Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants, USEPA Green Book, January 31, 2022. Available on-line: https://www3.epa.gov/airquality/greenbook/anayo_nc.html

13 Letter from the USEPA Region 4 Air, Pesticides, and Toxics Management Division to the Durham-Chapel Hill Carrboro Metropolitan Planning Organization and the Capital Area Metropolitan Planning Organization.

maintenance area can demonstrate that timely attainment of NAAQS will be achieved.[14] Furthermore, the area is in attainment for the 2008 and 2015 8-hour ozone standards. Regardless, the area continues to operate under the maintenance plan for the 1997 8-hour ozone standard. For the purpose of this study, the federal *de minimis* threshold for ozone will be applied in the air quality analysis.

2.4 Air Quality Monitoring in Region

The North Carolina Department of Environmental Quality Division of Air Quality has established an air monitoring network around the state that measures air pollution. The air quality monitoring station closest to the Airport is the Triple Oak monitor. The Triple Oak monitor collects CO, NO_2, and $PM_{2.5}$ ambient air data. The most recent publicly available data from this monitor indicates that concentrations of these pollutants are below the NAAQS.[15]

2.5 Criteria Pollutants of Concern

As of January 31, 2022, Wake and Durham counties operate under a maintenance plan for ozone and are in attainment for all other criteria pollutants.[16] The ozone precursor pollutants are VOC and NO_x; and as such, the pollutants of concern for this project are VOC and NO_x. **Table 2-3** identifies the applicable federal *de minimis* thresholds in tons per year for the project. For this analysis the pollutants of concern will be compared against the thresholds to determine significance. The emissions inventories prepared for the air quality analysis will also provide the emissions estimates for CO, SO_x, PM_{10}, and $PM_{2.5}$ for disclosures purposes only.

TABLE 2-3, APPLICABLE FEDERAL *DE MINIMIS* THRESHOLDS FOR WAKE AND DURHAM COUNTIES

CRITERIA AND PRECURSOR POLLUTANTS	SHORT TONS PER YEAR THRESHOLD
Ozone (VOC and NO_x)	100

Sources: USEPA, 40 CFR Part 93.153(b)(1) & (2).

14 Limited Maintenance Plan for the Great Smoky Mountains National Park, Rocky Mount, & Triangle Maintenance Areas for the 1997 8-Hour Ozone NAAQS, North Carolina Department of Environmental Quality, February 2022, Available on-line: https://deq.nc.gov/about/divisions/air-quality/air-quality-planning/state-implementation-plans-sips/limited-maintenance-plan-great-smoky-mountains-national-park-rocky-mount-triangle-maintenance-areas

15 Data available on-line at https://xapps.ncdenr.org/aq/ambient/AmbtSiteEnvista.jsp?site=371830021

16 Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants, USEPA Green Book, January 31, 2022. Available on-line: https://www3.epa.gov/airquality/greenbook/anayo_nc.html

3 Methodology for Air Quality

The overall approach to conducting this air quality analysis follows FAA guidelines for preparing NEPA documents, which includes FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures (including the Desk Reference);* FAA Order 5050.4B, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions*; and FAA's *Aviation Emissions and Air Quality Handbook Version 3 Update 1.* In accordance with these orders and guidance documents, the overall approach and goal of the air quality impact analysis is to meet the requirements of NEPA and the CAA.

> NEPA: Compliance with NEPA is accomplished by disclosing the potential emissions associated with the Proposed Action. This includes preparation of emission inventories of both construction activities and operational conditions for the Proposed Action, any development alternatives, and the No Action Alternative.
>
> CAA: The CAA requires that project emissions do not cause or contribute to violations of the NAAQS. In nonattainment and maintenance areas, a project's compliance with this requirement can be demonstrated by showing that the project emissions are *de minimis* or that they conform to the SIP for achieving and maintaining the NAAQS.

This air quality analysis included an evaluation of potentially affected operational activities for the Existing Conditions (2020); and the Proposed Action and the No Action Alternative for the projected future conditions in 2028 and 2033. The year 2028 was selected because it represents the projected opening year of the proposed runway replacement. In addition, 2033 is used as a basis for analysis, because it represents a condition five years beyond the proposed runway replacement opening year. The years of 2023 through 2030 were assessed for potential impacts associated with construction activity. In addition, in order to report the project's total annual incremental emissions over the entire period of construction, operational emissions were also reported for the years 2029 and 2030. As a conservative approach, it is assumed aviation activity levels in 2029 and 2030 would not exceed those for 2033. Therefore, for the purpose of this analysis, the 2033 landing and takeoff cycles (LTOs) were used to estimate operational emissions for 2029 and 2030. Total annual emissions for 2029 and 2030 would include construction activity for that year and operational emissions based on 2033 LTOs.

An emissions inventory was developed to summarize the total pollutants generated by all active emissions sources that may be affected by the Proposed Action. The emissions inventory provides the total annual pollutant emissions as tons per year for each analysis year. During the Existing Conditions (2020), the number of aircraft operations at RDU decreased dramatically as compared to the number of aircraft operations in 2019 due to the impacts to aviation associated with the COVID-19 public health emergency. Therefore, the Existing Conditions (2020) emissions are anticipated to be lower than those of normal conditions. However, the Existing Conditions (2020) is provided for background and context only. For the analysis of impacts, the Proposed Action was compared to the No Action Alternative for the 2028 and 2033 conditions. Results are provided later in this technical report.

3.1 Sources of Emissions

The following sources of emissions are included in this analysis.

- Aircraft
  - Emissions from Landing and Takeoff Cycles which include aircraft Engine Start-Up, Approach, Climb, and Taxi operations
- Motor Vehicles
  - It is not reasonable to include every roadway from any potential passengers' home to the Airport. There is no reliable motor vehicle data for every passengers' origin of destination. Therefore, the analysis for motor vehicles focuses on vehicle emissions that may be affected by the relocation of Lumley Road where traffic is reasonably foreseeable.
- Construction Activity
  - Emissions from on-road activity, including construction employee vehicle trips and material delivery/hauling trips
  - Emissions from non-road activity, including use of construction equipment such as excavators, graders, and pavers
  - Fugitive dust generated during demolition and construction as well as during clearing and grading activities

Aircraft engine ground run-ups are routine aircraft engine maintenance tests performed to test engines and diagnose engine issues. There would be no change to aircraft engine ground run-ups due to the Proposed Action. The larger jet aircraft use auxiliary power units (APUs) while at the gate to operate the heating, air conditioning, and electric systems. The APU is also used to 'start up' or restart the aircraft engines before departing from the gate area. Neither the Proposed Action nor the No Action Alternative would affect APU emissions and therefore were not included in this analysis. In addition, neither the Proposed Action nor the No Action Alternative would affect any natural gas boilers, diesel generators, fuel farms tanks referred to as stationary sources, or the ground support equipment (GSE), such as baggage tractors, belt loaders, catering vehicles, and emergency vehicles, and therefore were not included in this analysis.

3.2 Models Used in this Analysis

Emissions were evaluated using the FAA's Aviation Environmental Design Tool (AEDT) Version 3d.[17] AEDT models aircraft performance in space and time to estimate fuel consumption, air quality emissions, and noise consequences at airports. Emission factors for on-road and off-road motor vehicles were derived from the USEPA's Motor Vehicle Emissions Simulator (MOVES) model version 3. MOVES is an emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants, greenhouse gases, and hazardous air pollutants. The type of construction equipment and potential usage estimates for the project were developed using the Airport Construction Emissions Inventory Tool (ACEIT). The ACEIT was

[17] Per FAA memorandum dated September 27, 2017, Guidance on determining which version of the Aviation Environmental Design Tool (AEDT) to use for FAA actions and studies, "The current version of AEDT is required for all noise, fuel burn and emissions modeling for FAA actions where the environmental analysis is initiated on or after the version release date. As noted in the Federal Register and FAA Order 1050.1F, the required model version is the one in effect at the time the "environmental analysis process is underway." AEDT version 3d was the version when this EA was initiated.

developed by the Transportation Research Board (TRB) to assist airports and other stakeholders in developing airport construction emissions inventories.

3.3 Lead Emissions

Since 1975, lead emissions have been in decline due in part to the introduction of catalyst-equipped vehicles and decline in production of leaded gasoline. The chief source of lead emissions at airports would be the combustion of leaded aviation gasoline (Avgas) in small piston engine general aviation aircraft. Lead is not an ingredient in Jet A fuels that power large commercial service aircraft. In general, an analysis of lead is limited to projects that emit significant quantities of the pollutant (i.e. lead smelters). Some active general aviation airports prepare lead emissions inventories due to the large quantity of Avgas used. However, a lead inventory analysis was not conducted as part of this air quality analysis as this project does not include any elements that emit significant quantities of lead and lead is not a criteria pollutant of concern.

3.4 Hazardous Air Pollutants

Per FAA guidance, a hazardous air pollutant (HAP) emissions inventory should be considered if the Proposed Action is considered “major” (e.g., new airport, new runway, major runway extension, etc.); if the Proposed Action is located in a nonattainment or maintenance area; and/or if a criteria pollutant emissions inventory is also prepared. Because the Proposed Action includes the construction of a new replacement runway and is located in a maintenance area, a HAPS emissions inventory was conducted for this air quality analysis. However, the results are only provided for disclosure purposes as there are currently no federal standards specifically pertaining to HAPS emissions from aircraft engines or airports. Operational HAPS emissions were modeled for aircraft and motor vehicles. HAPS from aircraft were developed using AEDT and HAPS from motor vehicles were estimated using MOVES3. The HAPS emissions inventory is provided in **Attachment 1** and would not be directly comparable to any regulatory or enforceable ambient air quality standards or emission thresholds.

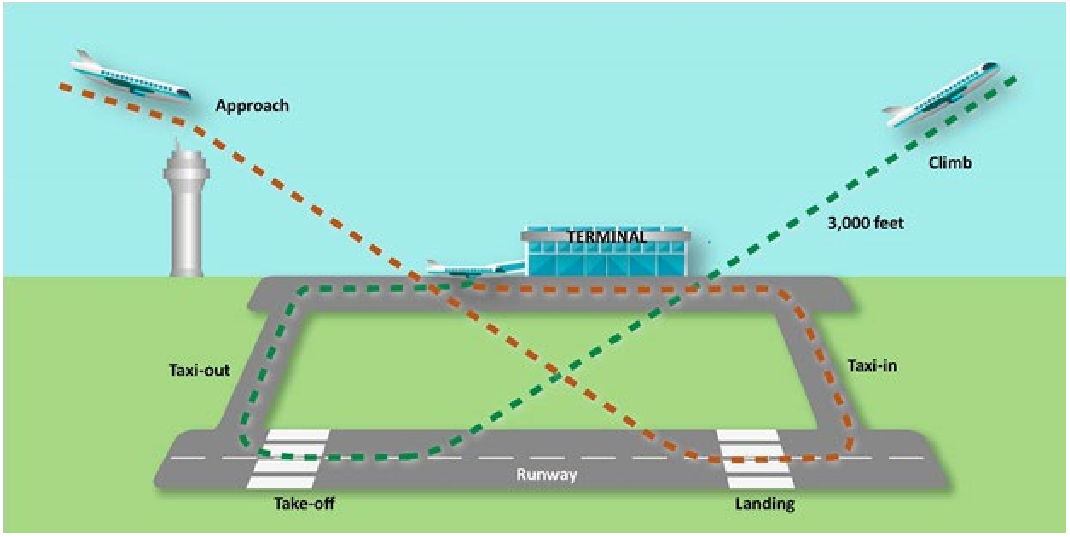
4 Existing Conditions (2020)

4.1 Aircraft

4.1.1 Aircraft Fleet Mix and Activity Level

The number and type of aircraft operations directly affect emissions. Aircraft emissions depend partly on the physical characteristics and performance parameters of each aircraft. This includes the airframe type and the type and number of engines. In addition to the physical characteristics of the aircraft operating at the Airport, emissions further depend on the time that each aircraft type operates in the various modes that define an LTO. According to the FAA’s *Aviation Emissions and Air Quality Handbook Version 3 Update 1*, an LTO generally consists of the approach, landing, taxi into the gate/terminal/or parking area, taxi out, takeoff, and climb. **Exhibit 4-1** provides an illustration of the LTO. The approach and climb portions of the LTO only go from or to the mixing height, or 3,000 feet above field elevation.

Exhibit 4-1, Landing and Take-Off Cycle



Source: Landrum & Brown, 2021.

In order to calculate emissions from aircraft, information concerning aircraft operations was collected. The number of annual operations at RDU for the Existing Conditions (2020) was based on Air Traffic Control Tower (ATCT) counts for the period from June 2020 through May 2021. During that period, 131,777 annual operations occurred. Specific aircraft types were developed from data from the RDU Airport Flight Tracking System for the same period. **Table 4-1** presents the annual aircraft operations with the AEDT engine code modeled for the Existing Conditions (2020).

TABLE 4-1, ANNUAL OPERATIONS BY AIRCRAFT TYPE – EXISTING CONDITIONS (2020)

AIRCRAFT TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Heavy	Airbus A300F4-600 Series	1PW048	912
Heavy	Boeing 767-300 ER Freighter	01P02GE188	2,118
Heavy	Boeing MD-11 Freighter	1GE031	169
Heavy	Boeing MD-11 Freighter	12PW101	275
Jet	Airbus A319-100 Series	3IA006	1,350
Jet	Airbus A319-100 Series	6CM044	843
Jet	Airbus A319-100 Series	4CM036	4,208
Jet	Airbus A319-100 Series	3IA007	862
Jet	Airbus A320-200 Series	01P08CM105	306
Jet	Airbus A320-200 Series	1IA003	3,729
Jet	Airbus A320-200 Series	3CM026	517
Jet	Airbus A320-200 Series	2CM014	337
Jet	Airbus A320-NEO	01P20CM128	1,695
Jet	Airbus A321-200 Series	3CM025	580
Jet	Airbus A321-200 Series	3IA008	875
Jet	Airbus A321-200 Series	01P08CM104	345

AIRCRAFT TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Jet	Boeing 717-200 Series	4BR002	1,766
Jet	Boeing 737-700 Series	3CM031	5,762
Jet	Boeing 737-700 Series	3CM032	563
Jet	Boeing 737-800 Series	3CM032	3,044
Jet	Boeing 737-800 Series	8CM051	6,683
Jet	Boeing 737-900 Series	8CM066	636
Jet	Boeing 737-900-ER	01P11CM121	2,782
Jet	Boeing 737-900-ER	01P11CM122	481
Jet	Bombardier CRJ-700	5GE083	499
Jet	Bombardier CRJ-700-ER	5GE083	647
Jet	Bombardier CRJ-900	01P08GE190	6,056
Jet	Embraer ERJ170	01P08GE197	3,311
Jet	Embraer ERJ175	01P08GE197	2,022
Jet	Embraer ERJ175-LR	01P08GE197	7,789
Jet	Embraer ERJ190-AR	10GE129	2,393
Prop	ATR 42-300	PW120	6,090
Prop	Cessna 172 Skyhawk	IO360	3,483
Prop	Cessna 182	IO360	378
Prop	Cessna 208 Caravan	PT6A14	1,826
Prop	Cirrus SR20	IO360	350
Prop	Cirrus SR22	TIO540	2,541
Prop	Diamond DA40	IO360	9,254
Prop	Diamond DA42 Twin Star	IO360	801
Prop	EADS Socata TBM-700	PT6A60	288
Prop	Mooney M20-K	TSIO36	320
Prop	Pilatus PC-12	PT6A67	7,126
Prop	Pilatus PC-12	PT67B	1,216
Prop	Piper PA-28 Cherokee Series	IO320	6,930
Prop	Piper PA-32 Cherokee Six	TIO540	361
Prop	Piper PA-34 Seneca	IO360	532
Prop	Piper PA46-TP Meridian	PT6A21	399
Prop	Raytheon Beech 55 Baron	TIO540	707
Prop	Raytheon Beech Bonanza 36	TIO540	999
Prop	Raytheon Super King Air 200	PT6A40	573
Prop	Raytheon Super King Air 300	PT6A60	1,099
Prop	SOCATA TBM 850	PT6A66	369
Regional	Bombardier Challenger 300	11HN003	1,439

