The Economic Impact of the Wallops Island Aerospace Cluster

Dragas Center for Economic Analysis and Policy

Old Dominion University

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1. Bottom Line Up Front

Wallops Island is located on the Eastern Shore of the Commonwealth of Virginia and is home to the Wallops Flight Facility, elements of the United States Navy, science missions from the National Oceanic and Atmospheric Administration (NOAA), and the Mid-Atlantic Regional Spaceport, which is owned and operated by the Virginia Commercial Space Flight Authority (dba. Virginia Spaceport Authority). With a long history of supporting science and defense activities, the Wallops Island Aerospace Cluster (WAIC) occupies an economic footprint that includes the Virginia counties of Accomack and Northampton as well as the Maryland counties of Somerset, Wicomico, and Worcester.

We estimated the economic impacts associated with the WAIC from 2018 to 2022. We used data from public and proprietary sources as well as data from interviews with representatives of organizations in the industry cluster. The economic environment has been challenging, with federal non-payroll spending having declined from its peak in Fiscal Year (FY) 2016 and the economic shock of the COVID-19 pandemic in 2020. We find, however, the economic impacts of the industry cluster remained resilient and that activity in the industry cluster is likely to increase significantly over the remainder of the decade. We found that:

1. From 2018 to 2022, the Wallops Island Aerospace Cluster added an average of between 3,300 and 4,600 jobs each year to the Virginia economy from 2018 to 2022

2. The average annual wage for the primary industries in the Wallops industry cluster was $110,069 in the fourth quarter of 2022. This wage is 2.2 times higher than the average wage for all industries in the surrounding communities ($48,977) and more than $40,000 higher than the average wage for all industries in Virginia.

3. From 2018 to 2022, the Wallops Island Aerospace Cluster increased real annual industry output in Virginia between $1.2 billion and $1.5 billion in 2023 dollars.

4. By 2030, the annual economic impact of the Wallops Island Aerospace Cluster is projected to approach $2 billion a year.

5. For every $1 appropriated to the Virginia Spaceport Authority by the Commonwealth of Virginia, annual average real industry output in Virginia increased by $2.9 from 2018 to 2022.

We note that our projections of future economic impact are conservative as we assume federal non-payroll spending only increases at the rate of inflation and capital spending in the cluster occurs primarily through Virginia Spaceport Authority. If launch cadence and capital spending from other sources increase significantly, the economic impact of the Wallops industry cluster and the return on investment for Virginia Spaceport Authority will increase as well over the remainder of the decade.

2. Executive Summary

In this report, we examine the economic impacts associated with public and private sector activities in the Wallops Island Aerospace Cluster. The Wallops Island Aerospace Cluster includes activities related to engineering, national security, sensors, and space research and flight. Geographically, the Wallops Island Aerospace Cluster spans Accomack County, where the Wallops Flight Facility is located, Northampton County as well as the Maryland counties of Somerset, Wicomico, and Worcester. This geographic footprint captures the flows of people, goods, and services between Wallops Island and its surrounding communities.

The presence of the Wallops Flight Facility and the employers in the Wallops Island Aerospace Cluster is a boon to counties that tend be older, have lower levels of educational attainment, lower levels of median household income, lower wages, and display higher levels of poverty than Virginia as a whole. If demographics influence economic destiny, the counties in the Wallops geographic footprint need an injection of higher paying, skilled jobs to attract and retain younger workers. These defense, aerospace, and engineering jobs align well with Virginia's goal of increasing science, technology, engineering, and math (STEM)-related jobs in the coming decade.

In the fourth quarter of 2022, annual wages in defense and aerospace professions in the Wallops Island Aerospace Cluster were over $110,000. Average annual wages in the cluster were almost $61,000 higher than the average wages in the surrounding communities and about $40,000 higher than average wages in Virginia. In other words, the compensation created by one aerospace or defense job in the Wallops cluster was the equivalent of creating 2.2 jobs in the surrounding communities.

Interviews with employers as well as local and state government representatives highlight the increasing stature of the Wallops Flight Facility, the Mid-Atlantic Regional Spaceport, and the Wallops Island Aerospace Cluster. The ongoing activities of federal and state departments and agencies are complemented by similar efforts by the private sector. The arrival of Rocket Lab in 2019 has increased the visibility of operations at Wallops Island, and the prospects for future growth are bright. Northrop Grumman plans to launch a newer version of its Antares rocket in the coming years, and Rocket Lab has broken ground in support of its upcoming Neutron Rocket. One only needs to observe how tourism dollars flow into communities in Florida and Texas to understand how spaceflight in Virginia can generate spillovers into adjacent industries.

The story of the Wallops Island Aerospace Cluster is also one of resilience. While non-payroll federal grants and contracts have declined significantly from 2016, the economic impacts

associated with Wallops have remained stable. Economic growth in the communities surrounding Wallops would have likely been more anemic if not for the presence of the aerospace cluster.

To estimate the economic impacts associated with the Wallops Island Aerospace Cluster, we employ annual data from 2018 to 2022. For transparency and replicability, we present our data on employment, spending, and contracts in this report. We generate two sets of economic impact estimates: one based on employment in defense and aerospace occupations in the cluster and one based on employment in defense, aerospace, and engineering occupations in the cluster. We argue this approach provides a lower and upper bound in which the economic impact of the Wallops Island Aerospace Cluster on the economy of Virginia actually lies.

Using publicly available data and interviews, we estimate that the Wallops Island Aerospace Cluster added an average of between 3,300 and 4,600 jobs each year to the Virginia economy from 2018 to 2022. We estimate that industrial output in Virginia due to the defense, aerospace, and engineering industries in the cluster increased by an average of $1.2 billion to $1.4 billion annually from 2018 to 2022. Finally, the Wallops Island Aerospace Cluster contributed between $888 million and $1.03 billion on average to Virginia's real (inflation-adjusted) Gross Domestic Product from 2018 to 2022.

An important question for policy makers is whether the return on investment for state appropriations is greater than one, that is, is Virginia Spaceport Authority providing taxpayers with a sufficient return on their tax dollars? Using our estimates of economic impact for Virginia Spaceport Authority and appropriations data, we estimated the ratio of the total increase in industry output to appropriations from 2018 to 2022. This notional real (inflation-adjusted) return on investment ranged from a high of 4.6 in 2019 (when capital expenditures were highest) to a low of 1.9 in 2021 (in the aftermath of the COVID-19 pandemic). On average, we estimate a return of investment of 2.9, that is, for every dollar appropriated to Virginia Spaceport Authority, industry gross output increased by approximately 2.9 dollars each year from 2018 to 2022.

The economic impact of the Wallops Island Aerospace Cluster is likely to increase over the remainder of the decade. Assuming increases in capital spending and launches occur as projected, we estimate aerospace, defense, and engineering industrial output will increase to between $1.3 and $1.9 billion annually, on average, for the remainder of the decade. By 2030, Wallops Island may contribute almost $2 billion annually to industry output in Virginia.

The challenge ahead is to foster conditions conducive to cluster growth. Workforce housing, transportation bottlenecks, broadband capacity, and consumer services may impede future growth. A broader, systemic view of the challenges facing Wallops Island will facilitate the growth of its industrial base and increase the future economic impact of the Wallops Island Aerospace Cluster on the economy of Virginia.

3. Faculty and Research Staff Biographies and Qualifications

Robert McNab, Principal Investigator, is the Director of the Dragas Center for Economic Analysis and Policy. He is a Professor of Economics and Chair of the Department of Economics in the Strome College of Business at Old Dominion University. His research focuses on topics in public finance, defense economics, and fiscal decentralization. He has worked at all levels of government on topics related to public budgeting and finance in more than 30 countries. He has published in *Applied Economics, Cornell Hospitality Quarterly, Defense and Peace Economics, National Tax Journal, Public Budgeting and Finance,* and *World Development,* among others. Professor McNab is a member of the of the Survey of Professional Forecasters of the Federal Reserve Bank of Philadelphia and is an Associate Editor with the *Journal of Economic Surveys*. He earned his PhD in Economics from the Andrew Young School of Policy Studies at Georgia State University.

Vinod Agarwal is the Director of the Economic Forecasting Project in the Dragas Center for Economic Analysis and Policy and Professor of Economics in the Department of Economics in the Strome College of Business at Old Dominion University. His research interests are in applied economics. His articles have appeared in various journals such as *Cornell Hotel and Restaurant Quarterly, Journal of Travel Research, Economic Development and Cultural Change, Eastern Economic Journal, Economics of Education Review, Growth and Change, Journal of the American Real Estate and Urban Economic Association, Social Science Quarterly,* and *Southern Economic Journal.* He earned his doctoral degree from the University of California at Santa Barbara.

Samuel Brown is Professor and Chair of Public Service. He received a PhD in Public Policy from the University of Maryland, Baltimore County, an M.B.A. from the University of Baltimore and a Bachelor's degree in Economics from Towson State University. Previously he was Director of the Hugo Wall School of Public Affairs and tenured Professor of Public Affairs at Wichita State University.

Old Dominion University (ODU), located in Norfolk, Virginia, is one of the eight colleges and universities in Hampton Roads. ODU is an accredited R1 research university offering 69 bachelor's degrees, 55 master's degrees, 41 doctoral degrees, and 2 educational specialist degrees. Currently, over 24,000 students, including an international student population of 1,408 representing 130 countries, are enrolled at ODU.

The Dragas Center for Economic Analysis and Policy (Dragas Center) undertakes a wide range of socio-economic, demographic, transportation, and defense-oriented studies. The Dragas Center produces the State of the Region Report for Hampton Roads and the State of the Commonwealth reports. The faculty of the Dragas Center have provided advice and assistance to numerous clients on economic impact analyses, regional economic development, and a wide range of public policy issues, including the impact of the opioid crisis and the emergence of Airbnb. More recently, the Dragas Center produced an analysis of the economic impact of a hurricane making landfall in Hampton Roads to inform local and state policymakers.

The views, opinions, and commentary expressed in this report are those of the primary authors and do not represent the official positions of the Commonwealth of Virginia, the Virginia Commercial Space Flight Authority, Old Dominion University, or the donors of the Dragas Center for Economic Analysis and Policy.

4. Introduction

Wallops Island is located on the Eastern Shore of the Commonwealth of Virginia and is home to the Wallops Flight Facility as well as the United States Navy Field Carrier Landing Practice activity, science missions from the National Oceanic and Atmospheric Administration (NOAA), and the Mid-Atlantic Regional Spaceport, which is owned and operated by the Virginia Commercial Space Flight Authority (dba. Virginia Spaceport Authority). With a long history of supporting science and defense activities, the Wallops Island Aerospace Cluster occupies an economic footprint that includes the Virginia counties of Accomack and Northampton as well as the Maryland counties of Somerset, Wicomico, and Worcester.

In this report, we examine the economic impacts associated with public and private sector activities in the Wallops Island Aerospace Cluster. We broaden the definition of the aerospace and defense industry cluster to include activities related to engineering, national security, sensors, and space research and flight. The attractiveness of this cluster is quite clear. In the fourth quarter of 2022, average annual wages for defense and aerospace employees in the cluster were $110,069, $40,000 higher than the average worker in Virginia ($69,745). However, employment in the industry cluster has declined recently, though prospects are improving with the arrival of Rocket Lab and other firms.

Using publicly available data and interviews, we estimate the annual employment gains associated with the Wallops Island Aerospace Cluster ranged between approximately 3,300 and 4,600. Within the cluster, we estimate average annual wages for defense and aerospace workers exceeded $110,000 and that average annual wages for the broader cluster were over

$90,000. We estimate real (inflation-adjusted) industry output increased between $1.2 billion and $1.5 billion, on average, due to the presence of the industry cluster. Furthermore, we estimate that the Wallops Island Aerospace Cluster's annual average contribution to the real Gross Domestic Product (GDP) in Virginia ranged between $888.4 million and $1.03 billion from 2018 to 2022.

The remainder of the report is structured as follows. In the next section, we briefly review the geography of Wallops Island, the activities associated with the Wallops Flight Facility, and previous studies of the economic impact of the Langley Research Center and the Wallops Flight Facility. We note the need to focus on the Wallops Flight Facility and public and private organizations associated with the installation that reside in the geographic footprint.

The following section of the report defines the Wallops Island Aerospace Cluster geographic footprint and examines the socio-economic characteristics of the counties that comprise the footprint. We examine economic activity, demographic characteristics, and the performance of the counties in the footprint relative to the Commonwealth of Virginia and the nation. We also discuss labor market trends, specifically examining pre- and post-COVID characteristics.

We then examine trends in the aerospace industry over the last two decades, with specific focus on the emergence of private launch companies. We discuss how companies such as SpaceX and Rocket Lab are transforming the commercial launch space industry. As the number of private launch companies continues to climb, we discuss the potential for Wallops Island to be the home for a new class of orbital launch vehicles and the conceivable gains from the aerospace and space tourism industries.

The following section of this report focuses on the Wallops Island Aerospace Cluster. We define the industry cluster. We compare the Wallops Island Aerospace Cluster with traditional aerospace clusters and how a broader definition is better suited for the purposes of our analysis. We discuss labor market and establishment trends in the Wallops Island Aerospace Cluster relative to Virginia and the United States.

We then present the economic impact methodology and additional assumptions underlying our analysis. We strive to present our methodology and assumptions to allow the interested reader to replicate our analysis. We discuss our selection of economic impact multipliers and the costs and benefits of using different platforms to estimate the economic impacts associated with the Wallops Island Aerospace Cluster.

The following section of this report presents and discusses our economic impact estimates. We first discuss the aggregate impact of the Wallops Island Aerospace Cluster over the study period with respect to employment and compensation. We then discuss how the Wallops Island Aerospace Cluster generates impacts in other industries. We discuss the potential economic impact of announced projects associated with the Wallops Island Aerospace Cluster and conclude with estimates of annual economic impact. The last section of this report concludes and offers policy recommendations.

5. Wallops Island and the Wallops Flight Facility

Wallops Island is a six-square-mile island located in Accomack County on the Eastern Shore of the Commonwealth of Virginia. The Wallops Flight Facility (WFF) is located on Wallops Island and is operated by NASA's Goddard Space Flight Center in Greenbelt, Maryland. The WFF consists of three separate parcels: the Main Base, the Mainland, and the Wallops Island Launch Site. Major facilities include Federal Aviation Administration (FAA)-certified runways, an experimental Unmanned Aerial Vehicle (UAV) runway, rocket launch pads, blockhouses for rocket control, and assembly buildings to support rocket vehicle preparation, integration, and launch activities.

Picture 1

Wallops Island Flight Facility

Photo Credit: NASA (2023)

The WFF supports a variety of activities for public and private organizations. The National Aeronautics and Space Administration (NASA) is one of the most visible organizations, operating the WFF, the associated ranges, and launching numerous sounding rockets over the last six-plus decades. The island is also home to the several activities of the United States, science missions from the National Oceanic and Atmospheric Administration (NOAA), and the Virginia Commercial Space Flight Authority (VCSFA or "Virginia Spaceport Authority"). Virginia Spaceport Authority owns and operates the Mid-Atlantic Regional Spaceport (MARS).

Since 1995, there have been 28 launches from MARS, most frequently launching the Antares rocket in various configurations. In August 2022, Northrop Grumman announced it had contracted with Firefly Aerospace to build the first stage of the Antares 300-series rockets as the 200-series used RD-181 engines which were manufactured in Ukraine using engines from Russia.[1] Northrop Grumman is planning to launch the final Antares 230+ in 2023 and the first flight of the Antares-300 series is anticipated to occur in 2024.

In 2018, Rocket Lab selected MARS as the location of its Launch Complex 2 due to, in part, the ability to service a wide range of orbital inclinations and an aggressive planned construction schedule.[2] By December 2020, Launch Complex 2 was complete, including a 66-ton launch platform and a 7.6-ton strongback for Rocket Lab's Electron rocket, both of which were manufactured in Virginia. In January 2023, Rocket Lab successfully launched its first Electron from

[1] https://news.northropgrumman.com/news/releases/northrop-grumman-teams-with-firefly-aerospace-to-develop-antares-rocket-upgrade-and-new-medium-launch-vehicle
[2] https://www.rocketlabusa.com/updates/rocket-lab-opens-launch-complex-2-confirms-u-s-air-force-payload-as-first-electron-mission-from-u-s-soil/

MARS. Rocket Lab is also planning to produce its newest rocket, the Neutron, at MARS.[3] The Neutron Production complex, when complete, will include a launch control center. Eventually, the Neutron will return to MARS after launch to allow for rapid refurbishment and relaunch. If successful, the Neutron facility and operations would significantly expand operations at MARS.

While economic activity at and around Wallops Island is most closely identified with the aerospace industry, we would be remiss if we did not note other technology-driven activities. Non-aerospace sector activities, including national defense, coastal resilience and engineering, information technology, and unmanned systems also drive employment and spending. These activities are not only associated with higher paying jobs, the nexus of "high-tech" firms can create network effects, that is, firms derive higher value by collocating with other firms of a similar nature. The positive feedback loop attracts other firms, increasing the concentration of high-tech firms and employees and the positive spillovers on the surrounding communities.

As illustrated in Figure 1, the number of high-tech establishments at and around Wallops Island remained relatively constant from 2004 Q1 to 2020 Q4, averaging 47 establishments a quarter over this period.[4] In 2021, the number of high-tech establishments increased from 50 in 2021 Q1 to 61 in 2021 Q4. The most recent data suggests that the increases were sustained, with a reported 74, 78, and 79 establishments in 2022 Q1, Q2, and Q3, respectively. Not surprisingly, the gains in high-tech establishments also coincide with a sustained rise in average annual wages.

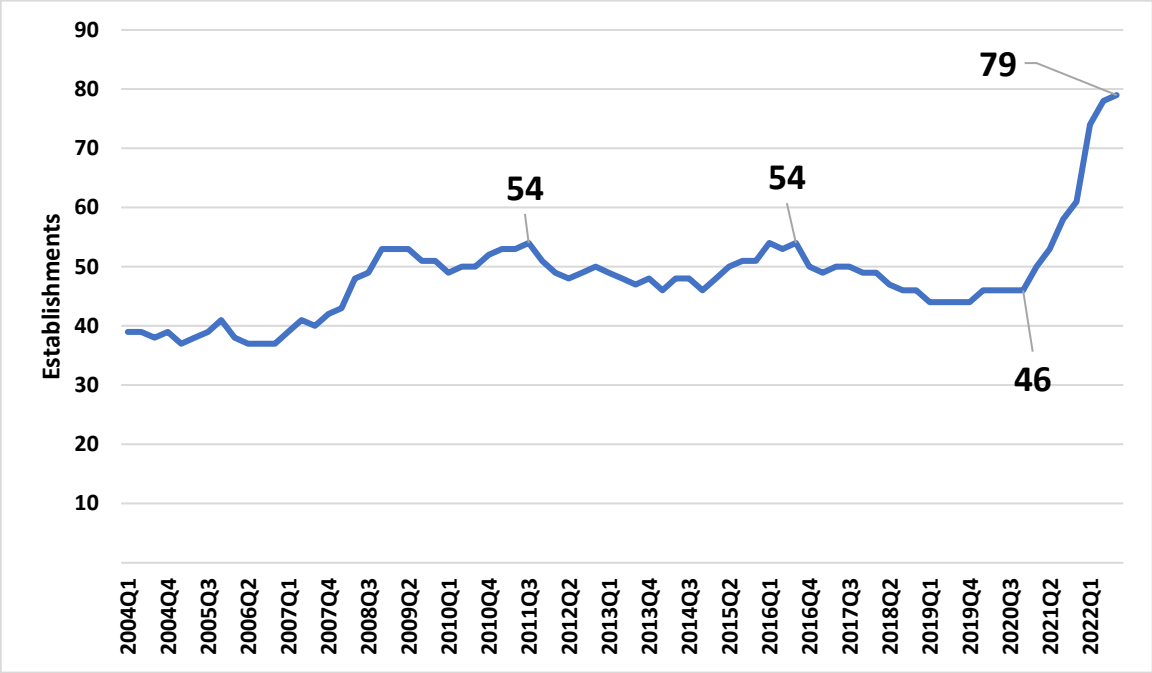
[3] https://www.rocketlabusa.com/launch/neutron/

[4] Using commuting patterns from the United States Census Bureau, we define the geographic footprint of Wallops Island to include the Virginia counties of Accomack and Northampton as well as the Maryland counties of Somerset, Wicomico and Worcester. We define high tech to include the industries of Engineering Services (NAICS 54133), Space Research and Technology (NAICS 92711), National Security (NAISC 928110), and All Other Professional, Scientific, and Technical Services (NAICS 54199).

Average annual wages among high-tech employees increased from $81,060 in 2021 Q4 to $89,665 in 2022 Q4, outpacing the annual wage growth for all employees in Virginia and the United States.

Figure 1 – High-Tech Establishments in the Wallops Island Footprint

2004 Q1 - 2022 Q3



Source: Chmura Economics, JOBSEQ (2023), four-quarter moving average. An establishment is a single physical location where one predominant activity occurs. Establishment data is lagged at least one quarter relative to labor and wage data.

With the recent growth in establishments and average annual wages, the open question is whether the economic impact of Wallops Island and its associated organizations and installations has increased as well? A Fiscal Year (FY) 2006 study by Wessex Group Ltd. of Williamsburg estimated the combined impact of the Langley Research Center (LaRC) and the

WFF. The study showed that the WFF increased economic output for the nation by $424 million and generated approximately 4,000 jobs (NASA Langley Research Center, 2006). A similar study for FY 2009 estimated that the LaRC and WFF together increased economic activity in Virginia by $1.15 billion and generated 10,295 jobs (NASA Langley Research Center, 2010). This study did not report specific estimates for the WFF but did report estimates for the LaRC. In FY 2009, this study estimated WFF's impact on the economy of Virginia was approximately $230 million and 2,157 jobs.

More recent estimates suggest that the economic impacts associated with the WFF have increased over time. Chmura Economics estimated the WFF generated $214.0 million in direct operating expenditures and $40.3 million in direct employee spending in FY 2015 for the United States, leading to a total economic impact of $802.1 million (Chmura Economics & Analytics, 2015). For Virginia, Chmura Economics estimated that WFF spending was approximately $90.7 million with an additional $23.9 million in employee spending, yielding a total economic impact of $261.5 million for the Commonwealth. Kapur Energy Environment Economics estimated the WFF generated a $238.1 million and $239.7 million direct economic impact in FY 2016 and FY 2017, respectively. These direct impacts generated $880.9 million and $891.9 million in total economic impacts nationwide in FY 2016 and FY 2017, respectively (Kapur Energy Environmental Economics, 2016, 2017). In 2019, Old Dominion University estimated that the WFF and its partners generated an annual economic impact on the Commonwealth of Virginia of approximately $1.4 billion with 1,900 jobs directly tied to operations at the facility (Filer, 2019). The most recent estimates in 2022 from NASA suggest an overall economic impact of $1.37 billion and 6,092 job in Virginia

These studies are informative and illustrate the economic impacts of the LaRC and the WFF. Except for the 2019 ODU study of the WFF and the most recent NASA estimates, however, most of the studies have focused on a geographic footprint bounded by the WFF and on NASA's operations at the WFF. While NASA undoubtedly accounts for a significant portion of economic activity at the WFF, we argue that a more expansive definition is needed, especially given the arrival of Rocket Lab and its plans for increasing launch cadence. Furthermore, we, as with the 2019 ODU study, argue that limiting the geographic footprint to Wallops Island likely biases estimates downward given the flows of business and labor among the five counties that comprise the expansive geographic footprint. Lastly, we caution that the measurement of economic impacts varies across studies, a key point when attempting to compare studies of economic impact from different sources across time.

As our focus is on the economic impact of the WIAC and public and private organizations associated with the WIAC, we make three distinct changes to the scope of our analysis. Here, we follow the 2019 ODU study that examined the economic impacts related to public and private sector activities associated with Wallops Island. We expand the scope of analysis to include public organizations such as the Department of Defense (specifically the Department of the Navy), Department of Homeland Security (specifically, the United States Coast Guard), the National Oceanic and Atmospheric Administration (NOAA), and the Virginia Spaceport Authority. We also include the activities of private sector organizations, namely Northrup Grumman and Rocket Lab, identified during our interviews with public and private sector representatives at the local, regional, and state level.

The broader scope of our analysis also requires a geographic footprint that extends beyond Wallops Island. Using commuting patterns from the United States Census Bureau, we define the geographic footprint of Wallops Island to include the Virginia counties of Accomack and Northampton as well as the Maryland counties of Somerset, Wicomico, and Worcester. Table 1 illustrates the distance from work census block to home census block for Accomack County in 2019. More than 60% of workers in Accomack travel north or south from their home to work, illustrating the ties among Accomack, Northampton, Somerset, Wicomico, and Worcester counties.

Table 1 - Distance from Work Census Block to Home Census Block, All Jobs

Accomack County, 2019

	Count	Share
Less than 10 Miles	4,648	39.7%
10 to 24 Miles	3,130	26.7%
25 to 50 Miles	1,410	12.0%
Greater than 50 Miles	2,519	21.5%
Total	11,707	100.0%

Source: United States Census Bureau, On the Map, 2023.

The data in Table 1 are echoed by employment data from NASA. In May 2023, approximately 43% of the Wallops workforce resided in Accomack County, followed by Worcester County (27%), Wicomico County (18%), and Somerset County (7%). Of the 266 employees in May 2023, 155 worked in engineering and science occupations, of which 100 (65%)

lived outside Accomack County. Of the 92 professional and administrative employees, 42 (46%) lived outside Accomack County. Seventeen employees worked as technicians and 9 (53%) lived outside Accomack County. Both of the clerical employees, however, lived in Accomack County. The flow of these employees illustrates the ties between Wallops Island and surrounding communities.

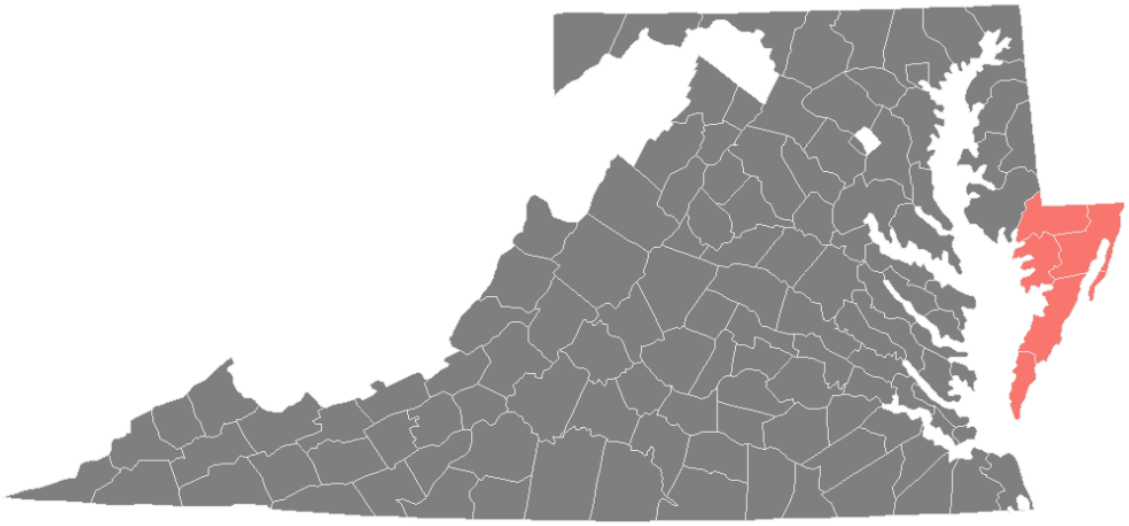
Lastly, we focus our attention on aerospace-related activities within the Wallops Island geographic footprint. Although the aerospace industry dominates industrial activity on Wallops Island, there is more to the aerospace ecosystem than the launch complex. The Coast Guard, Navy, NOAA, and other organizations also provide related activities and estimates for economic impact to account for these activities. Therefore, measuring total economic impact of the activity on the island will require a broader definition of industries and occupations than simply those specific to aerospace. In subsequent sections, we define the Wallops Island Aerospace Cluster (WIAC) and examine the characteristics of the WIAC relative to the workforce in the Wallops Island footprint as well as the Commonwealth of Virginia.

6. Economic Background

In this section, we define the economic footprint of Wallops Island. As noted previously, commuting patterns suggest that workers flow into (and out of) Accomack County, predominantly from counties to the north and south. Sizeable amounts of labor and spending flow between Wallops Island and the Virginia counties of Accomack and Northampton as well as the Maryland counties of Somerset, Wicomico, and Worcester. Figure 2 illustrates the geographic footprint of Wallops Island, the core of our study area. We employ this study area to examine how people and spending combine to impact the economy of the Commonwealth of Virginia.

Picture 2

Wallops Island Footprint



Source: Dragas Center for Economic Analysis and Policy (2023)

6.1 Demographics of the Wallops Footprint

The five counties that comprise the Wallops Footprint vary significantly with regard to demographic characteristics. Northampton County was the least populated of the five counties, with a total population of 12,226 in 2021. Wicomico County was the largest county in terms of population, with 103,223 residents in 2021. If we examine population growth, the Virginia counties of Accomack and Northampton have lost population over the last decade, while Wicomico and Worcester have grown over the same period.