AIRCRAFT TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Regional	Bombardier Challenger 600	01P05GE189	489
Regional	Bombardier Learjet 60	7PW077	281
Regional	Cessna 525 CitationJet	1PW035	1,462
Regional	Cessna 525 CitationJet	PW610F	891
Regional	Cessna 550 Citation II	1PW036	463
Regional	Cessna 560 Citation V	1PW037	1,703
Regional	Cessna 560 Citation XLS	PW530	1,344
Regional	Cessna 650 Citation III	1AS002	538
Regional	Cessna 680 Citation Sovereign	14PW103	999
Regional	CIRRUS SF-50 Vision	PW610F	437
Regional	Embraer 505	PW530	881
Regional	Gulfstream G280	01P11HN012	292
Regional	Gulfstream IV-SP	11RR048	331
Regional	Raytheon Beechjet 400	1PW035	918
Regional	Raytheon Hawker 800	1AS002	650
Helicopter	Aerospatiale SA-350D Astar (AS-350)	TPE3	564
Helicopter	Bell 407 / Rolls-Royce 250-C47B	250B17	471
Helicopter	Eurocopter EC-130	TPE3	242
Prop	Diamond DA40	IO360	2,815
Prop	Piper PA-28 Cherokee Series	IO320	1,153
Prop	Cessna 172 Skyhawk	IO360	777
Military	Eurocopter EC-155B1	T70041	168
Military	Raytheon Super King Air 200	PT6A40	291
Military	Boeing C-17A	F1171	155
Military	Lockheed C-130 Hercules	T56A15	530
Military	Cessna 560 Citation V	1PW037	188
Military	Eurocopter EC-130	TPE3	285
Military	Boeing F/A-18 Hornet	F4044	58
Military	Gulfstream G-5 Gulfstream 5 / G-5SP Gulfstream G500	3BR001	103
Military	Sikorsky SH-60 Sea Hawk	T70041	97

AIRCRAFT TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Military	Sikorsky UH-60 Black Hawk	T70070	575
Military	Fairchild SA-226-T Merlin III	TPE1	990
Total			**131,777**

Notes: Total may not sum due to rounding.
Source: Federal Aviation Administration (FAA) Operations Network (OpsNet) data, RDU Flight Tracking System data, Landrum & Brown analysis, 2021.

4.1.2 Aircraft Taxi Time

The amount of time an aircraft spends taxiing affects emissions. The taxi in and taxi out time is dependent on the airfield configuration, annual operating levels, and available facilities. The average taxi in and taxi out times for the Existing Conditions (2020) were determined using the FAA's AEDT model database. Based on FAA's AEDT data for RDU, the average taxi in time was four minutes and 48 seconds and the average taxi out time was 13 minutes and 58 seconds. These taxi in and taxi out times were applied to each operation in AEDT to develop the emissions inventory for the Existing Conditions (2020).

4.2 Motor Vehicles

Emissions from motor vehicles are a function of the vehicle-miles-travelled (VMT) within a specific roadway segment by a specific number and type of vehicle and the emission factor. Vehicle types such as passenger cars and long-haul trucks, have different emission factors. In addition, vehicles traveling at different rates of speed have different emission factors. Emissions are calculated by multiplying the annual VMT of each roadway segment by the emission factor using the specific vehicle distribution. The following provides a summary of the approach taken to document emissions from motor vehicles.

4.2.1 Roadway Segments

Three specific roadway segments that may be affected by the Proposed Action were defined (Segment 1, 2, and 3). Segments 1 and 2 are part of existing Lumley Road and Segment 3 is part of Commerce Boulevard. The roadway segments are shown on **Exhibit 4-2**.

Exhibit 4-2, Roadway Segments – Existing Conditions (2020)

Source: Landrum & Brown, 2021.

Distances and speeds in miles per hour (mph) for each roadway segment were determined. **Table 4-2** presents the distances and speeds for each roadway segment for the Existing Conditions (2020).

TABLE 4-2, ROADWAY SEGMENTS – EXISTING CONDITIONS (2020)

ROADWAY SEGMENT ID	SEGMENT LENGTH (MILES)	SPEED (MILES PER HOUR)
1	0.47	45
2	0.29	45
3	0.16	25

Source: Landrum & Brown, 2021.

4.2.2 Traffic Volumes

Data was collected on the traffic volumes that used these roadway segments in 2020 from the North Carolina Department of Transportation.[18] The data obtained was utilized to estimate VMTs. The distance of the roadway segment was multiplied by the traffic volume to determine the daily VMT for each segment, which was then converted to annual VMT by multiplying the daily VMT by 365. **Table 4-3** presents the annual average daily traffic for each roadway segment for the Existing Conditions (2020). Approximately 1,678,924 annual VMTs were estimated for Segment 1, approximately 1,423,341 for Segment 2, and approximately 213,573 for Segment 3.

[18] Annual Average Daily Traffic data accessed March 2022 via the following web address. https://ncdot.maps.arcgis.com/apps/webappviewer/index.html?id=964881960f0549de8c3583bf46ef5ed4

TABLE 4-3, TRAFFIC VOLUMES – EXISTING CONDITIONS (2020)

ROADWAY SEGMENT ID	ANNUAL AVERAGE DAILY TRAFFIC
1	9,800
2	13,500
3	3,700

Source: NCDOT and Landrum & Brown, 2021.

4.2.3 Vehicle Distribution

All vehicle types were grouped into four main categories based on similar engine and operating characteristics in order to assign an emission factor. **Table 4-4** provides the vehicle classifications used in the Existing Conditions (2020).

TABLE 4-4: VEHICLE CLASSIFICATIONS

MOVES DATABASE CLASSIFICATION	GENERAL VEHICLE DESCRIPTION
Passenger Car (PC)	Includes passenger cars, rental cars, employee cars, taxis, motorcycles
Passenger Truck (PT)	Includes light duty pickup trucks, vans
Short Haul Truck (SHT)	Includes buses, shuttle buses, hotel shuttle buses, box trucks, refuse trucks, single unit trucks, medium duty trucks
Long Haul Truck (LHT)	Includes heavy duty trucks, fueling trucks, tractor trailers

Source: Landrum & Brown, 2022; MOVES3 database classifications.

The vehicle distribution (vehicle mix) on each roadway segment was developed based on Wake County data contained in MOVES. **Table 4-5** provides the vehicle distribution percentages used in the Existing Conditions (2020).

TABLE 4-5: VEHICLE DISTRIBUTION ON WAKE COUNTY ROADWAYS

VEHICLE DISTRIBUTION (%)			
PASSENGER CAR	PASSENGER TRUCK	SINGLE UNIT SHORT-HAUL TRUCK	LONG-HAUL TRUCK
45%	45%	5%	5%

Source: MOVES3.

4.2.4 Emission Factors

Emission factors were determined using the USEPA's MOVES3. The emission factors are provided in **Attachment 2**. Emissions from motor vehicles were calculated by multiplying the annual VMT of each roadway segment by the emission factor using the specific vehicle distribution.

4.3 Existing Conditions (2020) Criteria Pollutant Emissions Inventory

The emissions inventory for the Existing Conditions (2020) is shown in **Table 4-6** and provides the total annual pollutant emissions as tons per year. The Existing Conditions (2020) emissions inventory shows the pollutants with the greatest emissions are CO and NO_x. There were approximately 529 tons of CO and 265 tons of NO_x. These pollutants are produced from the incomplete combustion of aircraft and motor vehicle engines.

TABLE 4-6, EXISTING CONDITIONS (2020) EMISSIONS INVENTORY (TONS/YEAR)

EMISSIONS SOURCE	CO	VOC	NO_x	SO_x	PM_{10}	$PM_{2.5}$
Aircraft Taxiing	266.2	45.9	37.4	10.5	0.9	0.9
Aircraft Landing and Takeoff	251.8	7.7	226.5	16.1	1.8	1.8
Motor Vehicles	11.1	0.2	1.3	0.0	0.0	0.0
Total:	**529.1**	**53.8**	**265.2**	**26.6**	**2.7**	**2.7**

Note: CO = Carbon Monoxide; VOC = Volatile Organic Compounds; NO_x = Nitrous Oxides; SO_x = Sulfur Oxides; PM_{10} = Coarse Particulate Matter; $PM_{2.5}$ = Fine Particulate Matter
Numbers may not sum due to rounding

Source: Landrum & Brown analysis, 2021.

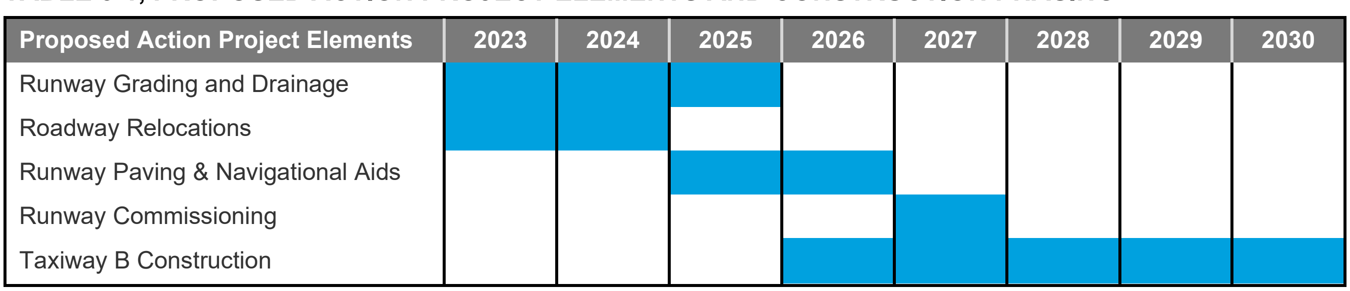
5 Construction

Temporary impacts would result from construction activities associated with the Proposed Action. Air pollutants would be emitted by construction equipment and fugitive dust generated during demolition and construction as well as during clearing and grading activities. Construction estimates (including phase durations and estimated quantities) were based on the preliminary engineering data provided by the Airport Authority in 2022.

5.1 Construction Phasing

Subject to FAA approval, construction could start as soon as 2023 with a duration of eight years. It is anticipated that the proposed runway replacement would be completed in 2027. **Table 5-1** provides the estimated construction phasing of the major EA proposed project elements.

TABLE 5-1, PROPOSED ACTION PROJECT ELEMENTS AND CONSTRUCTION PHASING



Source: Airport Authority, 2021.

5.2 On-Road Construction Vehicles

Potential sources of construction emissions include construction vehicles and equipment. Potential on-road construction emissions were estimated using the following formula as provided in the FAA's *Aviation Emissions and Air Quality Handbook Version 3 Update 1*.

> *Emission Rate (tons/year) for on-road vehicles = Emission Factor (grams/mile) x miles per day x # of days/year x (1 pound/453.59 grams) x (1 ton/2,000 pounds)*

Emission factors for on-road construction vehicles such as construction employees and material delivery were developed using the MOVES model. For employee vehicle trips related to construction activities, the model was run using gasoline passenger vehicles including cars and light duty pickup trucks. For material delivery and off-site haul vehicle trips, diesel combination long-haul trucks were assumed as they are the most common type of vehicle for construction delivery.

Total VMTs for vehicles operating during each Proposed Action element and for each type of on-road construction activity during each construction year were estimated. Potential on-road construction emissions were estimated by multiplying the VMT data by the appropriate emission factors and the necessary conversion factors to present the criteria air pollutant emissions in tons.

Final design for the Proposed Action is not yet complete. As part of the potential grading activities at the borrow sites, there is still a possibility to use a conveyor belt to transport the fill material. However, for this analysis, diesel trucks were assumed to be used to present a conservative approach in estimating emissions. The analysis assumed a round-trip 5.25-mile material delivery route along Pleasant Grove Road and Nelson Road to the airfield. Emissions from diesel trucks transporting the fill would be greater than emissions using an electric conveyor belt system.

5.3 Non-Road Construction Equipment

Potential non-road construction emissions, including use of excavators, graders, and pavers, were estimated using the following formula as provided in the FAA's *Aviation Emissions and Air Quality Handbook Version 3 Update 1*.

> *Equipment Emission Rate (tons/year) = Full Throttle Emission Factor (grams/hp-hour) x size (hp) x hours per year x Load Factor x usage Factor x (1 pound/453.59 grams) x (1 ton/2,000 pounds)*

The dimensions and quantities of the Proposed Action elements were obtained from the Airport Authority. Each proposed element was input into the ACEIT to estimate the type of construction equipment, horsepower, load factor[19], and operating hours for each project element. The USEPA's MOVES3 model was used to identify the emission factor of each criteria air pollutant for each equipment type. Non-road construction equipment emissions were calculated based on the number of operating hours of equipment use and the emission factors. The detailed assumptions of non-road construction equipment and the emission factors for the Proposed Action are provided in **Attachment 3**.

5.4 Fugitive Dust

Potential fugitive dust emissions from grading, moving soil, and digging, loading/unloading of trucks, movement of trucks on unpaved surfaces, and wind erosion of stockpiles were estimated using the

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[19] Load factors are values that represent the ratio of the average energy demand of the equipment (the load) to the maximum (peak load) of the equipment.

methodology and formula as provided in the FAA's *Aviation Emissions and Air Quality Handbook Version 3 Update 1*.

5.5 Construction Emissions

A construction emissions inventory was prepared to reflect the use of construction equipment and vehicles attributed to the Proposed Action. The annual construction emissions inventory is provided in **Table 5-2**. Potential fugitive dust emissions are reflected in the PM_{10} and $PM_{2.5}$ totals.

TABLE 5-2, PROPOSED ACTION CONSTRUCTION EMISSIONS INVENTORY

YEAR	ANNUAL EMISSIONS (TONS PER YEAR)					
	CO	VOC	NO_x	SO_x	PM_{10}	$PM_{2.5}$
2023	21.3	1.6	25.6	0.1	166.2	17.9
2024	45.9	3.0	47.2	0.2	167.4	19.1
2025	38.4	2.3	33.0	0.1	175.7	19.5
2026	9.8	0.8	12.3	0.0	169.9	17.7
2027	8.6	0.4	5.3	0.0	28.3	3.1
2028	8.6	0.4	5.3	0.0	28.3	3.1
2029	8.6	0.4	5.3	0.0	28.3	3.1
2030	5.3	0.4	5.0	0.0	28.3	3.1

Source: Landrum & Brown analysis, 2022.