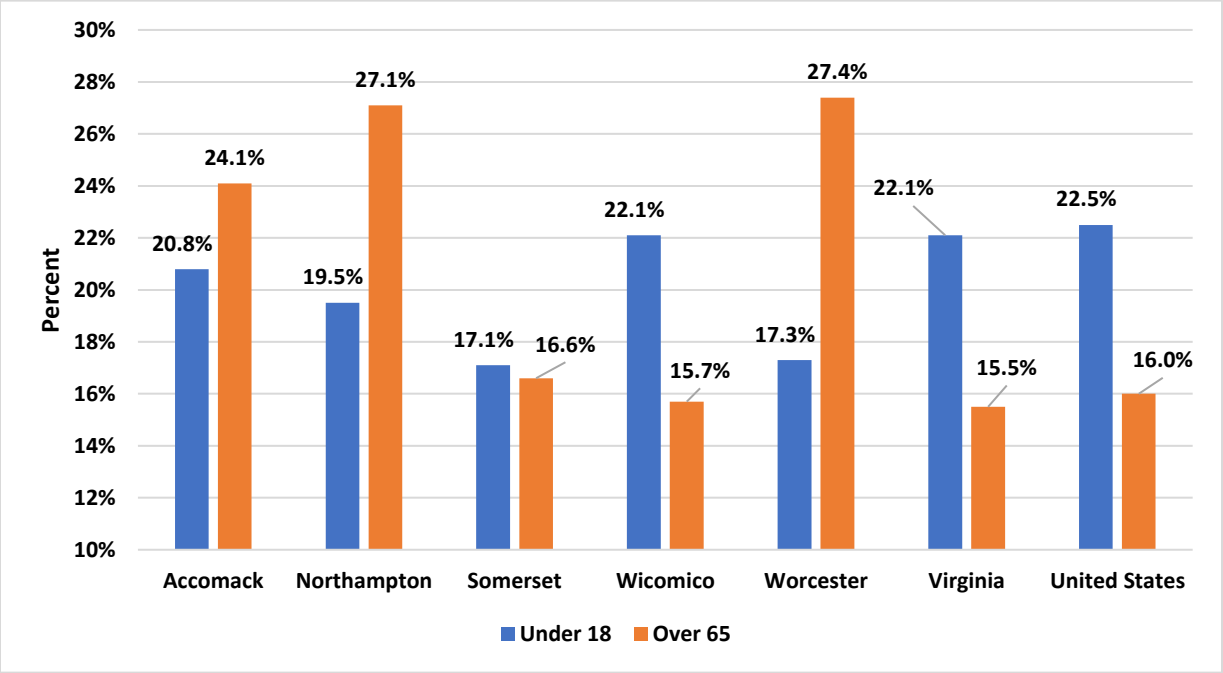
Annual average population growth from 2010 to 2019 for counties that comprised the Wallops Footprint (0.4%) was slower than Virginia (0.7%) and the nation (0.7%). From 2020 to 2021, however, population growth in the Wallops Footprint (0.4%) outpaced the Commonwealth (0.1%) and the United States. Two counties, Wicomico (0.5%) and Worcester (1.3%) accounted for the relatively faster pace of growth in the Wallops Footprint as Accomack (-0.3%) and Northampton (-1.2%) continued to observe population declines. Somerset County, which had experienced negative population growth over the last decade (-0.4%), saw its population grow by 0.1% from 2020 to 2021.

Figure 2 presents the percent of the population under 18 years of age and 65 years and older using data from the 2017 – 2021 American Community Survey for the five counties in the Wallops Footprint as well as Virginia and the United States. The counties in the Wallops Footprint are older, on average, than the Commonwealth and the nation. With respect to the proportion of the population over the age of 65, only Wicomico (15.7%) is below the national average (16.0%). Northampton (27.1%) and Worcester (27.4%) are more than 10 percentage points

higher than the national average, followed by Accomack (24.1%). With a higher proportion of the population approaching (or in) retirement, the pool of available labor may constrain future growth unless there is significant in-migration or an increase in the birth rate.

Figure 2 - Percent of Population Under 18 Years Old and 65 and Older, 2017 - 2021

Wallops Footprint Counties, Virginia, and the United States



Source: US Census Bureau American Community Survey 2017-2021.

Table 2 illustrates the population distribution by race for the counties in the Wallops Footprint, Virginia, and the United States using the 2017 – 2021 American Community Survey estimates. Relative to the nation and the Commonwealth, the counties in the Wallops Footprint had a higher proportion of residents who identified as Black or African American and a lower proportion of individuals who identified as Asian. Accomack (9.1%) and Northampton (9.3%) had

a higher proportion of individuals who identified as Hispanic or Latino than Virginia but still well below that for the nation (18.4%).

Table 2 - Population Distribution by Race, 2017 - 2021

Wallops Footprint Counties, Virginia, and the United States

	Asian	Black or African American	White	Hispanic or Latino
Accomack	0.8%	28.5%	64.5%	9.1%
Northampton	1.1%	32.1%	59.9%	9.3%
Somerset	0.9%	40.9%	52.2%	3.8%
Wicomico	2.9%	26.1%	63.8%	5.5%
Worcester	1.4%	12.4%	81.7%	3.7%
Wallops Footprint	1.9%	25.2%	66.6%	5.6%
Virginia	6.7%	19.0%	64.9%	5.9%
United States	5.7%	12.6%	68.2%	18.4%

Source: US Census Bureau American Community Survey 2017-2021.

Educational attainment data of the counties in the Wallops Footprint, Virginia, and the United States are presented in Table 3. The Wallops Footprint counties have a higher proportion of residents who do not have a high school diploma than Virginia or the nation. Likewise, a higher percentage of the population of the Wallops Footprint counties have a high school education but a lower proportion has any higher education degree than the Commonwealth or the United States. The lower levels of education attainment may constrain the ability of employers to expand, especially in technology-intensive industries. Employers may need to draw employees

to the Wallops Footprint to support technology-intensive operations, and economic development efforts should examine K-12, community and 4-year college and university curricula to better match the needs of current and future employers.

Table 3 - Educational Attainment, 2017 - 2021

Wallops Footprint Counties, Virginia, and the United States

	No High School Diploma	High School Graduate	Associate Degree	Bachelor's Degrees	Graduate or Professional Degree
Accomack	11.8%	34.7%	7.8%	12.1%	8.9%
Northampton	8.0%	31.6%	7.5%	17.2%	10.9%
Somerset	13.3%	36.5%	7.4%	11.9%	5.1%
Wicomico	8.4%	31.7%	7.9%	17.1%	11.7%
Worcester	5.5%	30.0%	8.2%	18.6%	12.0%
Wallops Footprint	8.7%	32.2%	7.9%	16.2%	10.6%
Virginia	5.5%	23.8%	7.9%	22.8%	17.6%
United States	6.3%	26.5%	8.7%	20.6%	13.1%

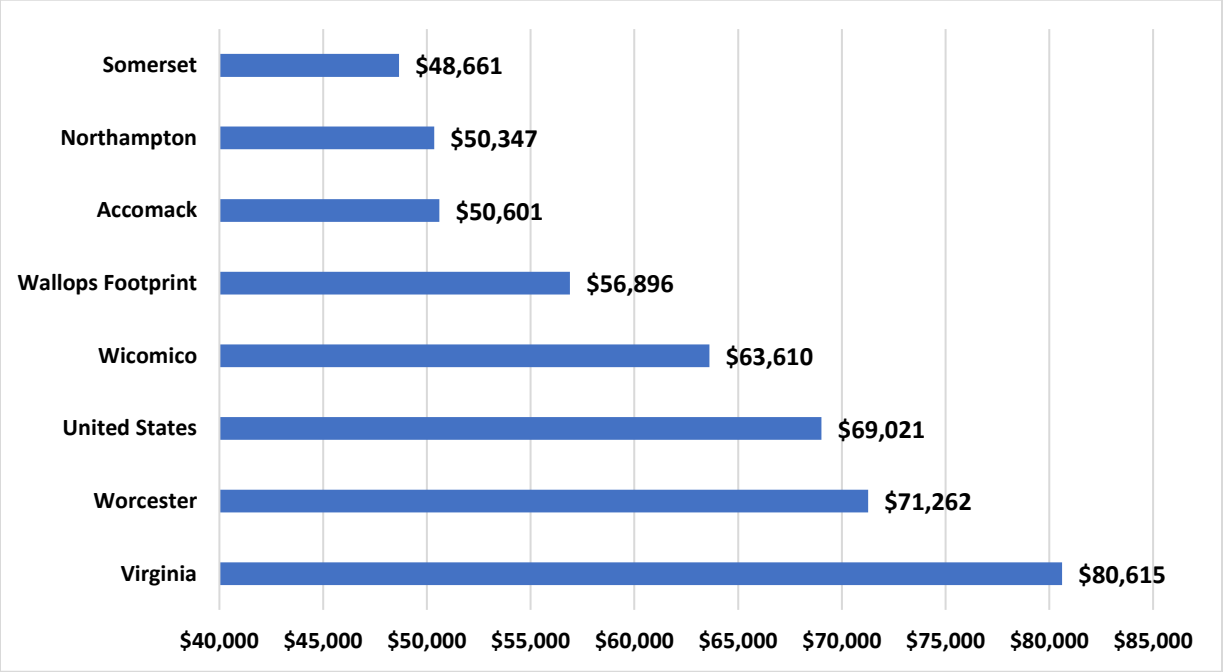
Source: US Census Bureau American Community Survey 2017-2021.

Median household income is a measure that captures the income in the last 12 months for the "middle" of the distribution of households in a geographic area. From 2017 to 2021, median household income in the United States was $69,021 (Figure 3). Median household income was lower than the nation for Somerset ($48,661), Northampton ($50,347), Accomack

($50,601), and Wicomico ($63,610). While median household income in Worcester ($71,262) was higher than the nation's, it was still below that of Virginia ($80,615). In other words, the median household in the Wallops Footprint earned less income than the median household in the Commonwealth from 2017 to 2021.

Figure 3 - Median Household Income, 2017 - 2021

Wallops Footprint Counties, Virginia, and the United States



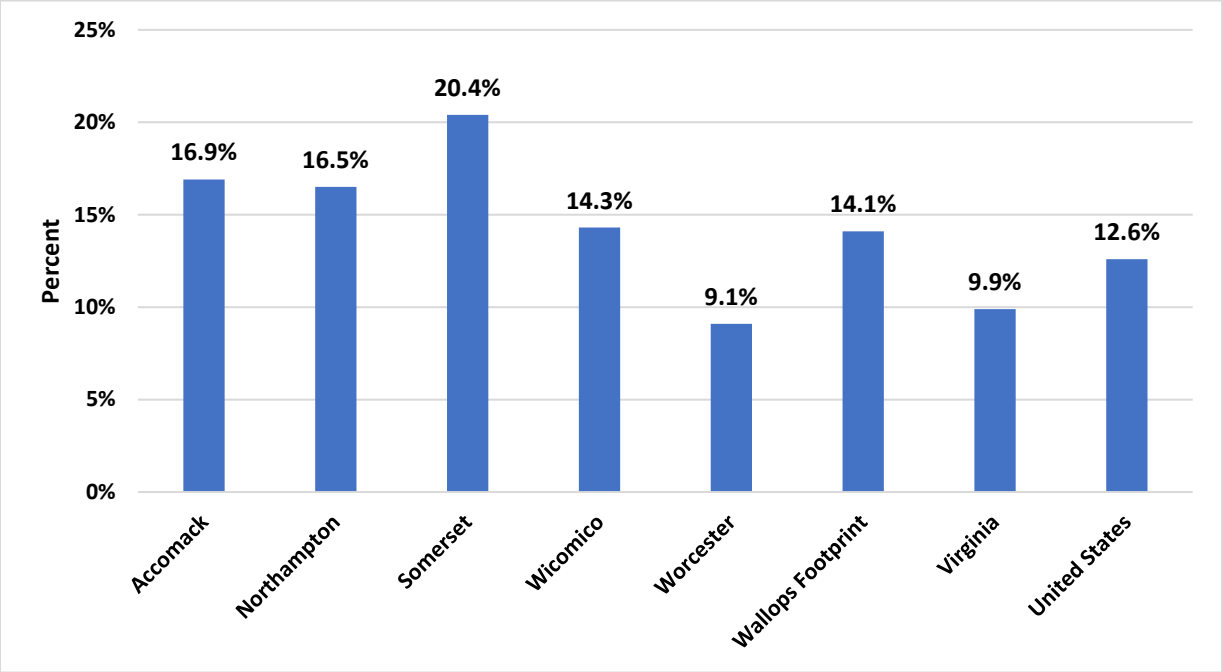
Source: US Census Bureau American Community Survey 2017-2021.

With lower observed levels of median household income from 2017 to 2021, it should be no surprise that more households were in poverty in the Wallops Footprint counties than Virginia or the United States (Figure 4). From 2017 to 2021, approximately 1 in 5 households in Somerset were at or below the poverty level. About 1 in 6 households were at or below the poverty level in Accomack and Northampton, while approximately 1 in 7 households were at or below the

poverty level in Wicomico. Only Worcester (9.1%) had fewer households in poverty than Virginia (9.9%) or the United States (12.6%).

Figure 4 - Poverty Rate, 2017 - 2021

Wallops Footprint Counties, Virginia, and the United States



Source: US Census Bureau American Community Survey 2017-2021.

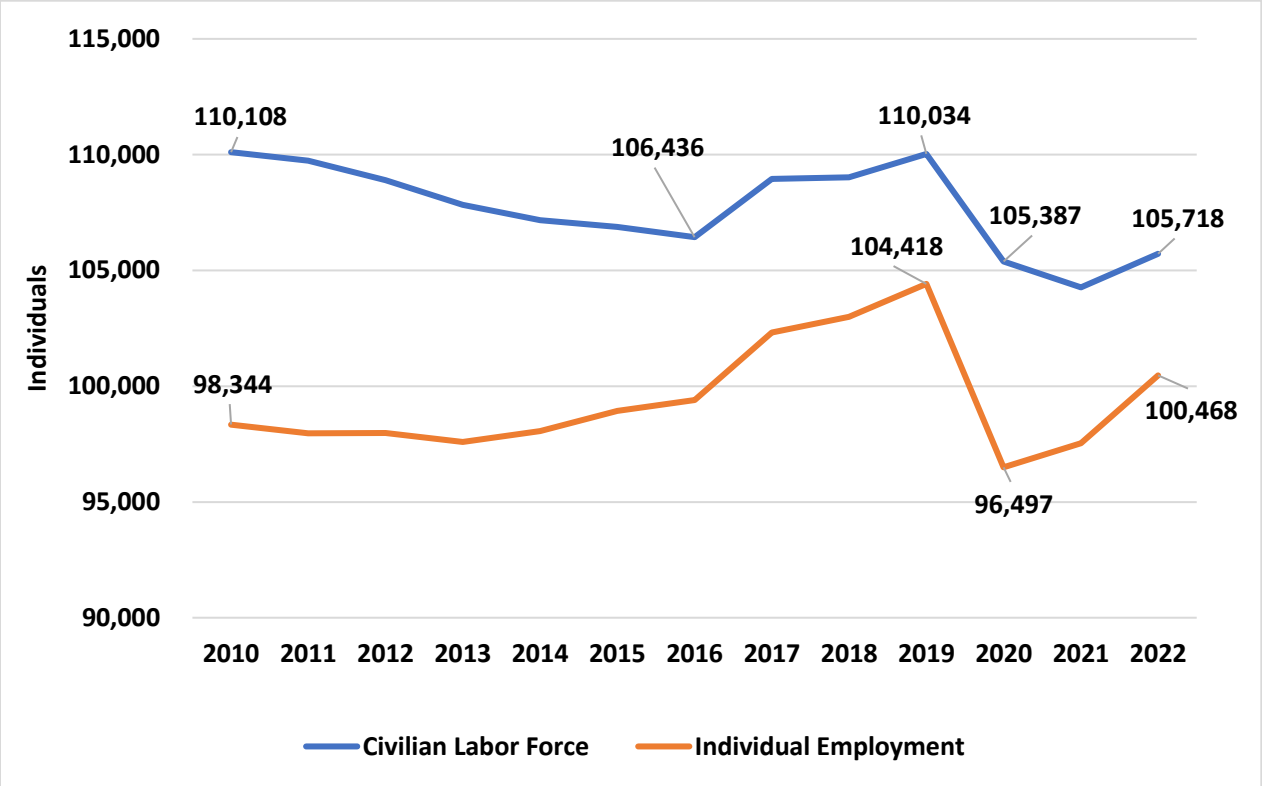
6.2 Economic Characteristics of the Wallops Footprint

The civilian labor force measures all persons 16 years of age or older who are employed or seeking employment (unemployed). For the counties in the Wallops Footprint, the civilian labor force declined from 110,108 in 2010 to 106,436 in 2016 (Figure 5). In the latter half of the previous decade, the civilian labor force recovered, reaching 110,034 in 2019. In other words, the civilian labor force in the Wallops Footprint was largely unchanged from 2010 to 2019. Over the same period, individual employment in the Wallops Footprint grew from 98,344 to 104,418. In

other words, while the civilian labor force was largely unchanged over the decade, individual employment grew by more than 6,000 individuals.

Figure 5 - Civilian Labor Force and Individual Employment, Wallops Footprint

2010 - 2022



Source: U.S. Bureau of Labor Statistics.

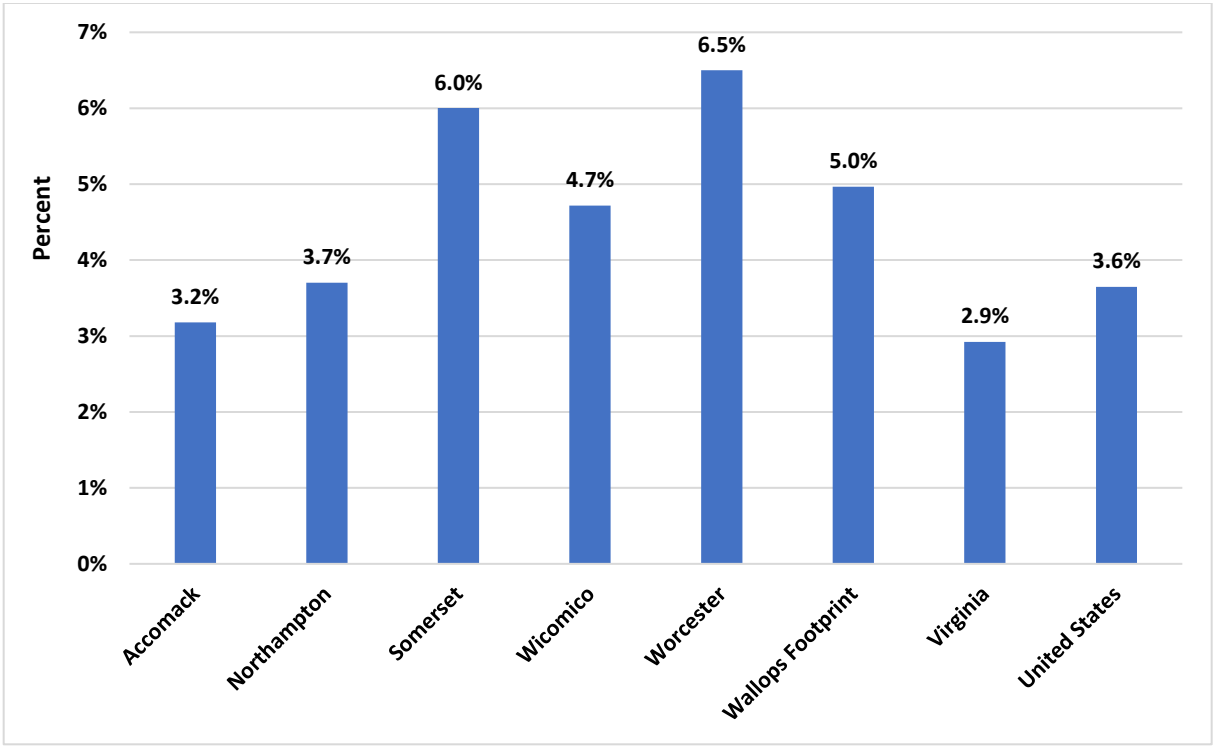
The shock from the COVID-19 pandemic and related restrictions of business and social activity depressed economic activity in the Wallops Footprint. The civilian labor force declined to 105,387 in 2020 (-4.2%) and to 104,269 in 2021 (-1.1%). The declines in individual employment, however, were more pronounced than those in the civilian labor force. From 2020 to 2021, employment declined by 7.6% to 96,497. Individual employment recovered in 2021 and 2022,

however, the level of employment in 2022 was still about 4,000 individuals less than the levels observed in 2019.

Figure 6 displays the annual unemployment rate in 2022 for the counties in the Wallops Footprint, Virginia, and the United States. The annual unemployment rate for Accomack and Northampton was approximately the same as the nation, but higher than that of the Commonwealth in 2022. For the Maryland counties, the annual unemployment rate in 2022 was higher than that of the nation. The annual unemployment rate was 2.4 percentage points higher in Somerset and 2.9 percentage points higher in Worcester relative to the annual unemployment rate of the United States in 2022.

Figure 6 –Annual Unemployment Rate, 2022

Wallops Footprint Counties, Virginia, and the United States

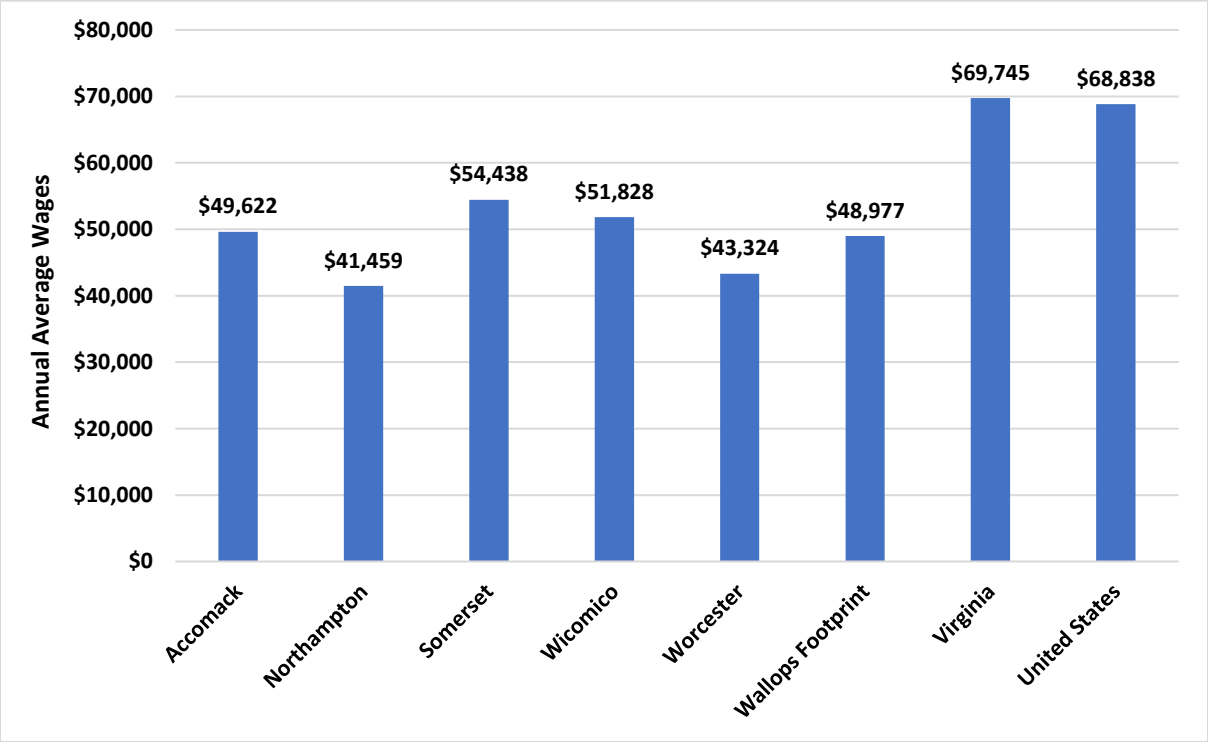


Source: U.S. Bureau of Labor Statistics.

Figure 7 displays how much workers earn on average in the Wallops footprint counties, Virginia, and the United States for 2022 Q4. Average annual wages in the Wallops Footprint counties are significantly lower than average wages in Virginia and the nation. In the fourth quarter of 2022, average annual wages varied from a low of $41,459 (Northampton) to a high of $54,438 (Somerset). During the same quarter, average annual wages were $68,838 and $69,745 for the U.S. and Virginia, respectively.

Figure 7 – Annual Wages, 2022 Q4

Wallops Footprint Counties, Virginia, and the United States



Source: JobsEQ. Data as of 2022 Q4.

In Figure 8, we illustrate the four-quarter average of covered employment for major industries in the Wallops Footprint ending in the fourth quarter of 2022. Health care and Social Assistance was the largest industry (15,123), followed by Accommodation and Food Services

(13,314), Retail Trade (11,996), and Educational Services (9,257). Manufacturing (7,356) and Public Administration (7,048) were followed by Construction (4,101), Administration and Support (3,570), and Professional, Scientific, and Technical Services (3,229). In total, all industries in the Wallops Footprint reported 92,115 covered employees in 2022 Q4.

Figure 8 - Wallops Footprint Industry Employment

Four-Quarter Average Ending in 2022 Q4

Source: JobsEQ. Data as of 2022 Q4.

In summary, except for Worcester (for some measures), residents in the Wallops Footprint tend to be older, have lower levels of educational attainment, have lower levels of median household income, lower wages, and display higher levels of poverty than Virginia. If demographics influence economic destiny, then improving the prospects of the Wallops Footprint in the coming years will require a concerted economic development effort to increase

the pool of highly skilled labor, whether by educating residents or improving in-migration. Increasing the economic linkages with the Virginia Beach – Norfolk – Newport News (Hampton Roads) metropolitan statistical area may be one prudent course of action to foster job growth in the future.

7. Trends in the Aerospace Industry

On July 21, 2011, the Space Shuttle Atlantis touched down at 5:57 a.m., ending an era in American spaceflight. Since the end of World War II, NASA and its antecedents dominated space flight in the United States, funding manned exploration of the Moon and low-Earth-orbit and remote exploration of the Solar System. The end of the Shuttle program led to significant reductions in contracts and personnel. The Space Launch System (SLS), proposed to return America to the Moon, was slated to originally launch in 2016 but did not actually launch until 2022. The SLS is prohibitively expensive and is likely not to achieve a launch cadence that would significantly lower costs-per-kilogram to orbit.

Until the 2010s, space flight was largely dominated by national space agencies and a handful of multinational corporations. The last decade, however, has seen a rapid shift in the marketplace, with the emergence of private, commercial space launch companies. Innovation in the industry has accelerated, and now private companies are ferrying cargo and people to the International Space Station.

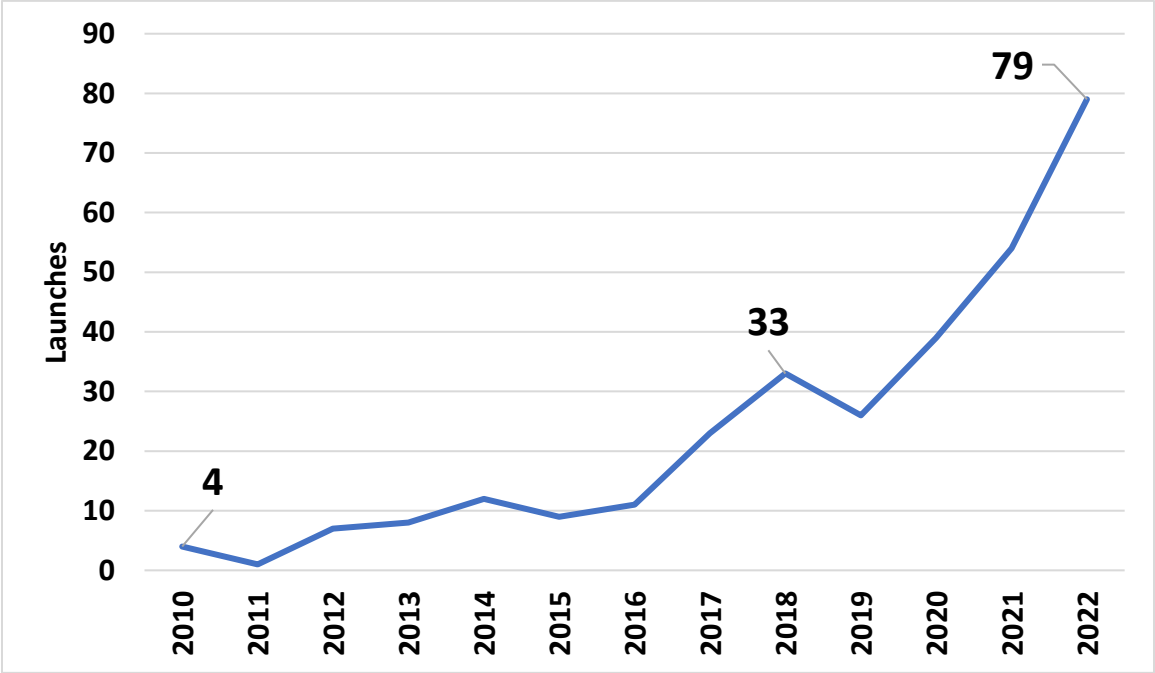
7.1 Trends in the Global Aerospace Industry

In 2010, there were 58 commercial launches globally. By 2020, there were 181 commercial launches globally. In 2022, there were 188 orbital launches globally, of which 178 reached orbit. Figure 9 illustrates the growth in licensed launches in the United States from 2010 to 2022. In 2010, there were 4 Federal Aviation Administration (FAA) licensed launches. By 2018, the number of FAA-licensed launches increased to 33. In 2022, there were 79 FAA-licensed

launches in the United States. We expect this trend to continue as new firms attempt to reach orbit and existing firms continue to increase launch cadence.