6 Future (2028) No Action Alternative

6.1 Aircraft

6.1.1 Aircraft Fleet Mix and Activity Level

Based on the aircraft activity forecast[20], there would be an increase in aircraft operations from the Existing Conditions (2020) to the Future (2028) No Action Alternative. There is a total of 257,610 aircraft operations forecasted for 2028 at RDU. **Table 6-1** presents the annual aircraft operations with the AEDT engine code modeled for the Future (2028) No Action Alternative.[21]

TABLE 6-1, ANNUAL OPERATIONS BY AIRCRAFT TYPE – FUTURE (2028) NO ACTION ALTERNATIVE

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Domestic Passenger / Air Carrier	Airbus A321-200 Series	01P08CM104	3,200
Domestic Passenger / Air Carrier	Airbus A321-200 Series	1IA005	9
Domestic Passenger / Air Carrier	Airbus A321-200 Series	3CM025	366

20 Raleigh-Durham International Airport. Aviation Activity Forecast, September 2021.
21 The aircraft type category for the Future scenarios is different from that of the Existing Conditions (Table 4-1) because the aircraft were derived from different sources. The aircraft type category for the Future scenarios was based on the aircraft activity forecast while the aircraft type category for the Existing Conditions was based on data from the RDU Airport Flight Tracking System.

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Domestic Passenger / Air Carrier	Airbus A321-200 Series	3IA008	539
Domestic Passenger / Air Carrier	Boeing 737-900-ER	01P11CM121	7,140
Domestic Passenger / Air Carrier	Boeing 737-900-ER	01P11CM122	1,098
Domestic Passenger / Air Carrier	Boeing 737-800 Series	3CM032	8,963
Domestic Passenger / Air Carrier	Boeing 737-800 Series	3CM034	560
Domestic Passenger / Air Carrier	Boeing 737-800 Series	8CM051	17,925
Domestic Passenger / Air Carrier	Boeing 737-800 Series	8CM066	560
Domestic Passenger / Air Carrier	Airbus A320-NEO	01P20CM128	5,427
Domestic Passenger / Air Carrier	Airbus A320-200 Series	1CM008	2,171
Domestic Passenger / Air Carrier	Airbus A320-200 Series	1CM009	2,171
Domestic Passenger / Air Carrier	Airbus A320-200 Series	1IA003	7,273
Domestic Passenger / Air Carrier	Airbus A320-200 Series	3CM026	868
Domestic Passenger / Air Carrier	Boeing 737-7	01P20CM136	11,342
Domestic Passenger / Air Carrier	Bombardier CS100	01P20PW183	17,323
Domestic Passenger / Air Carrier	Airbus A319-100 Series	3CM028	6,555
Domestic Passenger / Air Carrier	Airbus A319-100 Series	3IA006	3,277
Domestic Passenger / Air Carrier	Airbus A319-100 Series	3IA007	6,882
Domestic Passenger / Air Carrier	Airbus A319-100 Series	4CM036	655
Domestic Passenger / Air Carrier	Airbus A319-100 Series	6CM044	4,916
Domestic Passenger / Air Carrier	Bombardier CRJ-900	01P08GE190	9,088
Domestic Passenger / Regional Jet	Embraer ERJ175	01P08GE197	26,107

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Domestic Passenger / Regional Jet	Embraer ERJ175-LR	01P08GE197	6,679
Domestic Passenger / Regional Jet	Embraer ERJ170	01P08GE197	13,730
Domestic Passenger / Regional Jet	Bombardier CRJ-700	5GE083	565
Domestic Passenger / Regional Jet	Bombardier CRJ-700-ER	5GE083	2,261
Domestic Passenger / Regional Jet	Bombardier CRJ-700	5GE083	2,290
International / Air Carrier	Boeing 787-9 Dreamliner	01P17GE211	730
International / Air Carrier	Airbus A330-900N Series (Neo)	01P19RR119	632
International / Air Carrier	Boeing 737-900-ER	01P11CM121	16
International / Air Carrier	Boeing 737-800 Series	3CM032	70
International / Air Carrier	Boeing 737-800 Series	8CM051	70
International / Air Carrier	Airbus A320-200 Series	1IA003	404
International / Air Carrier	Bombardier CS100	01P20PW183	626
International / Air Carrier	Airbus A319-100 Series	4CM036	492
International / Air Carrier	Bombardier CRJ-900	01P08GE190	1,004
International / Regional Jet	Embraer ERJ175	01P08GE197	1,492
International / Regional Jet	Bombardier CRJ-200	01P05GE189	4
Freighter / Wide-Body	Boeing 767-300 ER Freighter	01P02GE188	3,418
Freighter / Wide-Body	Airbus A300F4-600 Series	1PW048	220
Freighter / Wide-Body	Airbus A300F4-600 Series	2GE039	392
Freighter / Wide-Body	Boeing 777 Freighter	01P21GE216	390
Freighter / Regional Jet	Cessna 208 Caravan	PT6A14	3,620
Air Taxi and GA / Jets	Bombardier Challenger 300	11HN003	3,664
Air Taxi and GA / Jets	Bombardier Challenger 600	01P05GE189	1,245
Air Taxi and GA / Jets	Bombardier Learjet 60	7PW077	716
Air Taxi and GA / Jets	Cessna 525 CitationJet	1PW035	3,723
Air Taxi and GA / Jets	Cessna 525 CitationJet	PW610F	2,269
Air Taxi and GA / Jets	Cessna 550 Citation II	1PW036	1,179
Air Taxi and GA / Jets	Cessna 560 Citation V	1PW037	4,335
Air Taxi and GA / Jets	Cessna 560 Citation XLS	PW530	3,422
Air Taxi and GA / Jets	Cessna 650 Citation III	1AS002	1,370
Air Taxi and GA / Jets	Cessna 680 Citation Sovereign	14PW103	2,544
Air Taxi and GA / Jets	CIRRUS SF-50 Vision	PW610F	1,113
Air Taxi and GA / Jets	Embraer 505	PW530	2,243

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Air Taxi and GA / Jets	Gulfstream G280	01P11HN012	744
Air Taxi and GA / Jets	Gulfstream IV-SP	11RR048	843
Air Taxi and GA / Jets	Raytheon Beechjet 400	1PW035	2,337
Air Taxi and GA / Jets	Raytheon Hawker 800	1AS002	1,655
Air Taxi and GA / Turboprops	ATR 42-300	PW120	3,036
Air Taxi and GA / Turboprops	Cessna 208 Caravan	PT6A14	910
Air Taxi and GA / Turboprops	EADS Socata TBM-700	PT6A60	144
Air Taxi and GA / Turboprops	Pilatus PC-12	PT67B	606
Air Taxi and GA / Turboprops	Pilatus PC-12	PT6A67	3,553
Air Taxi and GA / Turboprops	Piper PA46-TP Meridian	PT6A21	199
Air Taxi and GA / Turboprops	Raytheon Super King Air 200	PT6A40	286
Air Taxi and GA / Turboprops	Raytheon Super King Air 300	PT6A60	548
Air Taxi and GA / Turboprops	SOCATA TBM 850	PT6A66	184
Air Taxi and GA / Pistons	Cessna 172 Skyhawk	IO360	3,574
Air Taxi and GA / Pistons	Cessna 182	IO360	317
Air Taxi and GA / Pistons	Cirrus SR20	IO360	294
Air Taxi and GA / Pistons	Cirrus SR22	TIO540	2,132
Air Taxi and GA / Pistons	Diamond DA40	IO360	10,126
Air Taxi and GA / Pistons	Diamond DA42 Twin Star	IO360	672
Air Taxi and GA / Pistons	Mooney M20-K	TSIO36	268
Air Taxi and GA / Pistons	Piper PA-28 Cherokee Series	IO320	6,781
Air Taxi and GA / Pistons	Piper PA-32 Cherokee Six	TIO540	303
Air Taxi and GA / Pistons	Piper PA-34 Seneca	IO360	446
Air Taxi and GA / Pistons	Raytheon Beech 55 Baron	TIO540	593
Air Taxi and GA / Pistons	Raytheon Beech Bonanza 36	TIO540	838
Air Taxi and GA / Other / Helicopters	Aerospatiale SA-350D Astar (AS-350)	TPE3	834
Air Taxi and GA / Other / Helicopters	Bell 407 / Rolls-Royce 250-C47B	250B17	696
Air Taxi and GA / Other / Helicopters	Eurocopter EC-130	TPE3	358

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Military	Raytheon Super King Air 200	PT6A40	253
Military	Boeing C-17A	F1171	135
Military	Lockheed C-130 Hercules	T56A15	461
Military	Cessna 560 Citation V	1PW037	163
Military	Boeing F/A-18 Hornet	F4044	50
Military	Gulfstream G-5 Gulfstream 5 / G-5SP Gulfstream G500	3BR001	90
Military	Fairchild SA-226-T Merlin III	TPE1	860
Military	Eurocopter EC-155B1	T400	197
Military	Eurocopter EC-155B1	T70041	197
Military	Sikorsky SH-60 Sea Hawk	T70041	84
Military	Sikorsky UH-60 Black Hawk	T70070	500
Total			**257,610**

Notes: Total may not sum due to rounding.
Source: Landrum & Brown analysis, 2022.

6.1.2 Aircraft Taxi Time

There would be no change to the airfield configuration (the layout of the runways and taxiways) from the Existing Conditions (2020) to the Future (2028) No Action Alternative. Therefore, the aircraft taxi time for the Future (2028) No Action Alternative is expected to remain the same as the Existing Conditions (2020).

6.2 Motor Vehicles

6.2.1 Roadway Segments

There would be no change to Lumley Road or Commerce Boulevard from the Existing Conditions (2020) to the Future (2028) No Action Alternative. Therefore, the roadway segments, distances, and speeds for the Future (2028) No Action Alternative is expected to remain the same as the Existing Conditions (2020).

6.2.2 Traffic Volumes

Traffic levels on Lumley Road and Commerce Boulevard would be expected to increase in the future with the Future (2028) No Action Alternative compared to the existing conditions. Traffic volumes were increased at an annual growth rate of two percent to accommodate anticipated increases of vehicles on roadways.[22] **Table 6-2** presents the annual average daily traffic for each roadway segment for the Future (2028) No Action Alternative. Approximately 1,967,127 annual VMTs were estimated for Segment 1, approximately 1,667,670 for Segment 2, and approximately 250,235 for Segment 3.

[22] Davenport. Transportation Impact Analysis Lumley Road Relocation, May 19, 2021.

TABLE 6-2, TRAFFIC VOLUMES – FUTURE (2028) NO ACTION ALTERNATIVE

ROADWAY SEGMENT ID	ANNUAL AVERAGE DAILY TRAFFIC
1	11,482
2	15,817
3	4,335

Source: NCDOT and Landrum & Brown, 2022.

6.2.3 Vehicle Distribution

There would be no change to vehicle distribution from the Existing Conditions (2020) to the Future (2028) No Action Alternative. Therefore, the vehicle distributions for the Future (2028) No Action Alternative are expected to remain the same as the Existing Conditions (2020).

6.2.4 Emission Factors

The emission factors for the Future (2028) No Action Alternative were determined using the USEPA's MOVES3. The emission factors are provided in **Attachment 2**.

6.3 Future (2028) No Action Alternative Criteria Pollutant Emissions Inventory

The emissions inventory for the Future (2028) No Action Alternative is shown in **Table 6-3** and provides the total annual pollutant emissions as tons per year. The Future (2028) No Action Alternative emissions inventory shows the pollutants with the greatest emissions are CO and NO_x. There were approximately 827 tons of CO and 729 tons of NO_x. These pollutants are produced from the incomplete combustion of aircraft and motor vehicle engines.

TABLE 6-3, FUTURE (2028) NO ACTION ALTERNATIVE EMISSIONS INVENTORY (TONS/YEAR)

EMISSIONS SOURCE	CO	VOC	NO_x	SO_x	PM_{10}	$PM_{2.5}$
Aircraft Taxiing	547.6	57.5	98.9	26.5	2.1	2.1
Aircraft Landing and Takeoff	271.2	81.0	629.0	41.7	4.1	4.1
Motor Vehicles	8.4	0.1	0.7	0.0	0.0	0.0
Total:	**827.3**	**138.6**	**728.5**	**68.2**	**6.3**	**6.3**

Note: CO = Carbon Monoxide; VOC = Volatile Organic Compounds; NO_x = Nitrous Oxides; SO_x = Sulfur Oxides; PM_{10} = Coarse Particulate Matter; $PM_{2.5}$ = Fine Particulate Matter; Numbers may not sum due to rounding
Source: Landrum & Brown analysis, 2022.

7 Future (2028) Proposed Action

7.1 Aircraft

7.1.1 Aircraft Fleet Mix and Activity Level

The Proposed Action would provide the same capability for the Airport once Runway 5L/23R is relocated as it does today. No change to the number of aircraft operations or fleet mix would occur as a result of implementing the Proposed Action. Therefore, the number of aircraft operations and fleet mix for the Future (2028) No Action Alternative would remain the same for the Future (2028) Proposed Action. Based on the aircraft activity forecast, there is a total of 257,610 aircraft operations forecast for 2028 at RDU.

7.1.2 Aircraft Taxi Time

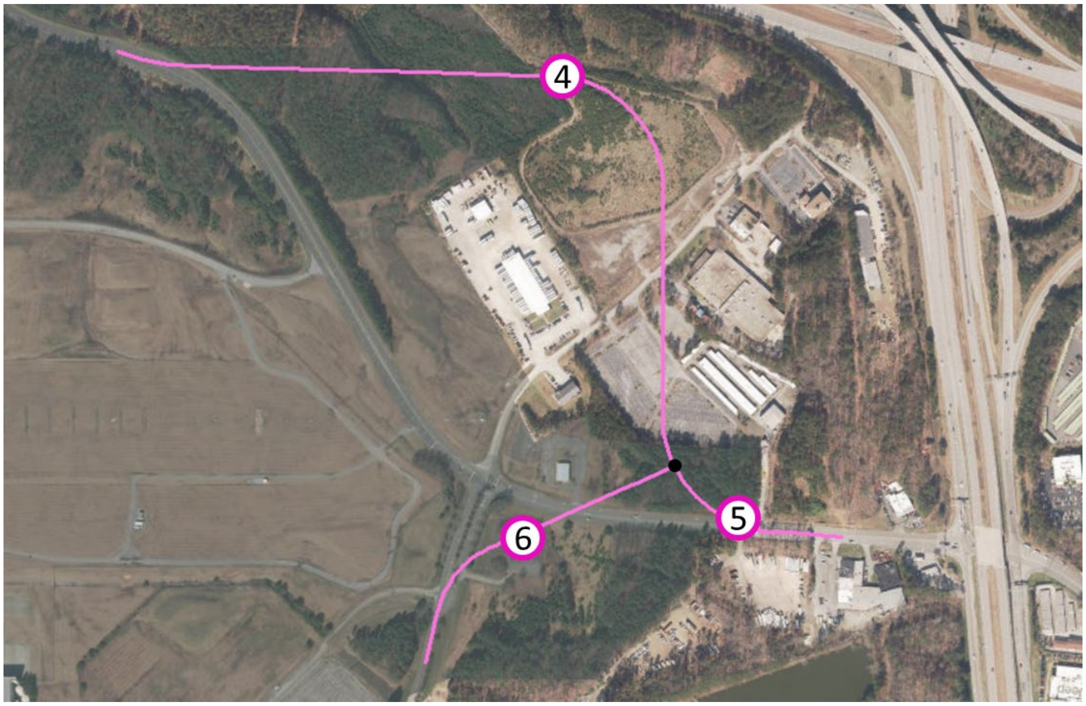
As a result of implementing the Proposed Action, the replacement Runway 5L/23R would be 537 feet northwest of the existing Runway 5L/23R. Aircraft using the replacement Runway 5L/23R would have to taxi a further distance to and from the terminal facilities than they would compared to the No Action Alternative. To account for the increase in aircraft taxiing emissions, an increase in taxi times was determined and applied to every aircraft operation. Aircraft were assumed to travel at a taxiing speed of 10 knots. An average increase in taxiing distance of 537 feet was assumed each for taxi in and taxi out operation. Because not every aircraft operation at RDU uses Runway 5L/23R, the existing runway use was used to determine that up to 61 percent of aircraft operations would experience an increase in taxi time. Therefore, the Future (2028) Proposed Action would result in an average taxi-in time of five minutes and eight seconds and an average taxi-out time of 14 minutes and 18 seconds. This is an overall increase of approximately 32 seconds of total taxi time per operation compared to the Future (2028) No Action Alternative.