Much of this growth can be attributed to the emergence of new commercial space companies, including SpaceX and Rocket Lab. Rocket Lab is of particular interest given its operations at MARS and its intent to expand its facilities for Neutron production in the coming years. We must recognize that what is now commonplace was once providence of national space agencies and a small number of private corporations. Expanding private space flight operations at MARS by attracting new and existing space launch corporations is likely to generate significant returns in investments, high paying jobs, and launch cadence.

Figure 9 – FAA Licensed Launches, United States, 2010 - 2022



Source: Federal Aviation Administration (2023).

Another major development in the commercial spaceflight industry has been the growing popularity of space tourism. Several companies, most notably Blue Origin and SpaceX, are offering suborbital (Blue Origin) or orbital (SpaceX) flights to private individuals. According to some industry estimates, the space tourism market could be worth up to $3 billion per year by 2030. An analogy would be the advent of commercial aircraft and passenger flight. Initially, commercial passenger service was beyond the reach of most. However, as technology expanded the reach and capacity of commercial aircraft increased as well. Deregulation further increased competition and lowered the relative price of commercial airline travel.

The commercial spaceflight industry has also made strides in developing reusable spacecraft and rockets. SpaceX's Falcon 9 rockets and Dragon spacecraft, for example, are designed to be reusable, which SpaceX argues significantly reduces the cost of spaceflight over time. Rocket Lab has also recovered some first stages through water landings rather than propulsive landings like SpaceX. Reusable rockets and spacecraft allow for more frequent launches and provide valuable engineering data on system components.

Finally, the commercial spaceflight industry has been playing an increasingly important role in global telecommunications and Earth observation. With the launch of thousands of small satellites in recent years, companies are providing new services such as global broadband internet and monitoring of climate change and natural disasters. According to the Space Report, there were 2,666 active satellites in orbit as of December 2020, with commercial satellites accounting for the majority of them. This trend is likely to continue in the future, as companies

such as SpaceX and Amazon's Project Kuiper plan to launch thousands of additional satellites in the coming years.

7.2 Stakeholder Perspectives on Virginia's Aerospace Industry

To complement the quantitative economic impact analysis, the Dragas Center for Economic Analysis and Policy interviewed a select group of stakeholders of the Wallops Island Aerospace Cluster, including the Virginia Economic Development Partnership, the Virginia Unmanned Space Center, the Virginia Space Flight Academy, and the Chincoteague Chamber of Commerce. Our aim was to learn more about the stakeholder perspectives on the economic impact of the Wallops Island Aerospace Cluster. The overall conclusion from these interviews was consistent: the stakeholders believe that the aerospace cluster has a significant economic impact on the region and the Commonwealth of Virginia.

As the state's economic development agency, the Virginia Economic Development Partnership (VEDP) views the aerospace and aviation industry as a key sector for economic growth. VEDP's staff noted Virginia's rich history in space flight and shared their commitment to build on this legacy to promote business and job growth in the state. From the perspective of VEDP, a strength of the Wallops Island Aerospace Cluster is the competitive advantage that it provides in attracting new space flight companies.

As the home to NASA's Wallops Flight Facility, the Eastern Shore of Virginia offers convenient access to the Atlantic Ocean for rocket launches. Additionally, Wallops Island offers a range of launch services to commercial customers through the Mid-Atlantic Regional Spaceport

(MARS)—a commercial spaceport within close proximity to the NASA Flight Facility. VEDP considers the Virginia aerospace cluster to be a mature industry, providing a key advantage for space flight companies. Having an ecosystem of aerospace companies and suppliers provides support to spaceflight operations. Rounding out this ecosystem of companies is the highly skilled aerospace and aviation workforce of engineers, technicians, and other management staff.

In its efforts to support new space flight capabilities, VEDP is supporting the Virginia Commercial Space Flight Authority in the development of a new spaceport in the Northern Neck Region of the state to provide a broader range of launch services to government and commercial customers. The Virginia Economic Development Partnership views space flight as a key component of its broader efforts to promote growth in the high-tech industries of Virginia. VEDP strives to create a vibrant business climate for space flight by promoting Wallops, the aerospace industry, and the emerging space flight capabilities of the cluster.

The Virginia Unmanned Systems Center (VUSC) is also a stakeholder organization to the Wallops Island Aerospace Cluster. Our interview with the leadership of VUSC, the state's lead organization for unmanned systems, robotics, and space flight research, revealed the importance of space flight from the perspectives of research, education, and technology. From the research perspective, VUSC views space flight research as a key component of the state's culture of innovation. The Wallops Island Aerospace Cluster is comprised of private companies and government agencies that work to establish the state of Virginia as a hub for space flight research and technology—attracting investments from around the globe. Another role of the aerospace

cluster from the perspective of VUSC is building a pipeline of talent for space flight and the aerospace industry more broadly. As a result of VUSC's collaborative efforts with the aerospace cluster, a number of education institutions developed training programs in spaceflight and unmanned systems. A third VUSC perspective is the instrumental role of WIAC in promoting spaceflight technology development. As a result of partnerships and collaborations of the private companies and government agencies on Wallops Island, Virginia has become a leader in developing new technologies, tools, and processes for spaceflight.

From the perspective of the Virginia Space Flight Academy (VSFA) the economic impact of the Wallops Island Aerospace Cluster (WIAC) is strong. VSFA believes that the cluster's impact is strengthened by its efforts to build a thicker pipeline of talent for the spaceflight and aerospace industries. Of particular significance to VSFA is the Wallops Research Park because it offers state-of-the-art resources to assist the Academy with its education mission. The Academy recognized the vital role that the aerospace cluster plays in creating employment opportunities for residents. In addition to adding to the employment roles in the region, the Academy highlighted the cluster's direct impact on the local economy with hotel bookings, demand for dining and other shopping options.

As the voice of the local business community, the Chincoteague Chamber of Commerce provides an important perspective on the impact of the Wallops Island Aerospace Cluster. The Chamber noted the WIAC's direct employment impacts for its residents. They believe that these impacts are critical because the local economy otherwise is heavily reliant on the seasonal and

cyclical nature of its tourism industry. Employing residents in a variety of high-paying jobs helps the region to withstand the economic fluctuations caused by the temporal nature of the tourism business in the town of Chincoteague and its surroundings during rocket launches.

The local chamber acknowledged the importance of the aerospace cluster to economic development in the region. With its wide range of research and development, the cluster contributes to the region's high-tech economy. The chamber believes that as the cluster attracts new private companies, the economic growth and development of the town of Chincoteague will continue to improve.

8. The Wallops Island Aerospace Cluster

To estimate the economic impact of an industry cluster, we must first define the industries that form the cluster. In this section, we discuss the Wallops Island Aerospace Cluster (WIAC) and how it differs from the Aerospace and National Security cluster defined by the U.S. Cluster Mapping Project at Harvard Business School. We then explore the economic characteristics of the WIAC.

8.1 Defining the Cluster

When estimating the economic impact of the WIAC, the answers to two questions will determine the scope of the economic impact estimates. First, what is the geographic catchment area of activities within the WIAC? A narrowly defined geographic focus that only contains the Wallops Flight Facility (WFF) would likely understate the contributions of the WIAC to the economy of the Commonwealth of Virginia. On the other hand, defining the geographic catchment of the WAIC to include the Eastern Shore as well as Hampton Roads would likely overstate the economic impact of the WIAC as it would capture national security and aerospace activities unrelated to the WIAC. As discussed previously, we define the Wallops Footprint to encompass the counties of Accomack, Northampton, Somerset, Wicomico, and Worcester based on the economic and demographic ties among these counties.

To ensure we are using a common language and before we answer the second question, we must first define the term “cluster.” An industry cluster is simply a geographic concentration of related industries in the region. An industry cluster emerges when there are sufficient

economic activities in a region in related industries to create collaborative impacts. Industry clusters emerge from the market process and serve as attractants for other companies. As the industry cluster grows, the region's comparative advantage in the cluster increases, deepening the pool of regional suppliers, service support industries, and the pool of available labor (Porter, 2003; Rodríguez-Pose & Crescenzi, 2008). The development of an industry cluster is positively correlated with income levels and employment growth (Spencer et al., 2010).

The second question is akin to the first: what industries comprise the WIAC? If we define the industry cluster too narrowly, we will bias our estimates of economic impact downward as we will fail to fully capture economic activity in the WIAC. On the other hand, an overly broad definition of activities in the industry cluster would attribute unrelated economic activity to the cluster. Given that the WFF is home to public sector activities of NASA, NOAA, DoD, USCG as well as the VCSFA and private sector organizations, including Northrop Grumman and Rocket Lab, a narrowly defined aerospace cluster would be insufficient for the purposes of our analysis. We would prefer to define the aerospace cluster to include national security, engineering, and related activities.

Our starting point is the U.S Cluster Mapping Project, a partnership between the Harvard Business School's Institute for Strategy and Competitiveness, the U.S. Department of Commerce, and the U.S. Economic Development Administration. This cluster definition is largely focused on the manufacturing of aircraft, aircraft parts, guided missiles, and space vehicle parts and equipment. While the WFF does have some aspects of vehicle integration, the manufacture of

the missiles, space vehicles, and sensors does not typically take place at the WFF. Instead, activities at the WFF tend to focus on sensors and sensor operation, launch activities, activities in support of the DoD and USCG, as well as engineering activities in support of the WFF and public and private organizations located in the Wallops Footprint. Simply put, the definition of the aerospace vehicles and defense cluster is too narrow for our purposes.

Table 4 - Aerospace Vehicles and Defense Cluster

Industry Name	NAICS
Aircraft Manufacturing	336411
Aircraft Engine and Engine Parts Manufacturing	336412
Other Aircraft Parts and Auxiliary Equipment Manufacturing	336413
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	334511
Guided Missile and Space Vehicle Manufacturing	336414
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	336415
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	336419

Sources: U.S. Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School (2022).

Following Old Dominion University's 2019 economic impact analysis, we expand the industry cluster definition to include the Engineering Services industry (NAICS 541330). Per the NAICS association, engineering services (NAICS 541330) include "establishments primarily engaged in applying physical laws and principles of engineering in the design, development, materials, instruments, structures, processes, and systems."[5] Examples of these types of establishments include civil engineering, construction engineering, environmental engineering, mechanical engineering, and engineering offices.

Second, we expand the industry cluster to include the Space Research and Technology industry (NAICS 927110). According to the NAICS association, "This industry comprises government establishments primarily engaged in the administration and operations of space flights, space research, and space exploration. Included in this industry are government establishments operating space flight centers."[6] This industry includes the Goddard Space Flight Center and the Langley Research Center, both of which are NASA facilities.

Third, we include the National Security industry (NAICS 928110) in the industry cluster. Per the NAICS association, "This industry comprises government establishments of the Armed Forces, including the National Guard, primarily engaged in national security and related activities." We argue that including this industry will more accurately reflect the industry cluster and allow us to estimate its economic impact more precisely.

[5] For more information, https://www.naics.com/naics-code-description/?code=541330
[6] For more information, https://www.naics.com/naics-code-description/?code=927110

Table 5 - Wallops Footprint Aerospace Vehicles and Defense Cluster

Industry Name	NAICS
Aircraft Manufacturing	336411
Aircraft Engine and Engine Parts Manufacturing	336412
Other Aircraft Parts and Auxiliary Equipment Manufacturing	336413
Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	334511
Guided Missile and Space Vehicle Manufacturing	336414
Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	336415
Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	336419
Engineering Services	541330
Space Research and Technology	927110
National Security	928110

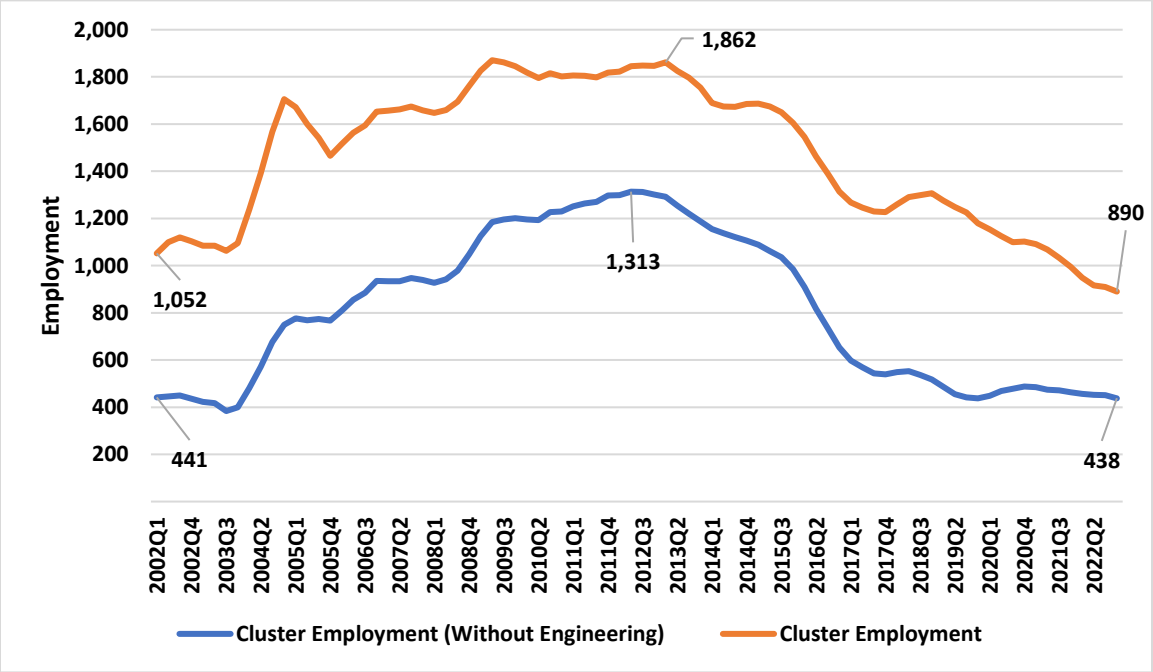
Sources: U.S. Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School (2022), and Old Dominion University's "The Economic Impact of the Wallops Aerospace Cluster" (2019).

8.2 Employment in the Wallops Island Aerospace Cluster

In Figure 10, we illustrate total cluster employment with and without the inclusion of the engineering industry. From 2002 Q1 to 2006 Q4, employment in the cluster rose by 36.4% (52.8% without engineering), and then by another 11.5% (39.4% without engineering) from 2007 Q1 to 2012 Q4. The most recent declines in employment have occurred in engineering occupations.