7.2 Motor Vehicles

7.2.1 Roadway Segments

The Proposed Action includes the relocation of a portion of Lumley Road. The roadway segments that would be relocated are shown on **Exhibit 7-1** and represented as Segment 4, 5, and 6.

Exhibit 7-1, Roadway Segments – Future (2028) Proposed Action



Source: Airport Authority and Landrum & Brown, 2021.

The distances and speeds in miles per hour (mph) for each roadway segment were determined. It is anticipated that vehicles would have to travel approximately 0.23 miles further due to the relocation of Lumley Road compared to the distance that they travel today. **Table 7-1** presents the distances and speeds for each roadway segment for the Future (2028) Proposed Action.

TABLE 7-1, ROADWAY SEGMENTS – FUTURE (2028) PROPOSED ACTION

ROADWAY SEGMENT ID	SEGMENT LENGTH (MILES)	SPEED (MILES PER HOUR)
4	0.72	45
5	0.16	45
6	0.27	25

Source: Landrum & Brown, 2021.

7.2.2 Traffic Volumes

There would be no change to traffic volumes due to the Proposed Action. However, the increase in distance travelled on these roadways would result in an increase to the annual VMTs. Approximately 2,997,963 annual VMTs were estimated for Segment 4, approximately 895,567 for Segment 5, and approximately 431,537 for Segment 6.

7.2.3 Vehicle Distribution

There would be no change to vehicle distribution on the roadways due to the Proposed Action. Therefore, the vehicle distributions for the Future (2028) Proposed Action would be the same as the Future (2028) No Action Alternative.

7.2.4 Emission Factors

There would be no change to vehicle emission factors due to the Proposed Action. Therefore, the emission factors for the Future (2028) Proposed Action would be the same as the Future (2028) No Action Alternative.

7.3 Future (2028) Proposed Action Criteria Pollutant Emissions Inventory

The emissions inventory for the Future (2028) Proposed Action is shown in **Table 7-2** and provides the total annual pollutant emissions as tons per year. The Future (2028) Proposed Action emissions inventory shows the pollutants with the greatest emissions are CO and NO_x. There were approximately 848 tons of CO and 732 tons of NO_x.

TABLE 7-2, FUTURE (2028) PROPOSED ACTION EMISSIONS INVENTORY (TONS/YEAR)

EMISSIONS SOURCE	CO	VOC	NO_x	SO_x	PM_{10}	$PM_{2.5}$
Aircraft Taxiing	567.1	60.7	102.4	27.5	2.2	2.2
Aircraft Landing and Takeoff	271.2	81.0	629.0	41.7	4.1	4.1
Motor Vehicles	9.5	0.1	0.7	0.0	0.0	0.0
Total:	**847.8**	**141.8**	**732.1**	**69.2**	**6.3**	**6.3**

Note: CO = Carbon Monoxide; VOC = Volatile Organic Compounds; NO_x = Nitrous Oxides; SO_x = Sulfur Oxides; PM_{10} = Coarse Particulate Matter; $PM_{2.5}$ = Fine Particulate Matter
Numbers may not sum due to rounding
Source: Landrum & Brown analysis, 2022.

8 Future (2033) No Action Alternative

8.1 Aircraft

8.1.1 Aircraft Fleet Mix and Activity Level

Based on the aircraft activity forecast, there would be an increase in operations from the Future (2028) No Action Alternative to the Future (2033) No Action Alternative. There is a total of 287,850 aircraft operations forecast for 2033 at RDU. **Table 8-1** presents the annual aircraft operations with the AEDT engine code modeled for the Future (2033) No Action Alternative. [23]

TABLE 8-1, ANNUAL OPERATIONS BY AIRCRAFT TYPE – FUTURE (2033) NO ACTION ALTERNATIVE

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Domestic Passenger / Air Carrier	Airbus A321-200 Series	01P08CM104	3,609

[23] The aircraft type category for the Future scenarios is different from that of the Existing Conditions (Table 4-1) because the aircraft were derived from different sources. The aircraft type category for the Future scenarios was based on the aircraft activity forecast while the aircraft type category for the Existing Conditions was based on data from the RDU Airport Flight Tracking System.

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Domestic Passenger / Air Carrier	Airbus A321-200 Series	1IA005	10
Domestic Passenger / Air Carrier	Airbus A321-200 Series	3CM025	412
Domestic Passenger / Air Carrier	Airbus A321-200 Series	3IA008	608
Domestic Passenger / Air Carrier	Boeing 737-900-ER	01P11CM121	7,991
Domestic Passenger / Air Carrier	Boeing 737-900-ER	01P11CM122	1,293
Domestic Passenger / Air Carrier	Boeing 737-800 Series	3CM032	9,562
Domestic Passenger / Air Carrier	Boeing 737-800 Series	3CM034	579
Domestic Passenger / Air Carrier	Boeing 737-800 Series	8CM051	20,862
Domestic Passenger / Air Carrier	Boeing 737-800 Series	8CM066	579
Domestic Passenger / Air Carrier	Airbus A320-NEO	01P20CM128	5,417
Domestic Passenger / Air Carrier	Airbus A320-200 Series	1CM008	2,216
Domestic Passenger / Air Carrier	Airbus A320-200 Series	1CM009	2,216
Domestic Passenger / Air Carrier	Airbus A320-200 Series	1IA003	9,553
Domestic Passenger / Air Carrier	Airbus A320-200 Series	3CM026	788
Domestic Passenger / Air Carrier	Boeing 737-7	01P20CM136	12,788
Domestic Passenger / Air Carrier	Bombardier CS100	01P20PW183	19,531
Domestic Passenger / Air Carrier	Airbus A319-100 Series	3CM028	8,355
Domestic Passenger / Air Carrier	Airbus A319-100 Series	3IA006	2,422
Domestic Passenger / Air Carrier	Airbus A319-100 Series	3IA007	8,083
Domestic Passenger / Air Carrier	Airbus A319-100 Series	6CM044	6,266
Domestic Passenger / Air Carrier	Bombardier CRJ-900	01P08GE190	8,770

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Domestic Passenger / Regional Jet	Embraer ERJ175	01P08GE197	30,618
Domestic Passenger / Regional Jet	Embraer ERJ175-LR	01P08GE197	7,166
Domestic Passenger / Regional Jet	Embraer ERJ170	01P08GE197	17,622
Domestic Passenger / Regional Jet	Bombardier CRJ-700-ER	5GE083	1,038
Domestic Passenger / Regional Jet	Bombardier CRJ-700	5GE083	2,286
International / Air Carrier	Airbus A350-900 series	01P18RR124	730
International / Air Carrier	Boeing 787-9 Dreamliner	01P17GE211	730
International / Air Carrier	Airbus A330-900N Series (Neo)	01P19RR119	632
International / Air Carrier	Boeing 737-900-ER	01P11CM121	24
International / Air Carrier	Boeing 737-800 Series	3CM032	102
International / Air Carrier	Boeing 737-800 Series	8CM051	102
International / Air Carrier	Airbus A320-200 Series	1IA003	558
International / Air Carrier	Bombardier CS100	01P20PW183	862
International / Air Carrier	Airbus A319-100 Series	4CM036	720
International / Air Carrier	Bombardier CRJ-900	01P08GE190	1,138
International / Regional Jet	Embraer ERJ175	01P08GE197	1,702
Freighter / Wide-Body	Boeing 767-300 ER Freighter	01P02GE188	4,072
Freighter / Wide-Body	Airbus A300F4-600 Series	1PW048	188
Freighter / Wide-Body	Airbus A300F4-600 Series	2GE039	334
Freighter / Wide-Body	Boeing 777 Freighter	01P21GE216	444
Freighter / Regional Jet	Cessna 208 Caravan	PT6A14	4,132
Air Taxi and GA / Jets	Bombardier Challenger 300	11HN003	4,272
Air Taxi and GA / Jets	Bombardier Challenger 600	01P05GE189	1,452
Air Taxi and GA / Jets	Bombardier Learjet 60	7PW077	834
Air Taxi and GA / Jets	Cessna 525 CitationJet	1PW035	4,340
Air Taxi and GA / Jets	Cessna 525 CitationJet	PW610F	2,645
Air Taxi and GA / Jets	Cessna 550 Citation II	1PW036	1,374
Air Taxi and GA / Jets	Cessna 560 Citation V	1PW037	5,056
Air Taxi and GA / Jets	Cessna 560 Citation XLS	PW530	3,990
Air Taxi and GA / Jets	Cessna 650 Citation III	1AS002	1,597
Air Taxi and GA / Jets	Cessna 680 Citation Sovereign	14PW103	2,966
Air Taxi and GA / Jets	CIRRUS SF-50 Vision	PW610F	1,297
Air Taxi and GA / Jets	Embraer 505	PW530	2,615

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Air Taxi and GA / Jets	Gulfstream G280	01P11HN012	867
Air Taxi and GA / Jets	Gulfstream IV-SP	11RR048	983
Air Taxi and GA / Jets	Raytheon Beechjet 400	1PW035	2,725
Air Taxi and GA / Jets	Raytheon Hawker 800	1AS002	1,930
Air Taxi and GA / Turboprops	ATR 42-300	PW120	3,410
Air Taxi and GA / Turboprops	Cessna 208 Caravan	PT6A14	1,022
Air Taxi and GA / Turboprops	EADS Socata TBM-700	PT6A60	161
Air Taxi and GA / Turboprops	Pilatus PC-12	PT67B	681
Air Taxi and GA / Turboprops	Pilatus PC-12	PT6A67	3,991
Air Taxi and GA / Turboprops	Piper PA46-TP Meridian	PT6A21	223
Air Taxi and GA / Turboprops	Raytheon Super King Air 200	PT6A40	321
Air Taxi and GA / Turboprops	Raytheon Super King Air 300	PT6A60	615
Air Taxi and GA / Turboprops	SOCATA TBM 850	PT6A66	207
Air Taxi and GA / Pistons	Cessna 172 Skyhawk	IO360	3,530
Air Taxi and GA / Pistons	Cessna 182	IO360	313
Air Taxi and GA / Pistons	Cirrus SR20	IO360	290
Air Taxi and GA / Pistons	Cirrus SR22	TIO540	2,106
Air Taxi and GA / Pistons	Diamond DA40	IO360	10,002
Air Taxi and GA / Pistons	Diamond DA42 Twin Star	IO360	664
Air Taxi and GA / Pistons	Mooney M20-K	TSIO36	265
Air Taxi and GA / Pistons	Piper PA-28 Cherokee Series	IO320	6,699
Air Taxi and GA / Pistons	Piper PA-32 Cherokee Six	TIO540	299
Air Taxi and GA / Pistons	Piper PA-34 Seneca	IO360	441
Air Taxi and GA / Pistons	Raytheon Beech 55 Baron	TIO540	586
Air Taxi and GA / Pistons	Raytheon Beech Bonanza 36	TIO540	828
Air Taxi and GA / Other / Helicopters	Aerospatiale SA-350D Astar (AS-350)	TPE3	951
Air Taxi and GA / Other / Helicopters	Bell 407 / Rolls-Royce 250-C47B	250B17	794
Air Taxi and GA / Other / Helicopters	Eurocopter EC-130	TPE3	408

TYPE	AEDT AIRCRAFT DESCRIPTIONS	AEDT ENGINE CODE	TOTAL
Military	Raytheon Super King Air 200	PT6A40	253
Military	Boeing C-17A	F1171	135
Military	Lockheed C-130 Hercules	T56A15	461
Military	Cessna 560 Citation V	1PW037	163
Military	Boeing F/A-18 Hornet	F4044	50
Military	Gulfstream G-5 Gulfstream 5 / G-5SP Gulfstream G500	3BR001	90
Military	Fairchild SA-226-T Merlin III	TPE1	860
Military	Eurocopter EC-155B1	T400	197
Military	Eurocopter EC-155B1	T70041	197
Military	Sikorsky SH-60 Sea Hawk	T70041	84
Military	Sikorsky UH-60 Black Hawk	T70070	500
Total			**287,850**

Notes: Total may not sum due to rounding.
Source: Landrum & Brown analysis, 2022.

8.1.2 Aircraft Taxi Time

There would be no change to the airfield configuration (the layout of the runways and taxiways) from the Future (2028) No Action Alternative to the Future (2033) No Action Alternative. Therefore, the aircraft taxi time for the Future (2033) No Action Alternative is expected to remain the same as the Existing Conditions (2020) and the Future (2028) No Action Alternative.

8.2 Motor Vehicles

8.2.1 Roadway Segments

There would be no change to Lumley Road from the Existing Conditions (2020) to the Future (2033) No Action Alternative. Therefore, the roadway segments, distances, and speeds for the Future (2033) No Action Alternative is expected to remain the same as the Existing Conditions (2020) and the Future (2028) No Action Alternative.

8.2.2 Traffic Volumes

Traffic levels on Lumley Road and Commerce Boulevard would be expected to increase in the future with the No Action compared to the existing conditions. Traffic volumes were increased at an annual growth rate of two percent.[24] **Table 8-2** presents the annual average daily traffic for each roadway segment for the Future (2033) No Action Alternative. Approximately 2,171,867 annual VMTs were estimated for Segment 1, approximately 1,841,243 for Segment 2, and approximately 276,280 for Segment 3.

[24] Davenport. Transportation Impact Analysis Lumley Road Relocation, May 19, 2021.

TABLE 8-2, TRAFFIC VOLUMES AND VMTS – FUTURE (2033) NO ACTION ALTERNATIVE

ROADWAY SEGMENT ID	ANNUAL AVERAGE DAILY TRAFFIC
1	11,482
2	15,817
3	4,335

Source: NCDOT and Landrum & Brown, 2021.

8.2.3 Vehicle Distribution

There would be no change to vehicle distribution from the Existing Conditions (2020) or the Future (2028) No Action Alternative to the Future (2033) No Action Alternative. Therefore, the vehicle distributions for the Future (2033) No Action Alternative are expected to remain the same as the Existing Conditions (2020) and the Future (2028) No Action Alternative.

8.2.4 Emission Factors

The emission factors for the Future (2033) No Action Alternative were determined using the USEPA's MOVES3. The emission factors are provided in **Attachment 3**.

8.3 Future (2033) No Action Alternative Criteria Pollutant Emissions Inventory

The emissions inventory for the Future (2033) No Action Alternative is shown in **Table 8-3** and provides the total annual pollutant emissions as tons per year. The Future (2033) No Action Alternative emissions inventory shows the pollutants with the greatest emissions are CO and NO_x. There were approximately 913 tons of CO and 834 tons of NO_x.

TABLE 8-3, FUTURE (2033) NO ACTION ALTERNATIVE EMISSIONS INVENTORY (TONS/YEAR)

EMISSIONS SOURCE	CO	VOC	NO_x	SO_x	PM_{10}	$PM_{2.5}$
Aircraft Taxiing	622.0	67.4	112.6	30.2	2.4	2.4
Aircraft Landing and Takeoff	283.7	92.1	720.6	47.4	4.7	4.7
Motor Vehicles	6.8	0.0	0.5	0.0	0.0	0.0
Total:	**912.5**	**159.5**	**833.7**	**77.7**	**7.2**	**7.2**

Note: CO = Carbon Monoxide; VOC = Volatile Organic Compounds; NO_x = Nitrous Oxides; SO_x = Sulfur Oxides; PM_{10} = Coarse Particulate Matter; $PM_{2.5}$ = Fine Particulate Matter
Numbers may not sum due to rounding

Source: Landrum & Brown analysis, 2022.

9 Future (2033) Proposed Action

9.1 Aircraft

9.1.1 Aircraft Fleet Mix and Activity Level

There is no change to the number of aircraft operations or fleet mix as a result of implementing the Proposed Action. Therefore, the number of aircraft operations and fleet mix for the Future (2033) Proposed Action would remain the same the Future (2033) No Action Alternative. Based on the aircraft activity forecast, there is a total of 287,850 aircraft operations forecast for 2033 at RDU.

9.1.2 Aircraft Taxi Time

As a result of implementing the Proposed Action, the replacement Runway 5L/23R would be 537 feet northwest of the existing Runway 5L/23R. Aircraft using the replacement Runway 5L/23R would have to taxi a further distance to and from the terminal than they would compared to the No Action Alternative. To account for the increase in aircraft taxiing emissions, an increase in taxi times was determined and applied to every aircraft operation. Aircraft were assumed to travel at a taxiing speed of 10 knots. An average increase in taxiing distance of 537 feet was assumed each for taxi in and taxi out operation. Because not every aircraft operation at RDU uses Runway 5L/23, the existing runway use was used to determine that up to 61 percent of aircraft operations would experience an increase in taxi time. Therefore, the Future (2033) Proposed Action would result in an average taxi-in time of five minutes and eight seconds and an average taxi-out time of 14 minutes and 18 seconds. This is an overall increase of approximately 32 seconds of total taxi time per operation compared to the Future (2033) No Action Alternative.

9.2 Motor Vehicles

9.2.1 Roadway Segments

The Proposed Action includes the relocation of a portion of Lumley Road and Commerce Boulevard. The distances and speeds for the Future (2033) Proposed Action would be the same as the Future (2028) Proposed Action. It is anticipated that vehicles would have to travel approximately 0.23 miles further due to the relocation of Lumley Road compared to the distance that they travel today.

9.2.2 Traffic Volumes

There would be no change to traffic volumes due to the Proposed Action. However, the increase in distance travelled on these roadways would result in an increase to the annual VMTs. Approximately 3,309,994 annual VMTs were estimated for Segment 4, approximately 988,779 for Segment 5, and approximately 476,452 for Segment 6.

9.2.3 Vehicle Distribution

There would be no change to vehicle distribution on the roadways due to the Proposed Action. Therefore, the vehicle distributions for the Future (2033) Proposed Action would be the same as the Future (2033) No Action Alternative.

9.2.4 Emission Factors

There would be no change to vehicle emission factors due to the Proposed Action. Therefore, the emission factors for the Future (2033) Proposed Action would be the same as the Future (2033) No Action Alternative.

9.3 Future (2033) Proposed Action Criteria Pollutant Emissions Inventory

The emissions inventory for the Future (2033) Proposed Action is shown in **Table 9-1** and provides the total annual pollutant emissions as tons per year. The Future (2033) Proposed Action emissions inventory shows the pollutants with the greatest emissions are CO and NO_x. There were approximately 936 tons of CO and 838 tons of NO_x.

TABLE 9-1, FUTURE (2033) PROPOSED ACTION EMISSIONS INVENTORY (TONS/YEAR)

EMISSIONS SOURCE	CO	VOC	NO_x	SO_x	PM_{10}	$PM_{2.5}$
Aircraft Taxiing	644.1	71.1	116.6	31.3	2.5	2.5
Aircraft Landing and Takeoff	283.7	92.1	720.6	47.4	4.7	4.7
Motor Vehicles	7.7	0.0	0.5	0.0	0.0	0.0
Total:	**935.5**	**163.2**	**837.7**	**78.7**	**7.3**	**7.3**

Note: CO = Carbon Monoxide; VOC = Volatile Organic Compounds; NO_x = Nitrous Oxides; SOx = Sulfur Oxides; PM_{10} = Coarse Particulate Matter; $PM_{2.5}$ = Fine Particulate Matter

Source: Landrum & Brown analysis, 2022.

10 Air Quality Significance Determination

In this section, the emissions inventories prepared for Proposed Action are compared to the emissions inventories prepared for the No Action Alternative of the same future year to disclose the potential increase in emissions. The comparison of the emission inventories, which included an inventory of construction and operational emissions, were used for the evaluation of General Conformity as required for the CAA.

Table 10-1 provides the total emissions inventory summary. From 2023 through 2030, there is an increase in net emissions due to construction activities associated with the Proposed Action compared to the No Action Alternative. There is also an overall increase in operational emissions due to aircraft taxiing emissions as Runway 5L/23R is moved further away from the Airport terminal facilities.

The pollutants of concern for this project are VOCs and NO_x. The applicable federal *de minimis* thresholds for these pollutants are 100 tons per year each for the project. Table 10-1 shows that neither of the relevant federal *de minimis* thresholds were equaled or exceeded for the Proposed Action in any analysis year. The emissions inventories prepared for the air quality analysis also provide the emissions estimates for CO, SO_x, PM_{10}, and $PM_{2.5}$ for disclosures purposes only.

TABLE 10-1, TOTAL EMISSIONS INVENTORY – PROPOSED ACTION

YEAR	SOURCE	ANNUAL EMISSIONS (SHORT TONS PER YEAR)					
		CO	VOC	NO_x	SO_x	PM_{10}	$PM_{2.5}$
	Federal *de minimis* Threshold	*N/A*	*100*	*100*	*N/A*	*N/A*	*N/A*
2023	Proposed Action (Construction)	21.3	1.6	25.6	0.1	166.2	17.9
	2023 Increase in Emissions	***21.3***	***1.6***	***25.6***	***0.1***	***166.2***	***17.9***
2024	Proposed Action (Construction)	45.9	3.0	47.2	0.2	167.4	19.1
	2024 Increase in Emissions	***45.9***	***3.0***	***47.2***	***0.2***	***167.4***	***19.1***
2025	Proposed Action (Construction)	38.4	2.3	33.0	0.1	175.7	19.5
	2025 Increase in Emissions	***38.4***	***2.3***	***33.0***	***0.1***	***175.7***	***19.5***
2026	Proposed Action (Construction)	9.8	0.8	12.3	0.0	169.9	17.7
	2026 Increase in Emissions	***9.8***	***0.8***	***12.3***	***0.0***	***169.9***	***17.7***
2027	Proposed Action (Construction)	8.6	0.4	5.3	0.0	28.3	3.1
	2027 Increase in Emissions	***8.6***	***0.4***	***5.3***	***0.0***	***28.3***	***3.1***
2028	No Action Alternative	827.3	138.6	728.5	68.2	6.3	6.3
2028	Proposed Action (Construction and Operation)	856.4	142.2	737.4	69.2	34.7	9.5
	2028 Increase in Emissions	***29.1***	***3.6***	***8.9***	***1.0***	***28.4***	***3.2***
2029	No Action Alternative	912.5	159.5	833.7	77.7	7.2	7.2
2029	Proposed Action (Construction and Operation)	944.0	163.6	843.0	78.8	35.6	10.4
	2029 Increase in Emissions	***31.6***	***4.1***	***9.3***	***1.1***	***28.4***	***3.2***
2030	No Action Alternative	912.5	159.5	833.7	77.7	7.2	7.2
2030	Proposed Action (Construction and Operation)	940.8	163.6	842.7	78.7	35.6	10.4
	2030 Increase in Emissions	***28.3***	***4.1***	***9.1***	***1.1***	***28.4***	***3.2***
2033	No Action Alternative	912.5	159.5	833.7	77.7	7.2	7.2
2033	Proposed Action (Operation)	935.5	163.2	837.7	78.7	7.3	7.3

	2033 Increase in Emissions	***23.0***	***3.7***	***4.0***	***1.1***	***0.1***	***0.1***
Federal Threshold Exceeded?		*N/A*	***No***	***No***	*N/A*	*N/A*	*N/A*

Notes: N/A = Not applicable.
Numbers may not sum to totals due to rounding.
Source: Landrum & Brown analysis, 2022

The air quality analysis demonstrates that Proposed Action would not cause an increase in air emissions above the applicable *de minimis* thresholds. Therefore, the Proposed Action conforms to the SIP and the CAA and would not create any new violation of the NAAQS, delay the attainment of any NAAQS, nor increase the frequency or severity of any existing violations of the NAAQS. As such, no adverse impact on local or regional air quality is expected by construction and implementation of the Proposed Action. No further analysis or reporting is required under the CAA or NEPA.

10.1 Mitigation, Avoidance, and Minimization Measures

The Proposed Action does not exceed the applicable thresholds of significance for any pollutants; therefore, no mitigation measures are required. However, the following minimization measures and Best Management Practices (BMPs) are being provided to further minimize air quality impacts from the Proposed Action. Note, these measures are provided for disclosure and were not included as part of the modeling or reflected in the emissions inventory.

Construction of the Proposed Action would result in a short-term increase of particulate matter (airborne fugitive dust) emissions from vehicle movement and soil excavation in and around the construction site. The Airport Authority will ensure that measures are taken to reduce fugitive dust emissions by adhering to guidelines included in FAA Advisory Circular (AC) 150/5370-10H, *Standard Specifications for Construction of Airports*.[25]

Methods of controlling dust and other airborne particles will be implemented to the maximum possible extent and may include, but would not be limited to, the following:

- Exposing the minimum area of erodible earth;
- Applying temporary mulch with or without seeding;
- Using water sprinkler trucks;
- Using covered haul trucks;
- Using dust palliatives or penetration asphalt on haul roads; and,
- Using plastic sheet coverings.

In addition, when possible, utilizing alternatively fueled equipment and reducing the idling time on equipment will be employed to minimize potential air quality impacts. Prior to construction, an application will be submitted, and a permit received to construct and operate Air Pollution Abatement facilities and/or Emission Sources as per 15A North Carolina Administrative Code (NCAC) (2Q.O100 thru 2Q.0300), as applicable. Furthermore, any open burning associated with the project will be in compliance with 15A NCAC 2D.1900.

25 FAA AC, 2014, Standard Specifications for Construction of Airports, Item C-102, Temporary Air and Water Pollution, Soil Erosion, and Siltation Control, AC 150/5370-10H.

11 Regulatory Setting for Climate

The federal regulatory setting for climate in NEPA documents is continually changing. Per FAA Order 1050.1F Desk Reference, there are no federal significance thresholds for GHG emissions, nor has the FAA identified specific factors to consider in making a significance determination for GHG emissions.

12 Methodology for Climate

Per FAA Order 1050.1F, the discussion of potential climate impacts should be documented in a separate section of the NEPA document, distinct from air quality. FAA guidance notes that if a project might increase criteria pollutants and/or fuel use, it could increase greenhouse gas (GHG) emissions, warranting an emissions inventory.

GHG emissions inventories were conducted for this analysis to provide the estimate of the annual rate (metric tons per year) of GHG emissions attributable to airport sources for the No Action and the Proposed Action. The GHG emissions inventories were conducted in accordance with the guidelines provided in FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures* (including the Desk Reference); FAA Order 5050.4B, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions*; and FAA's *Aviation Emissions and Air Quality Handbook Version 3 Update 1*.

GHG emissions inventories were prepared based on actual and/or estimated fuel usage or VMTs and an appropriate emission factor. The GHG emissions inventories were prepared using the same data and assumptions as developed for the air quality criteria pollutant emissions inventories. The emissions results for all inventories were summed and are provided in tabular form for each analysis year. A comparison was made of the GHG inventories between the Future (2028) No Action Alternative and the Future (2028) Proposed Action. Similarly, a comparison was made between the Future (2033) No Action Alternative and the Future (2033) Proposed Action.

12.1 Pollutants

GHGs are gases that trap heat in the earth's atmosphere. GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFC), and perfluorocarbons (PFCs). Of these GHGs, only CO_2, CH_4 and N_2O are potentially emitted directly or indirectly as a consequence of the Proposed Action and are included in this analysis.

12.2 Global Warming Potential

GHGs differ from each other in their ability to absorb energy and how long they stay in the atmosphere. The Global Warming Potential (GWP) is a standard of measurement that was developed to allow comparisons of the global warming impacts of different gases by converting each gas amount to a carbon dioxide equivalent (CO_2e). GWPs provide a common unit of measure, which allows for one emission estimate of these different gases.

GWPs based on a 100-year period (GWP 100) provided in the FAA's *Aviation Emissions and Air Quality Handbook Version 3 Update 1* and based on the Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5) are used in this evaluation. CO_2 has a GWP of one (1) because it is the gas used as the reference point. Methane does not last as long in the atmosphere as CO_2 however it absorbs much more energy. Therefore, one ton of methane has 34 times more heat capturing potential than one ton of carbon dioxide. The amount of methane emissions would be multiplied by 34 to determine its CO_2e value. Nitrous oxides last in the atmosphere far longer than CO_2. The amount of nitrous oxides emissions would be multiplied by 298 to determine its CO_2e value.

13 Existing Conditions (2020) GHG Emissions Inventory

Table 13-1 provides the GHG CO_2e for the Existing Conditions (2020) in metric tons per year.

TABLE 13-1, EXISTING CONDITIONS GHG EMISSIONS INVENTORY (METRIC TONS/YEAR)

EMISSIONS SOURCE	CO_2e
Aircraft Taxiing	25,554
Aircraft Landing and Takeoff	39,460
Motor Vehicles	1,283
Total:	66,297

Note: Numbers may not sum due to rounding
Source: Landrum & Brown analysis, 2021.

14 GHG Construction Emissions Inventory

The GHG construction emissions inventories were prepared using the same data and assumptions as developed for the criteria pollutant construction emissions inventories. The construction emissions inventory for the Proposed Action is shown in **Table 14-1**. As the table shows, peak construction GHG emissions are expected to occur in 2024 and produce 57,180 metric tons of CO_2e.

TABLE 14-1, GHG CONSTRUCTION EMISSIONS INVENTORY –PROPOSED ACTION

YEAR	SOURCE	ANNUAL GHG EMISSIONS (CO_2e METRIC TONS PER YEAR)
2023	Construction Only	30,472
2024	Construction Only	57,182
2025	Construction Only	38,544
2026	Construction Only	12,053
2027	Construction Only	6,505
2028	Construction Only	6,505
2029	Construction Only	6,505
2030	Construction Only	5,910

Note: Numbers may not sum due to rounding.
Source: Landrum & Brown analysis, 2021.

15 Future (2028) No Action Alternative GHG Emissions Inventory

Table 15-1 provides the GHG CO_2e for the Future (2028) No Action Alternative in metric tons per year.