Figure 10 - Wallops Island Aerospace Cluster Employment

Four-Quarter Moving Average, 2002 Q1 – 2022 Q4



Source: JobsEQ. Data as of 2022 Q4.

The passage of the 2011 Budget Control Act and caps on discretionary federal spending, combined with a relatively tepid recovery from the Great Recession of 2007 to 2009, led to a reduction in aerospace and defense employment in the WIAC. From 2013 Q1 to 2022 Q4,

employment in the WAIC fell by 52.2%. When we exclude the engineering services-related industries, employment fell by 66.1%. If there is a modicum of good news in the data, it is that employment in the defense and aerospace industry appeared to stabilize in 2020, and the most recent job losses have come in the engineering industry.

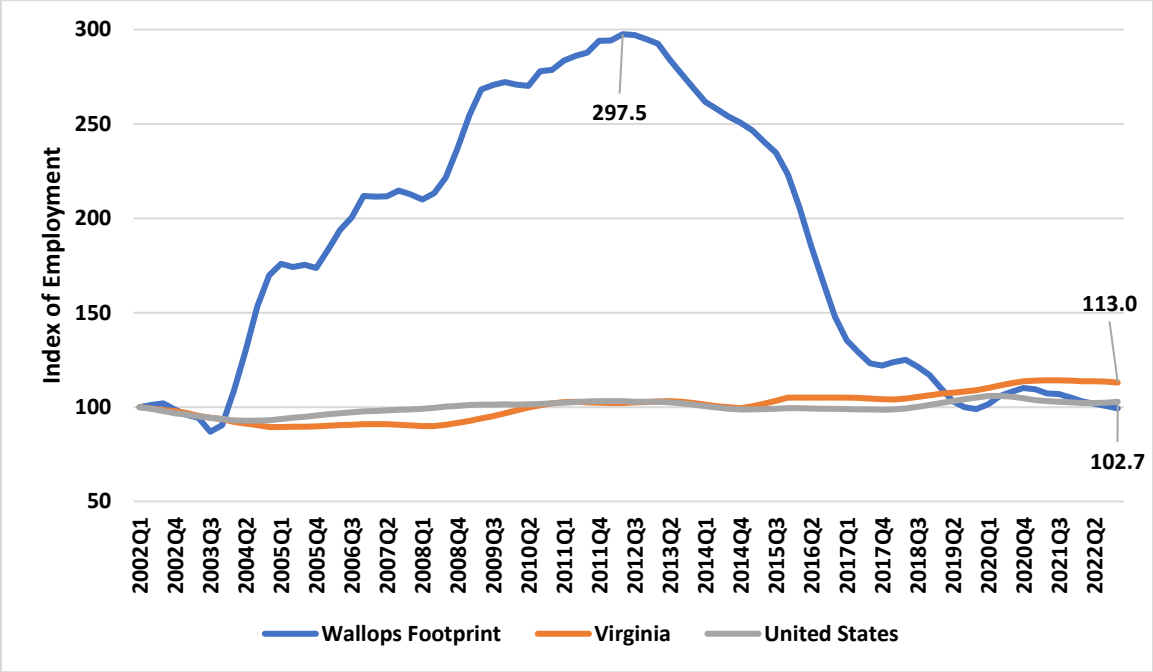
When we compare the employment performance of the WIAC with the same industry cluster definition for Virginia and the United States, a different picture emerges regarding the performance of the WIAC, as shown in Figure 11. In 2022 Q4, the number of jobs in the WIAC was roughly the same as it was in 2002 Q1. In Virginia, there were 2.7% more jobs in 2022 Q4 than 2002 Q1, while the number of jobs nationally increased by 13.0% over the same period. Depending on where one stood over the last decade, the fortunes of Wallops Island either appeared to be increasing, or more recently, declining back to the beginning of the century.

We would, however, be remiss if we did not also examine signs that a revival in the cluster is within reach. The number of establishments in the Wallops industry cluster has risen in recent years, which is typically a precursor to employment increases in the industry cluster. If business formation continues apace, then we should reasonably expect increasing fortunes in the current decade. Recent capital investments into the Wallops facility are likely to bear fruit as NASA, Northrup Grumman, Rocket Lab, and others aim to increase their launch cadence in coming years. As we have noted previously, the advent of the new Antares and Neutron rockets will have a transformative impact on Wallops, with employment rising in the future.

Figure 11 - Aerospace Cluster Employment

Wallops Island Footprint, Virginia, and the United States

Four-Quarter Moving Average, 2002 Q1 – 2022 Q4



Source: JobsEQ. Data as of 2022 Q4. Index is equal to 100 in 2002 Q1. Aerospace cluster does not include engineering services-related industries.

8.3 Wages in the Wallops Island Aerospace Cluster

The occupational mix of an industry cluster is representative of a region's ability to support the ongoing activities of the cluster and to expand the cluster in the future. Table 6 illustrates the selection of primary occupations in the WIAC and the average annual wages of each occupation. An immediate observation is that the occupations related to engineering, information technology, and aerospace are relatively well compensated when compared to the other occupations in the cluster.

Table 6 - Selected Occupations in the Wallops Island Aerospace Cluster, 2022

Occupation	Employment	Average Annual Wages
Aerospace Engineers	79	$114,100
Civil Engineers	56	$89,100
Engineers, All Other	44	$111,500
Project Management Specialists	30	$98,200
Engineering Technologists and Technicians, Except Drafters, All Other	29	$78,200
Mechanical Engineers	26	$100,700
Electronics Engineers, Except Computer	24	$126,800
Business Operations Specialists, All Other	21	$93,600
Software Developers	19	$98,300
Electrical Engineers	21	$99,400

Source: JobsEQ. Data as of 2022 Q4 except wages which are as of 2022. Note that occupation-by-industry wages represent adjusted national data and may not be consistent with regional, all-industry occupation wages shown elsewhere in JobsEQ.

Comparison of average wages in the WIAC with other industries in the Wallops Footprint and Virginia, displayed in table 7, highlights the relatively high wages for employees in the aerospace industry cluster. In 2022 Q4, average annual wages in the Wallops Aerospace cluster were $93,268 with engineering services included and $110,069 without engineering services. In Virginia, there was little difference in average annual wages with or without engineering services,

averaging approximately $117,000 in 2022 Q4. **In other words, every new job gained (lost) in the aerospace cluster in the Wallops Island Footprint generated the same compensation as 3 to 3.6 jobs in the Consumer Services or Textile/Leather industries.**

Table 7 - Average Wages for Selected Industry Clusters

Wallops Footprint and Virginia, 2022 Q4

Industry Cluster	Average Annual Wages (Wallops Footprint)	Virginia
Consumer Svc.	$30,643	$36,243
Textile/Leather	$30,896	$43,540
Food Mfg.	$43,762	$55,152
Auto/Auto-related	$45,379	$55,908
Education	$48,981	$53,766
Utilities	$49,526	$63,718
Machinery Mfg.	$49,542	$78,447
Retail	$49,765	$66,434
Construction	$50,058	$65,509
Public Admin.	$54,950	$90,575
Freight Tran.	$55,864	$61,330
Professional Svc.	$62,015	$104,447
Health	$62,838	$62,318

Wallops Aerospace (With Engineering)	$93,268	$117,122
Wallops Aerospace (Without Engineering)	$110,069	$117,760

Source: JobsEQ. Data as of 2022 Q4.

8.4 Evidence from Employers in the Wallops Island Aerospace Cluster

Our interviews with employers in the Wallops Island Aerospace Cluster provide additional evidence of the demand for high-skill employees to support activities in the cluster. One major employer reported that their employees reside throughout the cluster geographic footprint and that a majority was engaged in engineering-related activities. This employer reported that its average salary for employees directly engaged in activities supporting the industry cluster exceeded $90,000, well above the average salary for all private sector employees in the Wallops geographic footprint.

Another employer in the industry cluster reported similar employment patterns. Industrial and mechanical engineers were among the highest compensated employees. While there were fewer management personnel for these employers, these employees received annual salaries in excess of $100,000, and, in the case of senior managers, well in excess of that amount. This employer also noted that their capital projects provided employment for contractors, engineers, and other workers in the Wallops footprint. A number of employers also reported community engagement activities, which are not captured in the analysis but highlight the contribution of these firms to the overall quality of life in the region.

Another major employer in the WIAC provided us with the number of employees and average annual wages by occupation type. Engineering and science employees earned, on average, about $134,000 annually, followed by professional administrative employees, who earned about $116,000. Employees who worked as technicians averaged slightly more than $100,000 annually. The relatively small number of clerical employees earned almost $55,000 a year.

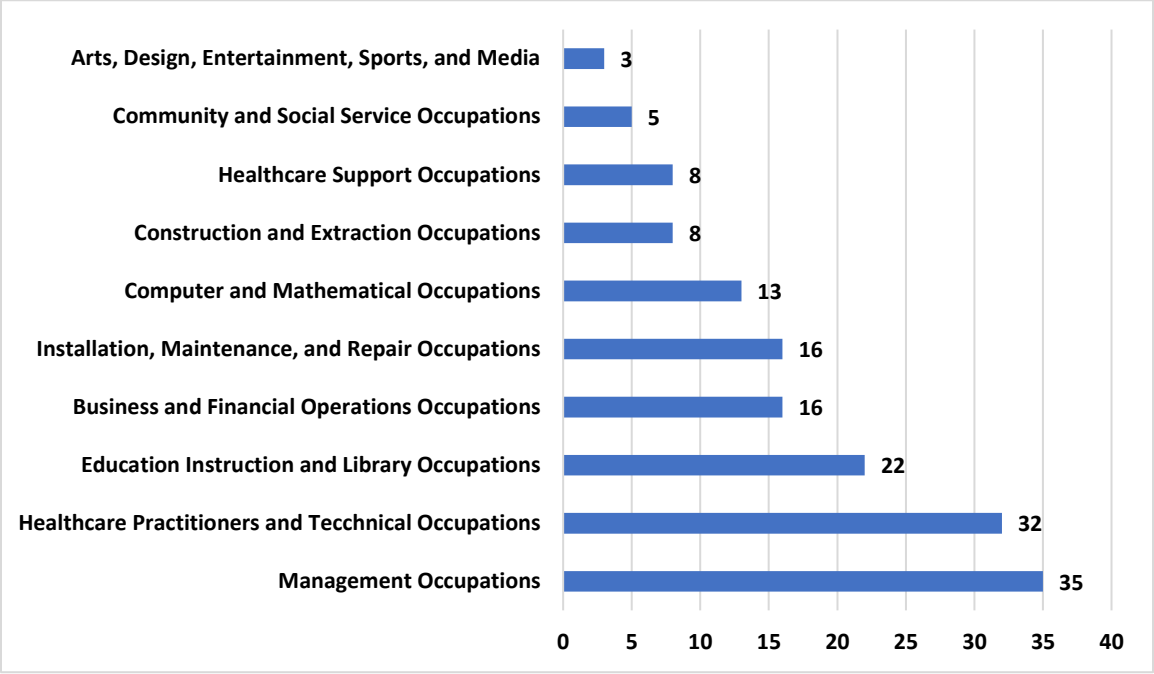
8.4 Occupation Gaps in the Wallops Island Aerospace Cluster

Generating higher paying jobs in the Wallops Footprint is desirable as each job has a larger economic impact than a job in a lower paying industry. However, if there are not sufficient workers, employers may find themselves with unrealized demand, that is, open positions that cannot be filled by the available pool of labor. One would reasonably expect that average annual wages would continue to rise for these occupations as employers compete in a market characterized by a scarcity of available skilled labor. On the other hand, occupations with a surplus of available labor will likely not see wages increase at a rapid pace, as employers will be available to fill open positions with relative ease.

Figure 12 illustrates the potential **annual** occupation supply deficit for the Wallops Footprint over the next 10 years. The largest projected occupational gap occurs in Management Occupations with an average annual wage of $108,300, followed by Healthcare Practitioners and Technical Occupations ($94,500). The estimated annual supply deficit for these occupations in the Wallops Footprint is more than 30 workers annually. The projected supply deficit for

Computer and Mathematical Occupations ($93,600), which we argue is likely part of the Wallops Island Aerospace Cluster, is 13 annually. We note that these occupations likely require a two-year or higher college degree, signaling a mismatch between the educational attainment level of the Wallops Footprint and the future needs of employers.

Figure 12 - Average Annual Occupation Supply Deficit in Wallops Footprint

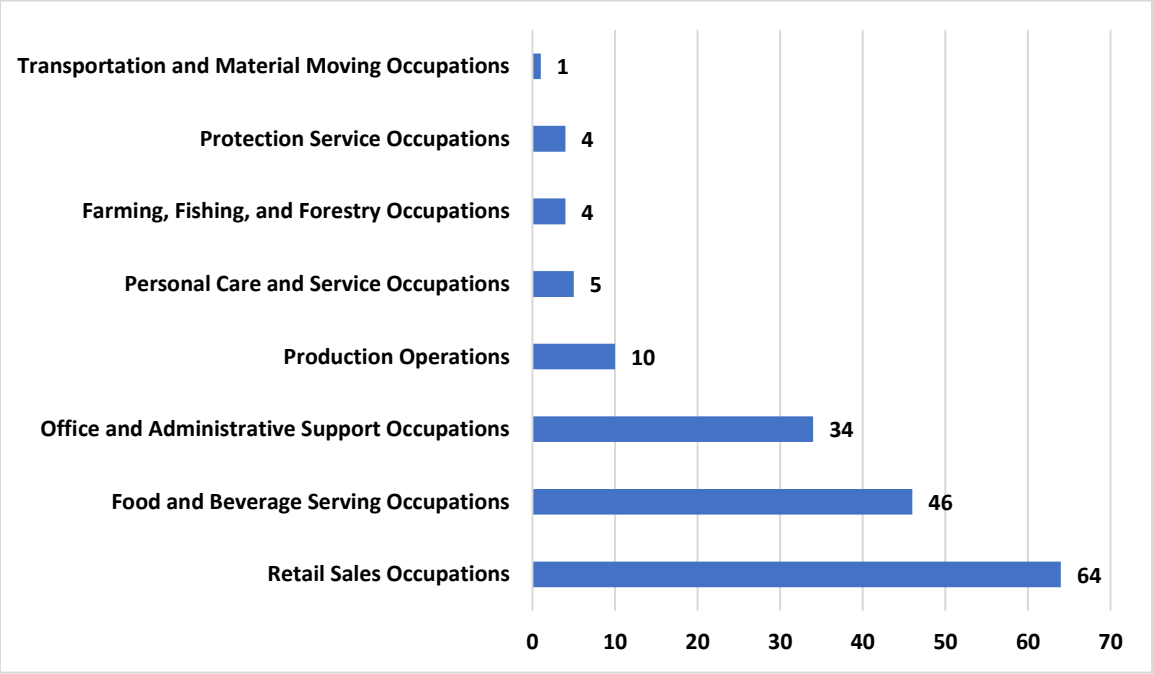


Source: JobsEQ. Data as of 2022 Q4. Average estimated supply gaps over 10 years.