TABLE 15-1, FUTURE (2028) NO ACTION ALTERNATIVE GHG EMISSIONS INVENTORY (METRIC TONS/YEAR)

EMISSIONS SOURCE	CO_2e
Aircraft Taxiing	64,837
Aircraft Landing and Takeoff	101,910
Motor Vehicles	1,263
Total:	**168,010**

Note: Numbers may not sum due to rounding
Source: Landrum & Brown analysis, 2022.

16 Future (2028) Proposed Action GHG Emissions Inventory

Table 16-1 provides the GHG CO_2e for the Future (2028) Proposed Action in metric tons per year.

TABLE 16-1, FUTURE (2028) PROPOSED ACTION GHG EMISSIONS INVENTORY (METRIC TONS/YEAR)

EMISSIONS SOURCE	CO_2e
Aircraft Taxiing	67,142
Aircraft Landing and Takeoff	101,908
Motor Vehicles	1,419
Total:	**176,974**

Note: Numbers may not sum due to rounding
Source: Landrum & Brown analysis, 2022.

17 Future (2033) No Action Alternative GHG Emissions Inventory

Table 17-1 provides the GHG CO_2e for the Future (2033) No Action Alternative in metric tons per year.

TABLE 17-1, FUTURE (2033) NO ACTION ALTERNATIVE GHG EMISSIONS INVENTORY (METRIC TONS/ YEAR)

EMISSIONS SOURCE	CO_2e
Aircraft Taxiing	73,871
Aircraft Landing and Takeoff	115,885
Motor Vehicles	1,291
Total:	**191,047**

Note: Numbers may not sum due to rounding
Source: Landrum & Brown analysis, 2022.

18 Future (2033) Proposed Action GHG Emissions Inventory

Table 18-1 provides the GHG CO_2e for the Future (2033) Proposed Action in metric tons per year.

TABLE 18-1, FUTURE (2033) PROPOSED ACTION GHG EMISSIONS INVENTORY (METRIC TONS/YEAR)

EMISSIONS SOURCE	CO_2e
Aircraft Taxiing	76,497
Aircraft Landing and Takeoff	115,880
Motor Vehicles	1,451
Total:	**193,828**

Note: Numbers may not sum due to rounding
Source: Landrum & Brown analysis, 2022.

19 Climate Significance Determination

In this section, the GHG emissions inventories prepared for Proposed Action are compared to the GHG emissions inventories prepared for the No Action Alternative of the same future year to disclose the potential increase in GHG emissions. The results of the comparison between the Proposed Action and the No Action Alternative for 2028 are shown in **Table 19-1**.

TABLE 19-1: SUMMARY OF 2028 GHG EMISSIONS, PROPOSED ACTION COMPARED TO THE NO ACTION ALTERNATIVE

SCENARIO	ANNUAL EMISSIONS (CO_2e metric tons per year)
	Total CO_2e
No Action Alternative	168,010
Proposed Action (Construction and Operational GHG Emissions)	176,974
2028 Increase in Emissions	***8,965***

Note: Totals may not sum due to rounding
Source: Landrum & Brown analysis, 2022.

The results of the comparison between the Proposed Action and the No Action Alternative for 2033 are shown in **Table 19-2**.

TABLE 19-2: SUMMARY OF 2033 GHG EMISSIONS, PROPOSED ACTION COMPARED TO THE NO ACTION ALTERNATIVE

SCENARIO	ANNUAL EMISSIONS (CO_2e metric tons per year)
	Total CO_2e
No Action Alternative	191,047
Proposed Action (Operational Only)	193,828
2033 Increase in Emissions	***2,780***

Note: Totals may not sum due to rounding
Source: Landrum & Brown analysis, 2022.

As shown in Table 19-1 and Table 19-2, the Proposed Action would increase GHG emissions compared to the No Action Alternative. The Proposed Action would increase GHG emissions by 8,965 CO_2e metric tons over the No Action Alternative in 2028 and by 2,780 CO_2e metric tons over the No Action Alternative in 2033.

Per FAA Order 1050.1F Desk Reference, there are no federal significance thresholds for GHG emissions, nor has the FAA identified specific factors to consider in making a significance determination for GHG emissions. There is a considerable amount of ongoing scientific research to improve understanding of global climate change and FAA guidance will evolve as the science matures or if new federal requirements are established.

19.1 Level of Preparedness and Climate Adaptation

FAA 1050.1F Desk Reference states that the level of preparedness and climate adaptation with respect to the impacts of climate change should also be discussed. This involves describing current measures in place at the Airport to adapt to the impacts of climate change.

The Airport Authority currently conducts various initiatives that conserve natural resources, reduces emissions with the use of biodiesel in certain Airport Authority vehicles, reduces solid waste through recycling efforts, and conserves energy with LED lighting and fritted glass to reduce cooling needs.

In addition, the Airport Authority is currently developing RDU's first Sustainability Management Plan to improve the tracking and communication of the airport's sustainability initiatives, increase efficiency, and better incorporate economic savings and environmental stewardship into project planning. The Sustainability Management Plan will provide a road map for the integration of environmental sustainability into its planning, construction, maintenance, operations, and design processes. RDU is developing sustainability goals with respect to energy usage, materials and waste management, GHG emissions, water and stormwater management, business continuity and resiliency, sustainable buildings and infrastructure, land use and natural resources management, community/customers/employees, and sustainable transportation.

The potential impacts of climate change to the Airport may include increased rainfall intensity, higher summer temperatures, and increased storms with high winds and rain. The Proposed Action includes constructing drainage improvements to accommodate the increase in impervious surfaces.

19.2 Mitigation, Avoidance, and Minimization Measures

No mitigation measures are required to mitigate the potential increase in GHGs attributed to the Proposed Action. However, for FAA NEPA reviews of proposed actions that would result in increased emissions of GHGs, consideration should be given to whether there are areas within the scope of a project where such emissions could be reduced. GHG emissions reduction can come from measures such as changes to more fuel-efficient equipment, delay reductions, use of renewable fuels, and operational changes. The Airport Authority will continue to ensure that the Airport and its tenants are operating in an environmentally responsible and sustainable way.

ATTACHMENT 1 HAZARDOUS AIR POLLUTANTS

The following hazardous air pollutant (HAPS) emissions are provided strictly for disclosure purposes as there are currently no federal standards specifically pertaining to HAPS emissions from aircraft engines or airports. The reported HAPS emissions inventories are not directly comparable to any regulatory or enforceable ambient air quality standards or emission thresholds.

TABLE A-1, HAP EMISSIONS INVENTORY – EXISTING CONDITIONS (2020)

HAZARDOUS AIR POLLUTANT	ANNUAL EMISSIONS (SHORT TONS PER YEAR)		
	AIRCRAFT	MOTOR VEHICLES	TOTAL
1,1,1-Trichloroethane	0.000	0.000	0.000
1,3-Butadiene	0.914	0.000	0.914
2,2,4 Trimethylpentane	0.000	0.000	0.000
2-Methylnaphthalene	0.105	0.000	0.105
Acetaldehyde	2.325	0.003	2.328
Acetone	0.286	0.000	0.286
Acrolein (2-propenal)	1.319	0.000	1.319
Benzaldehyde	0.258	0.000	0.258
Benzene	0.918	0.006	0.924
Butyl cellosolve	0.000	0.000	0.000
Chlorobenzene	0.000	0.000	0.000
Cyclohexane	0.000	0.000	0.000
Dichloromethane	0.000	0.000	0.000
Ethyl ether	0.000	0.000	0.000
Ethylbenzene	0.094	0.000	0.094
Ethylene bromide	0.000	0.000	0.000
Ethylene glycol	0.000	0.000	0.000
Formaldehyde	6.755	0.005	6.761
Isomers of xylene	0.000	0.000	0.000
Isopropylbenzene	0.002	0.000	0.002
m & p-Xylene	0.153	0.000	0.153
Methyl alcohol	0.922	0.000	0.922
Methyl chloride	0.000	0.000	0.000
Methyl ethyl ketone	0.000	0.000	0.000
Methyl tert butyl ether	0.000	0.000	0.000
m-xylene	0.000	0.000	0.000
Naphthalene	0.293	0.000	0.293
n-Butyl alcohol	0.000	0.000	0.000
n-Heptane	0.035	0.000	0.035
n-Hexane	0.000	0.000	0.000
o-Xylene	0.091	0.000	0.091
Perchloroethylene	0.000	0.000	0.000
Phenol (carbolic acid)	0.378	0.000	0.378
Phthalic anhydride	0.000	0.000	0.000
Propionaldehyde	0.401	0.000	0.401
Styrene	0.170	0.000	0.170
Thyl acetate	0.000	0.000	0.000
Toluene	0.344	0.013	0.357
Trichloroethylene	0.000	0.000	0.000
Trichlorotrifluoroethan	0.000	0.000	0.000
Vinyl acetate	0.000	0.000	0.000

Source: Landrum & Brown analysis, 2022

TABLE A-2, HAP EMISSIONS INVENTORY – FUTURE (2028) NO ACTION ALTERNATIVE

HAZARDOUS AIR POLLUTANT	ANNUAL EMISSIONS (SHORT TONS PER YEAR)		
	AIRCRAFT	MOTOR VEHICLES	TOTAL
1,1,1-Trichloroethane	0.000	0.000	0.000
1,3-Butadiene	1.798	0.000	1.798
2,2,4 Trimethylpentane	0.000	0.000	0.000
2-Methylnaphthalene	0.214	0.000	0.214
Acetaldehyde	4.567	0.001	4.568
Acetone	0.465	0.000	0.465
Acrolein (2-propenal)	2.603	0.000	2.603
Benzaldehyde	0.504	0.000	0.504
Benzene	1.798	0.003	1.801
Butyl cellosolve	0.000	0.000	0.000
Chlorobenzene	0.000	0.000	0.000
Cyclohexane	0.000	0.000	0.000
Dichloromethane	0.000	0.000	0.000
Ethyl ether	0.000	0.000	0.000
Ethylbenzene	0.185	0.000	0.185
Ethylene bromide	0.000	0.000	0.000
Ethylene glycol	0.000	0.000	0.000
Formaldehyde	13.197	0.002	13.199
Isomers of xylene	0.000	0.000	0.000
Isopropylbenzene	0.003	0.000	0.003
m & p-Xylene	0.301	0.000	0.301
Methyl alcohol	1.879	0.000	1.879
Methyl chloride	0.000	0.000	0.000
Methyl ethyl ketone	0.000	0.000	0.000
Methyl tert butyl ether	0.000	0.000	0.000
m-xylene	0.000	0.000	0.000
Naphthalene	0.577	0.000	0.577
n-Butyl alcohol	0.000	0.000	0.000
n-Heptane	0.068	0.000	0.068
n-Hexane	0.000	0.000	0.000
o-Xylene	0.178	0.000	0.178
Perchloroethylene	0.000	0.000	0.000
Phenol (carbolic acid)	0.760	0.000	0.760
Phthalic anhydride	0.000	0.000	0.000
Propionaldehyde	0.781	0.000	0.781
Styrene	0.332	0.000	0.332
Thyl acetate	0.000	0.000	0.000
Toluene	0.682	0.004	0.686
Trichloroethylene	0.000	0.000	0.000
Trichlorotrifluoroethan	0.000	0.000	0.000
Vinyl acetate	0.000	0.000	0.000

Source: Landrum & Brown analysis, 2022

TABLE A-3, HAP EMISSIONS INVENTORY – FUTURE (2028) PROPOSED ACTION

HAZARDOUS AIR POLLUTANT	ANNUAL EMISSIONS (SHORT TONS PER YEAR)		
	AIRCRAFT	MOTOR VEHICLES	TOTAL
1,1,1-Trichloroethane	0.000	0.000	0.000
1,3-Butadiene	1.855	0.000	1.855
2,2,4 Trimethylpentane	0.000	0.000	0.000
2-Methylnaphthalene	0.221	0.000	0.221
Acetaldehyde	4.703	0.001	4.705
Acetone	0.478	0.000	0.478
Acrolein (2-propenal)	2.684	0.000	2.684
Benzaldehyde	0.519	0.000	0.519
Benzene	1.851	0.003	1.856
Butyl cellosolve	0.000	0.000	0.000
Chlorobenzene	0.000	0.000	0.000
Cyclohexane	0.000	0.000	0.000
Dichloromethane	0.000	0.000	0.000
Ethyl ether	0.000	0.000	0.000
Ethylbenzene	0.191	0.000	0.191
Ethylene bromide	0.000	0.000	0.000
Ethylene glycol	0.000	0.000	0.000
Formaldehyde	13.599	0.002	13.601
Isomers of xylene	0.000	0.000	0.000
Isopropylbenzene	0.003	0.000	0.003
m & p-Xylene	0.310	0.000	0.310
Methyl alcohol	1.935	0.000	1.935
Methyl chloride	0.000	0.000	0.000
Methyl ethyl ketone	0.000	0.000	0.000
Methyl tert butyl ether	0.000	0.000	0.000
m-xylene	0.000	0.000	0.000
Naphthalene	0.595	0.000	0.595
n-Butyl alcohol	0.000	0.000	0.000
n-Heptane	0.070	0.000	0.070
n-Hexane	0.000	0.000	0.000
o-Xylene	0.183	0.000	0.183
Perchloroethylene	0.000	0.000	0.000
Phenol (carbolic acid)	0.784	0.000	0.784
Phthalic anhydride	0.000	0.000	0.000
Propionaldehyde	0.805	0.000	0.805
Styrene	0.342	0.000	0.342
Thyl acetate	0.000	0.000	0.000
Toluene	0.704	0.005	0.709
Trichloroethylene	0.000	0.000	0.000
Trichlorotrifluoroethan	0.000	0.000	0.000
Vinyl acetate	0.000	0.000	0.000

Source: Landrum & Brown analysis, 2022

TABLE A-4, HAP EMISSIONS INVENTORY – FUTURE (2033) NO ACTION ALTERNATIVE

HAZARDOUS AIR POLLUTANT	ANNUAL EMISSIONS (SHORT TONS PER YEAR)		
	AIRCRAFT	MOTOR VEHICLES	TOTAL
1,1,1-Trichloroethane	0.000	0.000	0.000
1,3-Butadiene	2.079	0.000	2.079
2,2,4 Trimethylpentane	0.000	0.000	0.000
2-Methylnaphthalene	0.249	0.000	0.249
Acetaldehyde	5.274	0.001	5.275
Acetone	0.525	0.000	0.525
Acrolein (2-propenal)	3.012	0.000	3.012
Benzaldehyde	0.582	0.000	0.582
Benzene	2.078	0.002	2.080
Butyl cellosolve	0.000	0.000	0.000
Chlorobenzene	0.000	0.000	0.000
Cyclohexane	0.000	0.000	0.000
Dichloromethane	0.000	0.000	0.000
Ethyl ether	0.000	0.000	0.000
Ethylbenzene	0.214	0.000	0.214
Ethylene bromide	0.000	0.000	0.000
Ethylene glycol	0.000	0.000	0.000
Formaldehyde	15.244	0.001	15.246
Isomers of xylene	0.000	0.000	0.000
Isopropylbenzene	0.004	0.000	0.004
m & p-Xylene	0.347	0.000	0.347
Methyl alcohol	2.179	0.000	2.179
Methyl chloride	0.000	0.000	0.000
Methyl ethyl ketone	0.000	0.000	0.000
Methyl tert butyl ether	0.000	0.000	0.000
m-xylene	0.000	0.000	0.000
Naphthalene	0.667	0.000	0.667
n-Butyl alcohol	0.000	0.000	0.000
n-Heptane	0.079	0.000	0.079
n-Hexane	0.000	0.000	0.000
o-Xylene	0.205	0.000	0.205
Perchloroethylene	0.000	0.000	0.000
Phenol (carbolic acid)	0.882	0.000	0.882
Phthalic anhydride	0.000	0.000	0.000
Propionaldehyde	0.902	0.000	0.902
Styrene	0.383	0.000	0.383
Thyl acetate	0.000	0.000	0.000
Toluene	0.788	0.004	0.792
Trichloroethylene	0.000	0.000	0.000
Trichlorotrifluoroethan	0.000	0.000	0.000
Vinyl acetate	0.000	0.000	0.000

Source: Landrum & Brown analysis, 2022

TABLE A-5, HAP EMISSIONS INVENTORY – FUTURE (2033) PROPOSED ACTION

HAZARDOUS AIR POLLUTANT	ANNUAL EMISSIONS (SHORT TONS PER YEAR)		
	AIRCRAFT	MOTOR VEHICLES	TOTAL
1,1,1-Trichloroethane	0.000	0.000	0.000
1,3-Butadiene	2.142	0.000	2.142
2,2,4 Trimethylpentane	0.000	0.000	0.000
2-Methylnaphthalene	0.256	0.000	0.256
Acetaldehyde	5.434	0.001	5.435
Acetone	0.540	0.000	0.540
Acrolein (2-propenal)	3.104	0.000	3.104
Benzaldehyde	0.599	0.000	0.599
Benzene	2.141	0.003	2.143
Butyl cellosolve	0.000	0.000	0.000
Chlorobenzene	0.000	0.000	0.000
Cyclohexane	0.000	0.000	0.000
Dichloromethane	0.000	0.000	0.000
Ethyl ether	0.000	0.000	0.000
Ethylbenzene	0.221	0.000	0.221
Ethylene bromide	0.000	0.000	0.000
Ethylene glycol	0.000	0.000	0.000
Formaldehyde	15.705	0.001	15.706
Isomers of xylene	0.000	0.000	0.000
Isopropylbenzene	0.004	0.000	0.004
m & p-Xylene	0.358	0.000	0.358
Methyl alcohol	2.246	0.000	2.246
Methyl chloride	0.000	0.000	0.000
Methyl ethyl ketone	0.000	0.000	0.000
Methyl tert butyl ether	0.000	0.000	0.000
m-xylene	0.000	0.000	0.000
Naphthalene	0.687	0.000	0.687
n-Butyl alcohol	0.000	0.000	0.000
n-Heptane	0.081	0.000	0.081
n-Hexane	0.000	0.000	0.000
o-Xylene	0.211	0.000	0.211
Perchloroethylene	0.000	0.000	0.000
Phenol (carbolic acid)	0.909	0.000	0.909
Phthalic anhydride	0.000	0.000	0.000
Propionaldehyde	0.929	0.000	0.929
Styrene	0.395	0.000	0.395
Thyl acetate	0.000	0.000	0.000
Toluene	0.812	0.004	0.817
Trichloroethylene	0.000	0.000	0.000
Trichlorotrifluoroethan	0.000	0.000	0.000
Vinyl acetate	0.000	0.000	0.000

Source: Landrum & Brown analysis, 2022

ATTACHMENT 2 CONSTRUCTION

TABLE A-6, ANNUAL ON-ROAD CONSTRUCTION ACTIVITY

YEAR	ON-ROAD VEHICLE ACTIVITY	VMTs
2021	Employee Commute	3,588,638
2021	Material Delivery	950,148
2022	Employee Commute	8,731,534
2022	Material Delivery	1,665,958
2023	Employee Commute	8,084,530
2023	Material Delivery	1,122,006
2024	Employee Commute	1,488,859
2024	Material Delivery	689,429
2025	Employee Commute	2,030,262
2025	Material Delivery	203,135
2026	Employee Commute	2,030,262
2026	Material Delivery	203,135
2027	Employee Commute	2,030,262
2027	Material Delivery	203,135
2028	Employee Commute	1,015,130
2028	Material Delivery	203,135

Note: VMT denotes vehicle miles travelled.
Source: Landrum & Brown analysis, 2021

TABLE A-7, ANNUAL NON-ROAD CONSTRUCTION ACTIVITY

YEAR	NON-ROAD EQUIPMENT	HORSE-POWER	LOAD FACTOR	HOURS OF ACTIVITY
2023	Asphalt Paver	350	1.18	50.0
2023	Bob Cat	75	0.21	480.0
2023	Chain Saw	44	2.8	8870.4
2023	Chipper/Stump Grinder	400	1.72	8870.4
2023	Concrete Truck	3600	3.54	727.7
2023	Curb/Gutter Paver	350	1.18	222.0
2023	Dozer	3500	11.8	41249.1
2023	Dump Truck	9000	8.85	1878.7
2023	Dump Truck (12 cy)	4800	4.72	55579.8
2023	Excavator	1050	3.54	11240.8
2023	Excavator with Bucket	175	0.59	240.0
2023	Flatbed Truck	2400	2.36	822.9
2023	Generator Sets	40	0.43	240.0

YEAR	NON-ROAD EQUIPMENT	HORSE-POWER	LOAD FACTOR	HOURS OF ACTIVITY
2023	Grader	1200	2.36	3567.4
2023	Hydroseeder	1800	1.77	604.7
2023	Loader	1050	3.54	425.3
2023	Off-Road Truck	1800	1.77	604.7
2023	Other General Equipment	3150	7.74	1855.1
2023	Pickup Truck	21600	21.24	44038.5
2023	Pumps	22	0.86	38.4
2023	Roller	1600	9.44	23334.7
2023	Scraper	1800	1.77	13746.9
2023	Skid Steer Loader	450	1.26	444.6
2023	Surfacing Equipment (Grooving)	50	1.18	63.9
2023	Tractors/Loader/Backhoe	1200	2.52	976.1
2023	Vibratory Compactor	12	0.86	444.0
2023	Water Truck	1200	1.18	4320.0
2024	Asphalt Paver	350	1.18	17.9
2024	Bob Cat	75	0.21	480.0
2024	Chain Saw	33	2.1	16243.2
2024	Chipper/Stump Grinder	300	1.29	16243.2
2024	Concrete Truck	3600	3.54	727.7
2024	Curb/Gutter Paver	350	1.18	222.0
2024	Dozer	3500	11.8	80829.8
2024	Dump Truck	9000	8.85	1706.1
2024	Dump Truck (12 cy)	4800	4.72	108692.4
2024	Excavator	1050	3.54	21939.3
2024	Excavator with Bucket	175	0.59	240.0
2024	Flatbed Truck	2400	2.36	294.9
2024	Generator Sets	40	0.43	240.0
2024	Grader	1200	2.36	7020.6
2024	Hydroseeder	1800	1.77	581.6
2024	Loader	1050	3.54	425.3
2024	Off-Road Truck	1800	1.77	581.6
2024	Other General Equipment	3150	7.74	1241.4
2024	Pickup Truck	21000	20.65	81683.9
2024	Pumps	22	0.86	16.8
2024	Roller	1600	9.44	45631.5
2024	Scraper	1800	1.77	27120.1

YEAR	NON-ROAD EQUIPMENT	HORSE-POWER	LOAD FACTOR	HOURS OF ACTIVITY
2024	Skid Steer Loader	450	1.26	412.6
2024	Surfacing Equipment (Grooving)	50	1.18	22.9
2024	Tractors/Loader/Backhoe	1200	2.52	954.5
2024	Vibratory Compactor	12	0.86	444.0
2024	Water Truck	1200	1.18	5040.0
2025	Air Compressor	400	1.72	7006.4
2025	Asphalt Paver	350	1.18	132.1
2025	Chain Saw	33	2.1	8192.4
2025	Chipper/Stump Grinder	300	1.29	8192.4
2025	Concrete Saws	80	1.18	6730.4
2025	Concrete Truck	3600	3.54	8136.8
2025	Crane	600	0.86	276.0
2025	Crane w/ Concrete Pump	300	0.43	6419.8
2025	Curb/Gutter Paver	175	0.59	90.0
2025	Dozer	4725	15.93	42654.1
2025	Dump Truck	9600	9.44	2485.0
2025	Dump Truck (12 cy)	6600	6.49	57818.8
2025	Excavator	1575	5.31	11777.4
2025	Flatbed Truck	1800	1.77	2176.0
2025	Grader	1200	2.36	3541.6
2025	Hydroseeder	2400	2.36	677.1
2025	Loader	1225	4.13	920.9
2025	Off-Road Truck	2400	2.36	677.1
2025	Other General Equipment	3850	9.46	11484.0
2025	Pickup Truck	24000	23.6	53458.7
2025	Pumps	33	1.29	104.8
2025	Roller	2000	11.8	24240.0
2025	Rubber Tired Loader	525	1.77	6990.4
2025	Scraper	2400	2.36	14043.3
2025	Skid Steer Loader	525	1.47	973.5
2025	Slip Form Paver	175	0.59	310.6
2025	Surfacing Equipment (Grooving)	75	1.77	479.7
2025	Tractors/Loader/Backhoe	1200	2.52	1371.0
2025	Vibratory Compactor	6	0.43	180.0
2025	Water Truck	1800	1.77	7200.0
2026	Air Compressor	400	1.72	7334.0

YEAR	NON-ROAD EQUIPMENT	HORSE-POWER	LOAD FACTOR	HOURS OF ACTIVITY
2026	Asphalt Paver	175	0.59	239.3
2026	Chain Saw	11	0.7	13.2
2026	Chipper/Stump Grinder	100	0.43	13.2
2026	Concrete Saws	80	1.18	7058.0
2026	Concrete Truck	1800	1.77	9206.9
2026	Crane	600	0.86	276.0
2026	Crane w/ Concrete Pump	300	0.43	6419.8
2026	Dozer	2450	8.26	3514.9
2026	Dump Truck	5400	5.31	2605.0
2026	Dump Truck (12 cy)	3600	3.54	6198.3
2026	Excavator	875	2.95	1061.7
2026	Flatbed Truck	600	0.59	3942.9
2026	Grader	300	0.59	5.5
2026	Hydroseeder	1200	1.18	189.1
2026	Loader	700	2.36	749.4
2026	Off-Road Truck	1200	1.18	189.1
2026	Other General Equipment	2275	5.59	13828.3
2026	Pickup Truck	12600	12.39	17033.9
2026	Pumps	22	0.86	174.0
2026	Roller	1000	5.9	2199.3
2026	Rubber Tired Loader	525	1.77	7318.0
2026	Scraper	1200	1.18	820.4
2026	Skid Steer Loader	300	0.84	921.8
2026	Slip Form Paver	175	0.59	638.3
2026	Surfacing Equipment (Grooving)	50	1.18	944.6
2026	Tractors/Loader/Backhoe	600	1.26	1061.1
2026	Water Truck	1200	1.18	2880.0
2027	Asphalt Paver	175	0.59	166.5
2027	Chain Saw	11	0.7	414.0
2027	Chipper/Stump Grinder	100	0.43	414.0
2027	Concrete Truck	600	0.59	333.3
2027	Dozer	1225	4.13	3281.4
2027	Dump Truck	3600	3.54	4197.5
2027	Dump Truck (12 cy)	1800	1.77	4193.3
2027	Excavator	350	1.18	1404.3
2027	Excavator with Bucket	175	0.59	282.0

YEAR	NON-ROAD EQUIPMENT	HORSE-POWER	LOAD FACTOR	HOURS OF ACTIVITY
2027	Excavator with Hoe Ram	175	0.59	282.0
2027	Flatbed Truck	600	0.59	2742.9
2027	Grader	300	0.59	166.6
2027	Hydroseeder	600	0.59	150.1
2027	Loader	525	1.77	1894.4
2027	Off-Road Truck	600	0.59	150.1
2027	Other General Equipment	1225	3.01	6441.6
2027	Pickup Truck	7800	7.67	9363.6
2027	Pumps	11	0.43	138.0
2027	Roller	600	3.54	2352.1
2027	Scraper	600	0.59	555.0
2027	Skid Steer Loader	225	0.63	1900.4
2027	Surfacing Equipment (Grooving)	25	0.59	213.1
2027	Tractors/Loader/Backhoe	400	0.84	2405.4
2027	Water Truck	600	0.59	2880.0
2028	Asphalt Paver	175	0.59	166.5
2028	Chain Saw	11	0.7	414.0
2028	Chipper/Stump Grinder	100	0.43	414.0
2028	Concrete Truck	600	0.59	333.3
2028	Dozer	1225	4.13	3281.4
2028	Dump Truck	3600	3.54	4197.5
2028	Dump Truck (12 cy)	1800	1.77	4193.3
2028	Excavator	350	1.18	1404.3
2028	Excavator with Bucket	175	0.59	282.0
2028	Excavator with Hoe Ram	175	0.59	282.0
2028	Flatbed Truck	600	0.59	2742.9
2028	Grader	300	0.59	166.6
2028	Hydroseeder	600	0.59	150.1
2028	Loader	525	1.77	1894.4
2028	Off-Road Truck	600	0.59	150.1
2028	Other General Equipment	1225	3.01	6441.6
2028	Pickup Truck	7800	7.67	9363.6
2028	Pumps	11	0.43	138.0
2028	Roller	600	3.54	2352.1
2028	Scraper	600	0.59	555.0
2028	Skid Steer Loader	225	0.63	1900.4

YEAR	NON-ROAD EQUIPMENT	HORSE-POWER	LOAD FACTOR	HOURS OF ACTIVITY
2028	Surfacing Equipment (Grooving)	25	0.59	213.1
2028	Tractors/Loader/Backhoe	400	0.84	2405.4
2028	Water Truck	600	0.59	2880.0
2029	Asphalt Paver	175	0.59	166.5
2029	Chain Saw	11	0.7	414.0
2029	Chipper/Stump Grinder	100	0.43	414.0
2029	Concrete Truck	600	0.59	333.3
2029	Dozer	1225	4.13	3281.4
2029	Dump Truck	3600	3.54	4197.5
2029	Dump Truck (12 cy)	1800	1.77	4193.3
2029	Excavator	350	1.18	1404.3
2029	Excavator with Bucket	175	0.59	282.0
2029	Excavator with Hoe Ram	175	0.59	282.0
2029	Flatbed Truck	600	0.59	2742.9
2029	Grader	300	0.59	166.6
2029	Hydroseeder	600	0.59	150.1
2029	Loader	525	1.77	1894.4
2029	Off-Road Truck	600	0.59	150.1
2029	Other General Equipment	1225	3.01	6441.6
2029	Pickup Truck	7800	7.67	9363.6
2029	Pumps	11	0.43	138.0
2029	Roller	600	3.54	2352.1
2029	Scraper	600	0.59	555.0
2029	Skid Steer Loader	225	0.63	1900.4
2029	Surfacing Equipment (Grooving)	25	0.59	213.1
2029	Tractors/Loader/Backhoe	400	0.84	2405.4
2029	Water Truck	600	0.59	2880.0
2030	Asphalt Paver	175	0.59	166.5
2030	Chain Saw	11	0.7	414.0
2030	Chipper/Stump Grinder	100	0.43	414.0
2030	Concrete Truck	600	0.59	333.3
2030	Dozer	1225	4.13	3281.4
2030	Dump Truck	3600	3.54	4197.5
2030	Dump Truck (12 cy)	1800	1.77	4193.3
2030	Excavator	350	1.18	1404.3
2030	Excavator with Bucket	175	0.59	282.0