We highlight occupations in the Wallops Footprint with projections of excess supply in Figure 13. Two observations emerge from the data: (1) the occupations, on average, require a lower level of education than occupations in the aerospace cluster; and (2) the occupations, on average, earn less than occupations in the aerospace cluster. Relative to projected demand, there is likely to be an annual oversupply of more than 60 retail service workers, who earn, on average,

$42,200 annually. Similarly, there is likely to be an annual surplus of more than 45 food and beverage service workers, who earn $30,700 annually. These estimates suggest that there will be available labor to meet the needs of the employers, but that a non-trivial amount of the available labor will have insufficient skills or education to transition to higher-paid occupations.

Figure 13 - Average Annual Occupation Supply Surplus in Wallops Footprint



Source: JobsEQ. Data as of 2022 Q4. Average estimated supply gaps over 10 years.

8.5 Location Quotients in the Wallops Island Aerospace Cluster

To examine the question of industry concentration, we compare an industry's share of employment in Wallops Footprint with its share of national employment.[7] These "location quotients" (LQs) provide insight into whether an industry has a smaller, equal, or larger share of regional employment relative to the national average.[8] If an industry in the Wallops Footprint has a LQ of 2, for example, the industry's share of regional employment is twice the national average. In other words, the industry is two times as concentrated in the region than the nation. We can also examine wage location quotients (WQs) which examine whether an industry has a smaller, equal, or larger share of regional wages relative to the national average.

Location quotients are useful for a variety of reasons. First, location quotients can be used to identify industries that have higher-than-average per capita employment. Second, industries with high location quotients are typically exporting goods and services outside the region. These industries bring exogenous money into a region and typically generate a higher economic impact than firms that circulate money within a region. Third, industries with declining location quotients may be losing their competitive advantage, thus location quotients can serve as a signal of a region's declining (or improving) economic fortunes. Lastly, we must consider the overall size of each industry's employment in the region. A high LQ is a signal of concentration, but the impact

[7] A location quotient is equal to the ratio of local concentration to national concentration. Local concentration is equal to an industry's employment to total employment in a region. Likewise, national concentration is equal to an industry's employment to total employment nationally.

[8] For more information, see Bureau of Economic Analysis, "QCEW Location Quotient Details" available at: https://www.bls.gov/cew/about-data/location-quotients-explained.htm

of the industry on the regional economy is also dependent on the level of wages and employment. A high-wage industry with an LQ of 2 that employs 10,000 people will typically have a greater impact than a low-wage industry with an LQ of 5 that only employs 500 people. In this example, the high-wage industry would likely have a WQ greater than 1 while the lower-wage industry would likely have a WQ less than 1, signaling a higher-than-average proportion of wages were paid in the high-wage industry.

Table 8 illustrates the LQ and WQ for the industries in the aerospace cluster for the Wallops Footprint. While the Wallops Footprint does not appear to have a comparative advantage in aerospace manufacturing (LQ 0.05), engineering services (LQ 0.63), and national security (LQ 0.32), it does have a significant comparative advantage in the space research and technology industry (LQ 24.5).

Table 8 – Location and Wage Quotients, Wallops Footprint

Aerospace and Defense Cluster

Industry Name	NAICS	Location Quotient	Wage Quotient
Aerospace Product and Parts Manufacturing	3364	0.05	0.04
Engineering Services	5413	0.63	0.58
Space Research and Technology	9271	24.49	31.03
National Security	9281	0.32	0.44

Sources: JobsEQ (Location Quotients), Bureau of Labor Statistics (Wage Quotients), and Dragas Center for Economic Analysis and Policy. We report the four-digit NAICS for aerospace products and part manufacturing given the relatively low employment in the Wallops Footprint industry.

Likewise, the WQs for the Wallops Footprint confirm our argument that the Space Research and Technology industry is a relatively high-wage industry. The WQ of 31 means that a significant proportion of higher-paying jobs are located in an industry closely related to the Wallops Aerospace Cluster. The data provide strong evidence that increasing STEM-related employment in the WIAC will generate high-paying jobs that will spur economic development.

Interviews with representatives of firms located in and around the WFF provide additional evidence on how the WAIC provides high quality employment opportunities. From rocket integration to launch services, these jobs require significant levels of skill and experience and pay significantly more than jobs in other industries. Several employers noted that the industry serves as an attractor to the region, but that availability of housing, childcare, and other amenities constraints their ability to expand operations in the short term. Many employees that we spoke to want to live near the WFF but, due to these concerns, commute instead from locations in Maryland to the WFF. A broader discussion of how to empower communities to build more housing, improve transportation infrastructure, and improve the availability of services should occur alongside more traditional discussions of developing the WFF infrastructure to support increased operations.

9. Economic Impact Methodology

In this section, we briefly discuss our methodology for estimating the economic impacts of the Wallops Island Aerospace Cluster (WIAC) from 2018 to 2022. The geographic footprint of the WIAC encompasses the Virginia counties of Accomack and Northampton as well as the Maryland counties of Somerset, Wicomico, and Worcester. Our estimates focus on the impact of spending by organizations and installations in the cluster on the economy of the Commonwealth of Virginia.

9.1 Introduction

Estimating the economic impact of the Wallops Island Aerospace Cluster (WIAC) requires data on the number of jobs created by organizations and installations within the cluster and non-employee spending for goods and services within the cluster. Economists typically classify employment, compensation, and non-labor expenditures directly related to activities within a cluster as **direct economic impacts**. These direct economic impacts are akin to a rock dropped in a pond, with the direct impacts of employment, sales, and employee compensation rippling through the economy.

However, not all direct spending has an economic impact in the geographic area of interest. Increases in employment or expenditures that fall outside the study area are considered **leakages**. As leakages increase, the direct economic impacts fall. If, for example, NASA at the Wallops Flight Facility purchases $2 million in supplies, of which $1 million occurs outside of the

Wallops footprint, then we must account for the leakage of $1 million, or we would overstate the economic impact of the $2 million in spending.

The influence of direct employment and direct expenditures is captured by the **indirect economic impacts** and **induced economic impacts**. Indirect economic impacts occur when other economic agents respond to increased spending or employment by organizations and installations within the WIAC. An increase in direct spending increases demand for other goods and services, incentivizing employers to increase employment and spending. The indirect economic impacts are akin to a "supply chain" effect, with increases in direct employment and spending reverberating through suppliers within the geographical region of interest. The indirect economic impacts continue until the increase in demand is satisfied.

Induced economic impacts occur when income rises in the geographic area of interest from the initial demand shock. As the initial injection of employment or spending raises demand, more workers are hired by organizations and installations. The increases in income are then spent by workers, increasing overall demand for goods and services in the study area. The increases in demand continue to ripple through the economy until the demand shock is fully satisfied.

The indirect and induced economic impacts create a total economic impact that is larger than the initial direct impact. The notion of an economic multiplier summarizes the total economic impact of a change in economic activity. If a firm invests $2 million in a region, of which $1 million remains in the area, the $1 million (direct impact) that, in turn, generates $300,000 in

indirect economic impacts and $200,000 in induced economic impacts, then the economic impact multiplier effect is ($1,000,000 + $300,000 + $200,000) / $1,000,000 = 1.5.

There are two important considerations when evaluating economic multipliers. First, the size of the multiplier inherently depends on how much of the economic activity continues to recycle within the region. If leakages increase, the actual multiplier effect will necessarily be smaller. Conversely, the more concentrated an industry cluster in the geographic area, the larger the multiplier. Second, the multiplier effect, where spending spills over to a variety of other sectors, is great when the direct impact is positive; however, it is equally painful when there is a reduction in direct economic activity.

To ensure a common framework for interpretation, we define commonly used terms from the economic impact literature below.

- Compensation – the total payroll cost of employees, including wages, salaries, and all benefits.
- Employment – the annual average of full-time, part-time, and seasonal employment in an industry or region.
- Output – the measure of the total value of goods produced in an industry. However, output from one industry utilizes output from other industries, so the measure overstates the contribution of an industry to GDP.
- Value Added – the total market value of all final goods and services produced in a region in each period. The value added is the measure of the increase or decrease in GDP.

9.2 Input-Output Analysis

The core of economic impact modeling systems is the set of input-output (I-O) accounts that illustrate the linkages among industries in the geographic area of analysis. In most systems, the core is based on the Bureau of Economic Analysis' (BEA) national I-O accounts that show how goods and services produced by each industry are used by other industries and end users. The BEA publishes the national I-O accounts and the Regional Input-Output Modeling System (RIMS) which accounts for variations in regional supply conditions (Bureau of Economic Analysis, 2018).

Assume that producers are grouped into *n* industries and that technology within an industry is homogenous but heterogeneous across industries. Production is assumed to be strictly linear and purchase patterns are assumed to be fixed. Industries are assumed to be homogenous and there are no supply constraints. Lastly, there are no regional feedback mechanisms and no time dimension in most (but not all) I-O models. Let each industry *i* produce gross output X_i. Industry *i* sells output X_i to other industries z_{ij} and to final users, Y_i. Industry production is assumed to be collectively exhaustive. Equation (1) defines the gross output of industry *i* which is equal to:

$$X_i = z_{i1} + z_{i2} + \ldots + z_{in} + Y_i \quad (1)$$

Given this definition of industry production, equation (2) defines the set of technical coefficients across the industries in the I-O model. The technical coefficients are used to create the national make, use, and important tables which, in turn, are used to create the domestic direct requirements, regional direct requirements, household use, and regional total

requirement tables. From these requirement tables, we obtain the indirect and induced multipliers to estimate total economic impact.

$$a_{ij} = \frac{z_{ij}}{X_i} \quad (2)$$

We use IMPLAN to obtain economic impact estimates of the WIAC. We first generate annual estimates of economic impact for employment and then estimate the annual impacts associated with non-employee spending in the WIAC. We then combine these estimates to obtain the overall economic impact of the WAIC on the Commonwealth of Virginia. Given our assumptions, we argue that our estimates provide a reasonable range in which the "true" economic impact of the industry cluster lies.

9.3 Limitations

To generate estimates of economic impact, we rely on data from a variety of sources, including the Bureau of Labor Statistics and Chmura Economics JobsEQ platform. We provide our estimates in this report so that the interested reader can replicate our analysis, a feature not found in previous studies. While this approach may result in more conservative estimates of economic impact, we argue that our estimates are transparent and replicable. We argue that this approach to generating economic impacts provides a lower bound that can be updated over time as new employment and spending data become available.

10. Economic Impact Estimates

To estimate the total economic impact of the Wallops Island Aerospace Cluster on the Commonwealth of Virginia from 2018 to 2022, we construct two sets of estimates: economic impacts associated with employment and economic impacts associated with non-payroll spending. The employment-related impacts examine how job gains and losses shift the impact of the Wallops Island Aerospace Cluster over time. Likewise, the non-payroll spending-related impacts capture how shifts in federal and state spending alter the economic impact of the industry cluster. We note that it is important to examine impacts across time rather than for one specific year, because changes in employment and non-payroll spending may inflate (or deflate) the expected economic impacts of Wallops Island on the economy of the Commonwealth of Virginia for any given year.

10.1 Employment-Related Economic Impacts

We present the estimates of employment-related economic impacts in Tables 9 and 10. To estimate the total economic impact of the Wallops Island Aerospace Cluster on the Commonwealth of Virginia from 2018 to 2022, we first estimate direct annual employment over this period. Our interviews with industry subject matter experts suggest that a non-trivial proportion of engineers in the Wallops footprint are employed in activities associated with the aerospace and defense industry. We, however, lack sufficient data to ascertain the specific proportion of engineers employed in and around the WIAC. We are left with two alternatives: assume a proportion of engineering employment is attributable to the WIAC or provide estimates

with and without engineering employment. We thus construct two sets of employment estimates: one for the industry cluster without engineering employment and one for the industry cluster with engineering employment.

We present our annual economic impact estimates for employment for the industry cluster in Table 9. If we limit our focus to defense and aerospace employment, we estimate that average annual employment in Wallops footprint was 477 from 2018 to 2022. Given the direct employment of 477 employees, total employment in Virginia increased, on average, by 1,487 employees a year. The employment multiplier was approximately 3.1, illustrating how the creation of defense and aerospace industry cluster jobs has significant spillover impacts on total employment in the Commonwealth. On average, the annual employment of 477 employees raised compensation in Virginia by $218.2 million. Annual average industry output increased by $848.3 million. Annual average real GDP in Virginia increased by approximately $596.4 million from 2017 to 2022.

In Table 10, we broaden our definition of industry cluster employment to include engineering employment. While the multiplier for defense and aerospace employment was approximately 3.1, the employment for defense, aerospace, and engineering employment (broadly defined) is approximately 2.4. From 2018 to 2022, direct employment in the industry cluster averaged 1,121 jobs, increasing overall employment in Virginia to approximately 2,719 jobs annually. Average annual compensation in Virginia increased by $330.9 million over the

study period. Average industry output increased by about $1.1 billion while average annual real GDP in Virginia increased by $740.7 million from 2018 to 2022.

Our estimates highlight the employment-associated economic impact of the Wallops Island Aerospace Cluster from 2018 to 2022. Total annual employment in Virginia increased between 1,487 and 2,719 jobs while industry output increased between $848.3 million to $1.1 billion. Virginia's annual real GDP increased, on average, by $596.4 to $740.7 million over the study period.