YEAR	NON-ROAD EQUIPMENT	HORSE-POWER	LOAD FACTOR	HOURS OF ACTIVITY
2030	Excavator with Hoe Ram	175	0.59	282.0
2030	Flatbed Truck	600	0.59	2742.9
2030	Grader	300	0.59	166.6
2030	Hydroseeder	600	0.59	150.1
2030	Loader	525	1.77	1894.4
2030	Off-Road Truck	600	0.59	150.1
2030	Other General Equipment	1225	3.01	6441.6
2030	Pickup Truck	7800	7.67	9363.6
2030	Pumps	11	0.43	138.0
2030	Roller	600	3.54	2352.1
2030	Scraper	600	0.59	555.0
2030	Skid Steer Loader	225	0.63	1900.4
2030	Surfacing Equipment (Grooving)	25	0.59	213.1
2030	Tractors/Loader/Backhoe	400	0.84	2405.4
2030	Water Truck	600	0.59	1440.0

Source: Landrum & Brown analysis, 2022

TABLE A-8, ANNUAL ON-ROAD EQUIPMENT EMISSION FACTORS

ACTIVITY	GRAMS PER VEHICLE MILE							
	CO	VOC	NO_x	SO_x	PM_{10}	$PM_{2.5}$	CO_2	CH_4
Employee Commute	2.9	0.0	0.1	0.0	0.0	0.0	317.1	0.0
Material Delivery	2.2	0.1	4.1	0.0	0.1	0.1	1,678.1	0.0

Note: 2023 emission factors unique to Wake County were applied for all construction years
Source: MOVES3

TABLE A-9, ANNUAL NON-ROAD EQUIPMENT EMISSION FACTORS

ACTIVITY	HORSE-POWER	GRAMS PER HORSEPOWER-HOUR							
		CO	VOC	NO_x	SO_x	PM_{10}	$PM_{2.5}$	CO_2	CH_4
Air Compressors	100	0.58	0.07	1.62	0.00	0.09	0.09	590.16	0.01
Chippers/Stump Grinders (com)	100	1.52	0.30	3.28	0.00	0.28	0.27	589.49	0.01
Concrete/Industrial Saws	11	2.48	0.84	4.18	0.00	0.24	0.23	593.76	0.07
Concrete/Industrial Saws	40	0.36	0.10	2.60	0.00	0.04	0.03	595.85	0.01
Cranes	300	0.13	0.04	0.49	0.00	0.02	0.02	530.94	0.00
Crawler Tractor/Dozers	175	0.17	0.02	0.46	0.00	0.04	0.04	536.76	0.00
Excavators	175	0.11	0.02	0.35	0.00	0.03	0.02	536.78	0.00
Generator Sets	40	0.86	0.23	3.30	0.00	0.16	0.15	589.69	0.02
Graders	300	0.09	0.02	0.28	0.00	0.02	0.02	536.77	0.00
Irrigation Sets	600	0.66	0.15	2.12	0.00	0.12	0.11	530.60	0.01
Off-highway Trucks	600	0.07	0.02	0.23	0.00	0.01	0.01	536.78	0.00
Other Construction Equipment	175	0.33	0.05	0.97	0.00	0.08	0.08	536.68	0.00
Pavers	175	0.21	0.03	0.57	0.00	0.05	0.05	536.74	0.00
Plate Compactors	6	2.52	0.81	4.19	0.00	0.25	0.25	588.04	0.07
Pumps	11	2.64	0.82	4.29	0.00	0.28	0.27	588.02	0.07
Rollers	100	0.56	0.04	1.31	0.00	0.08	0.08	596.03	0.00
Scrapers	600	0.29	0.04	0.72	0.00	0.05	0.05	536.71	0.00
Skid Steer Loaders	75	3.06	0.70	4.06	0.00	0.52	0.50	693.91	0.02

Surfacing Equipment	25	1.50	0.35	3.77	0.00	0.17	0.17	595.14	0.03
Tractors/Loaders/Backhoes	75	1.79	0.37	3.34	0.00	0.27	0.26	694.89	0.02
Tractors/Loaders/Backhoes	100	2.13	0.33	2.25	0.00	0.35	0.34	695.02	0.01
Tractors/Loaders/Backhoes	175	1.04	0.23	1.76	0.00	0.20	0.20	625.86	0.01

Note: 2023 emission factors unique to Wake County were applied for all construction years
Source: MOVES3

ATTACHMENT 3 MOTOR VEHICLES

TABLE A-10, OPERATIONAL VEHICLE EMISSION FACTORS 2020 CRITERIA POLLUTANTS

VEHICLE TYPE	SPEED (MPH)	GRAMS PER VEHICLE MILE TRAVELLED								
		CO	NO_X	SO_X	VOC	$PM_{2.5}$	PM_{10}	CO_2	CH_4	N_2O
Passenger Car (gasoline)	25	4.0919	0.1690	0.0024	0.0577	0.0022	0.0025	355.3081	0.0158	0.0022
Passenger Truck (gasoline)	25	4.9801	0.3300	0.0030	0.0967	0.0039	0.0044	458.7290	0.0228	0.0042
Short-Haul Truck (diesel)	25	1.5839	2.9053	0.0039	0.1778	0.0709	0.0770	1149.4900	0.0222	0.0033
Long-Haul Truck (diesel)	25	1.5136	2.7577	0.0038	0.1535	0.0638	0.0693	1116.1200	0.0215	0.0033
Passenger Car (gasoline)	45	2.7758	0.1388	0.0019	0.0341	0.0018	0.0021	278.8633	0.0095	0.0012
Passenger Truck (gasoline)	45	3.5722	0.2881	0.0024	0.0571	0.0029	0.0032	367.1049	0.0138	0.0023
Short-Haul Truck (diesel)	45	0.9983	1.7191	0.0031	0.1158	0.0469	0.0510	906.9930	0.0123	0.0018
Long-Haul Truck (diesel)	45	0.9418	1.5740	0.0029	0.0996	0.0419	0.0455	867.5710	0.0118	0.0018

Note: mph denotes miles per hour
Source: MOVES3

TABLE A-11, OPERATIONAL VEHICLE EMISSION FACTORS 2028 CRITERIA POLLUTANTS

VEHICLE TYPE	SPEED (MPH)	GRAMS PER VEHICLE MILE TRAVELLED								
		CO	NO_X	SO_X	VOC	$PM_{2.5}$	PM_{10}	CO_2	CH_4	N_2O
Passenger Car (gasoline)	25	2.7673	0.0474	0.0019	0.0189	0.0016	0.0018	291.9318	0.0080	0.0017
Passenger Truck (gasoline)	25	2.9638	0.0865	0.0026	0.0249	0.0024	0.0027	385.0564	0.0095	0.0023
Short-Haul Truck (diesel)	25	1.2875	1.9025	0.0033	0.0493	0.0159	0.0173	997.7330	0.0155	0.0033
Long-Haul Truck (diesel)	25	1.3138	1.9435	0.0033	0.0603	0.0193	0.0210	977.3730	0.0146	0.0033
Passenger Car (gasoline)	45	1.9125	0.0404	0.0015	0.0118	0.0012	0.0014	229.2837	0.0050	0.0009
Passenger Truck (gasoline)	45	2.1768	0.0813	0.0021	0.0153	0.0017	0.0019	308.6747	0.0060	0.0013
Short-Haul Truck (diesel)	45	0.7748	0.9056	0.0026	0.0283	0.0104	0.0113	786.5090	0.0074	0.0018
Long-Haul Truck (diesel)	45	0.7821	0.9292	0.0025	0.0359	0.0124	0.0135	754.6360	0.0068	0.0018

Note: mph denotes miles per hour
Source: MOVES3

TABLE A-12, OPERATIONAL VEHICLE EMISSION FACTORS 2033 CRITERIA POLLUTANTS

VEHICLE TYPE	SPEED (MPH)	GRAMS PER VEHICLE MILE TRAVELLED								
		CO	NO_X	SO_X	VOC	$PM_{2.5}$	PM_{10}	CO_2	CH_4	N_2O
Passenger Car (gasoline)	25	1.9598	0.0156	0.0018	0.0109	0.0014	0.0016	267.1039	0.0057	0.0016
Passenger Truck (gasoline)	25	2.1976	0.0253	0.0024	0.0140	0.0017	0.0020	357.1363	0.0068	0.0018
Short-Haul Truck (diesel)	25	1.2370	1.7194	0.0031	0.0282	0.0081	0.0088	933.9310	0.0144	0.0033
Long-Haul Truck (diesel)	25	1.2458	1.7298	0.0031	0.0369	0.0119	0.0129	916.5610	0.0141	0.0033
Passenger Car (gasoline)	45	1.3572	0.0133	0.0014	0.0068	0.0011	0.0012	209.8992	0.0036	0.0009
Passenger Truck (gasoline)	45	1.6059	0.0225	0.0019	0.0086	0.0013	0.0015	286.5261	0.0043	0.0010
Short-Haul Truck (diesel)	45	0.7363	0.7632	0.0025	0.0141	0.0050	0.0054	735.8750	0.0066	0.0018
Long-Haul Truck (diesel)	45	0.7343	0.7750	0.0024	0.0200	0.0075	0.0082	707.2840	0.0064	0.0018

Note: mph denotes miles per hour
Source: MOVES3

TABLE A-13, OPERATIONAL VEHICLE EMISSION FACTORS 2020 HAZARDOUS AIR POLLUTANTS

VEHICLE TYPE	SPEED (MPH)	GRAMS PER VEHICLE MILE TRAVELLED											
		Ben-zene	1,3-Butad-iene	Formal-dehyde	Aceta-ldehyde	Acro-lein	2,2,4-Trimethyl-pentane	Ethyl Benzene	Hexane	Propion-aldehyde	Styrene	Toluene	Xylene
Passenger Car (gasoline)	25	0.0023	0.0002	0.0008	0.0006	0.0000	0.0010	0.0011	0.0011	0.0000	0.0001	0.0048	0.0039
Passenger Truck (gasoline)	25	0.0038	0.0004	0.0013	0.0011	0.0001	0.0017	0.0018	0.0018	0.0001	0.0001	0.0081	0.0066
Short-Haul Truck (diesel)	25	0.0012	0.0004	0.0137	0.0067	0.0011	0.0004	0.0007	0.0003	0.0008	0.0002	0.0013	0.0028
Long-Haul Truck (diesel)	25	0.0011	0.0004	0.0117	0.0058	0.0010	0.0004	0.0006	0.0003	0.0007	0.0002	0.0011	0.0027
Passenger Car (gasoline)	45	0.0014	0.0001	0.0005	0.0004	0.0000	0.0006	0.0006	0.0007	0.0000	0.0000	0.0028	0.0023
Passenger Truck (gasoline)	45	0.0022	0.0002	0.0008	0.0006	0.0000	0.0010	0.0011	0.0011	0.0000	0.0001	0.0048	0.0039
Short-Haul Truck (diesel)	45	0.0008	0.0003	0.0091	0.0043	0.0007	0.0003	0.0004	0.0002	0.0005	0.0001	0.0008	0.0015
Long-Haul Truck (diesel)	45	0.0007	0.0002	0.0078	0.0037	0.0006	0.0002	0.0004	0.0002	0.0004	0.0001	0.0007	0.0014

Note: mph denotes miles per hour
Source: MOVES3

TABLE A-14, OPERATIONAL VEHICLE EMISSION FACTORS 2028 HAZARDOUS AIR POLLUTANTS

VEHICLE TYPE	SPEED (MPH)	GRAMS PER VEHICLE MILE TRAVELLED											
		Ben-zene	1,3-Butad-iene	Formal-dehyde	Aceta-ldehyde	Acro-lein	2,2,4-Trimethyl-pentane	Ethyl Benzene	Hexane	Propion-aldehyde	Styrene	Toluene	Xylene
Passenger Car (gasoline)	25	0.0009	0.0000	0.0003	0.0002	0.0000	0.0003	0.0003	0.0005	0.0000	0.0000	0.0015	0.0012
Passenger Truck (gasoline)	25	0.0011	0.0000	0.0004	0.0002	0.0000	0.0004	0.0004	0.0006	0.0000	0.0000	0.0020	0.0016
Short-Haul Truck (diesel)	25	0.0002	0.0001	0.0029	0.0019	0.0003	0.0002	0.0003	0.0001	0.0002	0.0000	0.0006	0.0020
Long-Haul Truck (diesel)	25	0.0003	0.0001	0.0038	0.0023	0.0003	0.0002	0.0003	0.0001	0.0002	0.0000	0.0006	0.0020
Passenger Car (gasoline)	45	0.0005	0.0000	0.0002	0.0001	0.0000	0.0002	0.0002	0.0003	0.0000	0.0000	0.0009	0.0007
Passenger Truck (gasoline)	45	0.0007	0.0000	0.0002	0.0001	0.0000	0.0002	0.0003	0.0004	0.0000	0.0000	0.0012	0.0010
Short-Haul Truck (diesel)	45	0.0001	0.0001	0.0018	0.0011	0.0002	0.0001	0.0002	0.0000	0.0001	0.0000	0.0003	0.0010
Long-Haul Truck (diesel)	45	0.0002	0.0001	0.0024	0.0014	0.0002	0.0001	0.0002	0.0001	0.0001	0.0000	0.0003	0.0009

Note: mph denotes miles per hour
Source: MOVES3

TABLE A-15, OPERATIONAL VEHICLE EMISSION FACTORS 2033 HAZARDOUS AIR POLLUTANTS

VEHICLE TYPE	SPEED (MPH)	GRAMS PER VEHICLE MILE TRAVELLED											
		Ben-zene	1,3-Butad-iene	Formal-dehyde	Aceta-ldehyde	Acro-lein	2,2,4-Trimethyl-pentane	Ethyl Benzene	Hexane	Propion-aldehyde	Styrene	Toluene	Xylene
Passenger Car (gasoline)	25	0.0005	0.0000	0.0002	0.0001	0.0000	0.0001	0.0002	0.0003	0.0000	0.0000	0.0008	0.0007
Passenger Truck (gasoline)	25	0.0011	0.0000	0.0004	0.0002	0.0000	0.0004	0.0004	0.0006	0.0000	0.0000	0.0020	0.0016
Short-Haul Truck (diesel)	25	0.0001	0.0000	0.0011	0.0012	0.0001	0.0001	0.0003	0.0000	0.0001	0.0000	0.0004	0.0019
Long-Haul Truck (diesel)	25	0.0001	0.0000	0.0019	0.0015	0.0002	0.0001	0.0003	0.0001	0.0001	0.0000	0.0005	0.0019
Passenger Car (gasoline)	45	0.0003	0.0000	0.0001	0.0000	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	0.0005	0.0004
Passenger Truck (gasoline)	45	0.0007	0.0000	0.0002	0.0001	0.0000	0.0002	0.0003	0.0004	0.0000	0.0000	0.0012	0.0010
Short-Haul Truck (diesel)	45	0.0000	0.0000	0.0006	0.0006	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0002	0.0009
Long-Haul Truck (diesel)	45	0.0001	0.0000	0.0011	0.0008	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0002	0.0009

Note: mph denotes miles per hour
Source: MOVES3