10.2 Spending-Related Economic Impacts

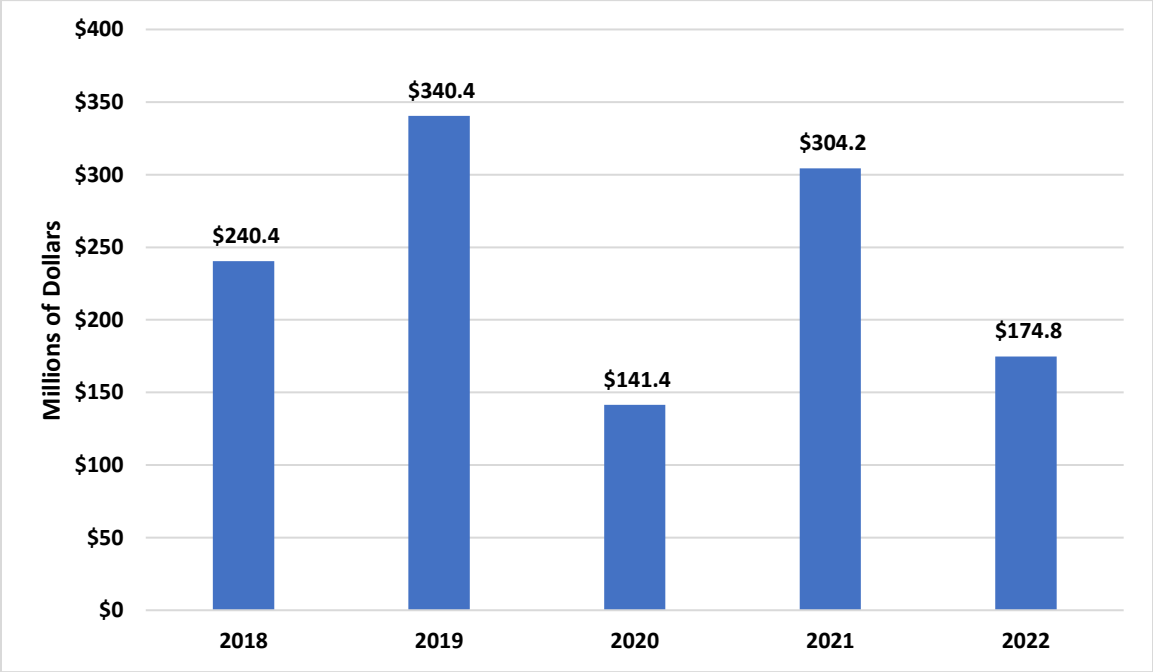
We also estimate the economic impact of non-payroll spending in the Wallops Island Aerospace Cluster. We obtain federal government contract and grant data from USASpending by place of performance. We argue that place of performance is more representative of spending patterns within the Wallops footprint, as other classifications of spending may be related to Wallops Island but may occur outside the Wallops Island geographic footprint. We include estimates of capital expenditures by the Virginia Commercial Space Flight Authority on facilities in and around the Wallops Flight Facility. We supplement with data from our interviews with employees in the WIAC. Lastly, we convert nominal expenditures to real expenditures using the annual Consumer Price Index.[9]

[9] One potential avenue of research is to delve more deeply into the federal grants and contracts data. Given the wide variation in non-payroll spending estimates across studies, this avenue could yield a more precise estimate of the type of federal government spending in the Wallops footprint.

Historically, federal non-payroll spending in the Wallops footprint has varied significantly across time. In FY 2010, for example, federal grants and contracts in the Wallops Footprint were approximately $619 million, falling to about $104 million in FY 2011 and approximately $49 million in FY 2012. By FY 2015, federal grants and contracts climbed back to around $117 million before surging to approximately $633 million in FY 2016. In FY 2017, federal grants and contracts again fell to around $444 million before dropping to $193 million in FY 2018. We present our estimates of non-payroll expenditures in Figure 14.

Figure 14 – Estimated Real Nonpayroll Expenditures

Wallops Island Geographic Footprint, 2018 - 2022



Sources: USASpending (2023), Virginia Spaceport Authority, Interviews with employers, and Dragas Center for Economic Analysis and Policy.

We estimate annual non-payroll spending associated with the WIAC was approximately $240.2 million from 2018 to 2022 (Table 11). This injection of non-payroll spending increased average annual employment in Virginia by almost 1,900 jobs over the study period. Annual average compensation increased by approximately $213.6 million while average annual industry output increased by $368.3 million. Annual average real GDP for Virginia increased by $292.0 million due to federal and state non-employee spending in the Wallops Island footprint.

10.3 Wallops Island: Estimates of Total Economic Impact

Having estimated the economic impacts associated with employment and non-payroll spending for the Wallops Island Aerospace Cluster, we can now turn our attention to the aggregate economic impact of the industry cluster. Given our range of estimates for employment, we generate a range of estimates for aggregate economic impact. We opine this approach allows the reader to understand the range in which "true" economic impact lies rather than relying on a specific point estimate of economic impact. We present our estimates for the total economic impact on Virginia in Tables 12 and 13.

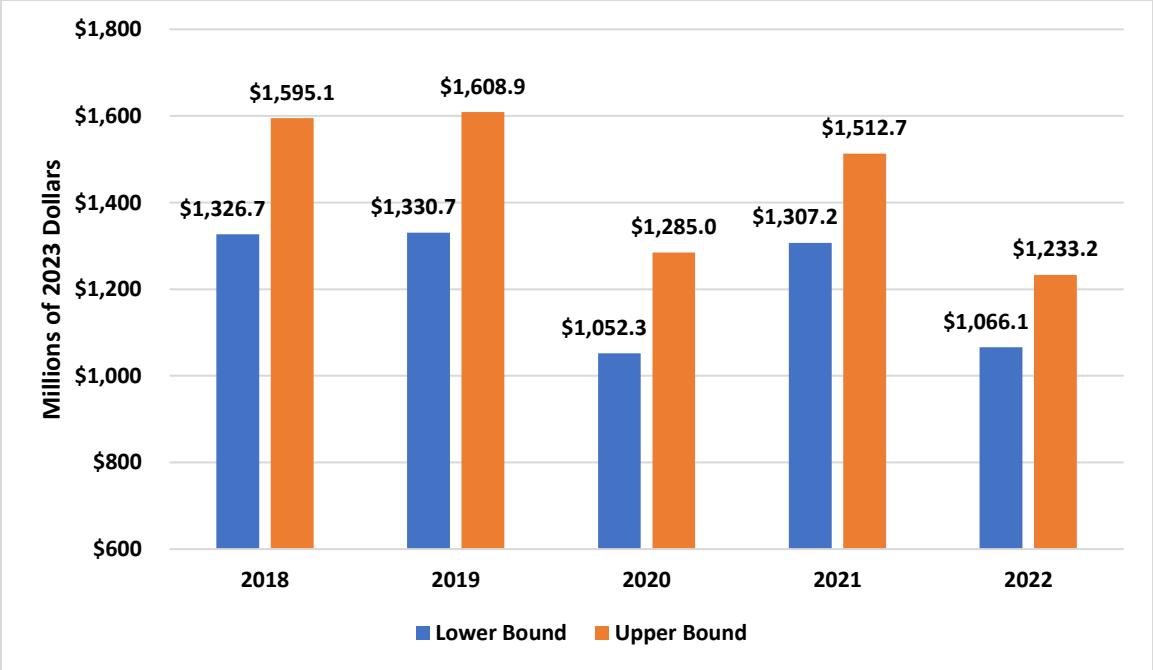
We estimate that from 2018 to 2022 annual average employment in Virginia increased between 3,366 and 4,597. These increases in jobs led to gains in average annual compensation, with average annual compensation increasing between $431.8 and $544.5 million from 2018 to 2022 due to the presence of the Wallops Island Aerospace Cluster. These gains in compensation are created by the direct employment in the industry cluster and employment gains generated by the inflow of federal and state funds into the Wallops Island geographic footprint. The range

of compensation impacts suggests that, on average, employment in and around the cluster raised labor income by approximately $500 million annually from 2018 to 2022.

We estimate that annual average industry output in Virginia was between $1.2 billion and $1.5 billion from 2018 to 2022 (Figure 15). We remind the reader that industry output represents the value of industry production, that is, sales plus or minus changes in inventory. In other words, output represents the sum of an industry's value added to the economy plus intermediate inputs. It is typically thought of as the "wealth" created by industry activity and is an expression of the total value of **all goods** produced by an industry. We caution that industry output includes the value of intermediate goods used by other industries.

Figure 15 – Average Annual Gains in Gross Output, Virginia

FY 2018 – FY 2022

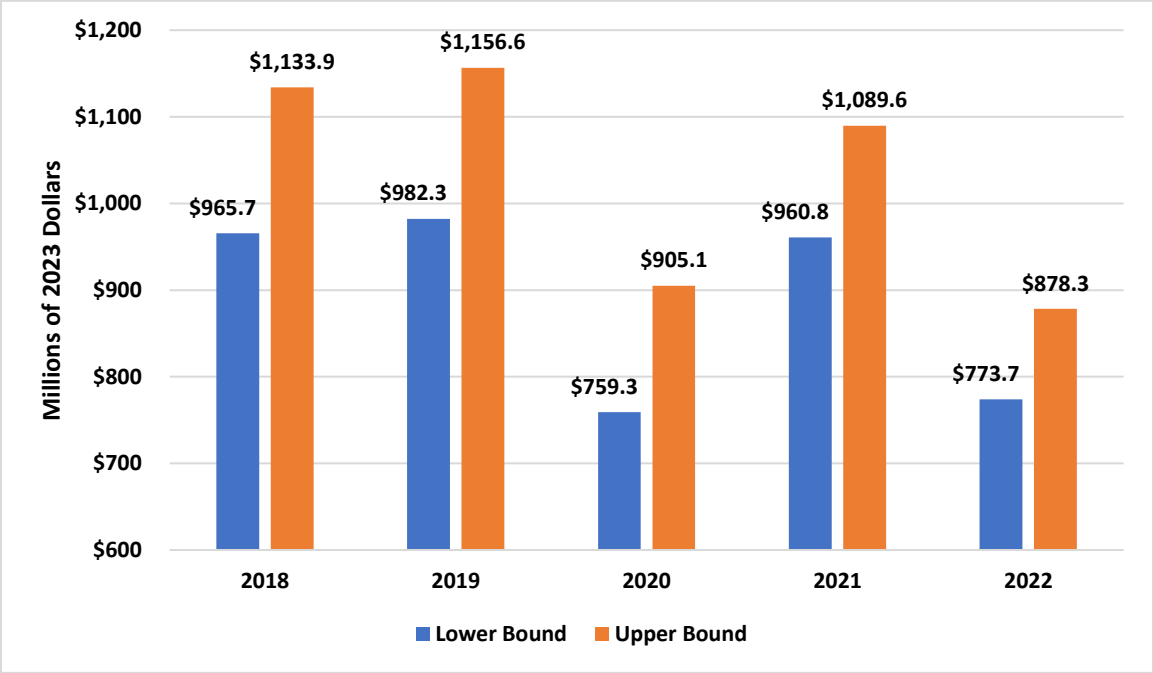


Source: Dragas Center for Economic Analysis and Policy.

We present annual estimates of the total increases in value added (real GDP) in Figure 16. We estimate that the WIAC annual average contribution to the Virginia economy ranged between $888.4 million and $1.03 billion from 2018 to 2022. We note that estimates of annual economic impact were higher in 2018 and 2019 due to significant capital expenditures at Wallops Island. Given projections of capital expenditures over the coming years, it is reasonable to assume that the economic impact of Wallops Island will return or exceed levels observed in 2018 and 2019.

Figure 16 – Average Annual Gains in Real GDP, Virginia

FY 2018 – FY 2022



Source: Dragas Center for Economic Analysis and Policy.

We remind the reader that the estimates provide lower and upper bounds of economic impact, depending on how broadly one defines employment in the industry cluster and investments in infrastructure at Wallops Island. As employment has declined among engineering professions in the cluster footprint, the difference between the lower and upper bounds has declined, falling to approximately $104.6 million in 2022, down from a peak of $174.3 million in 2019. The estimates in Figure 16 illustrate how variations in employment and spending can influence the annual estimates of economic impact, and thus we argue that an annual average over the study period is likely to be more representative of the impact of the WIAC on the economy of Virginia.

10.4 Virginia Spaceport Authority: Estimates of Economic Impact

To estimate the economic impact of the Virginia Commercial Space Flight Authority (d/b/a Virginia Spaceport Authority), we obtained estimates of compensation and capital spending. For employee compensation, we received compensation data for Virginia Spaceport Authority employees from FY 2018 to FY 2022, which we converted to calendar year data. Employee compensation data was aggregated into two classifications: (1) clerical/office employees, and (2) rocket or missile testing, launch, and similar functions. We mapped clerical/office compensation to IMPLAN industry 470 (Office administration) while rocket or missile testing, launch, and similar activities were mapped to IMPLAN industry 357 (Guided missile and space vehicle manufacturing). We secured estimates of capital expenditures for FY 2018 to FY 2023 and mapped these expenditures to institutional spending patterns (state/local government

investment). Where data were not available, we estimated average compensation or capital spending using available data. We converted historical compensation and spending data into 2023 dollars using the Consumer Price Index and then estimated the total annual economic impact.

Table 14 provides estimates of economic impact for Virginia Spaceport Authority from 2018 to 2022. We must note that large capital expenditures in 2018 and 2019 resulted in higher economic impact estimates in these years relative to 2020 to 2022. Personnel expenditures, however, have continued to increase over the study period. On average, compensation for Virginia Spaceport Authority employees and capital expenditures lifted overall employment in Virginia by 238 jobs each year over this period. Annual compensation in Virginia increased by approximately $21.7 million while industry output increased, on average, by $58.3 million. Virginia Spaceport Authority contributed approximately $36.8 million to Virginia's annual real GDP from 2018 to 2022.

An important question for policy makers is whether the return to investment for state appropriations is greater than 1, which would mean that Virginia Spaceport Authority provided taxpayers with a sufficient return on their tax dollars. To answer this question, we obtained appropriations data for Virginia Spaceport Authority from 2018 to 2022. We converted nominal appropriations to real appropriations using the Consumer Price Index. We then estimated the ratio of the total increase in real gross output relative to real taxpayer appropriations. As illustrated in Table 14, this national return on investment varied annually, ranging from a high of

4.6 in 2019 (when capital expenditures were highest) to a low of 1.9 in 2021 (in the aftermath of the COVID-19 pandemic). On average, we estimate that a return of investment of 2.9, that is, for every tax dollar appropriated to Virginia Spaceport Authority, gross output increased by approximately 2.9 dollars on average from 2018 to 2022.

We note that these estimates do not include the attraction of firms to Virginia. For example, the addition of Rocket Lab to the Wallops Island Aerospace Cluster will undoubtedly have a positive (and likely increasing) economic impact on the economy of Virginia in the near term. Virginia Spaceport Authority's improvements to the launch facilities at Wallops will not only service current clients, but also increase the ability of the Commonwealth to attract new firms to the aerospace industry. One must keep in mind that traditional economic impact estimates that focus on compensation and capital expenditures do not include these positive spillovers, which will only become evident as launch and other activities at the Wallops Flight Facility increase in the coming years.

10.5 Projections of Economic Impact for Wallops Island

To form projections of economic activity, we rely first on projections of capital spending from Virginia Spaceport Authority. As illustrated in Figure 17, capital improvements for Wallops Island will occur throughout the remainder of the decade. These capital improvements are necessary to support increased launch cadences by NASA, Northrup Grumman, Rocket Lab, and other firms and agencies. Virginia Spaceport Authority projects that the number of launches will exceed 20 a year by the middle of the decade and 30 a year by the end of the decade. We convert

nominal dollars into real 2023 dollars by assuming a rate of inflation of 3% over the remainder of the decade. Of course, projections of economic impact are based on assumptions of future economic activity and should be viewed accordingly.

Figure 17 – Projected Capital Expenditures, Virginia Spaceport Authority

Wallops Island, FY 2023 – FY 2030

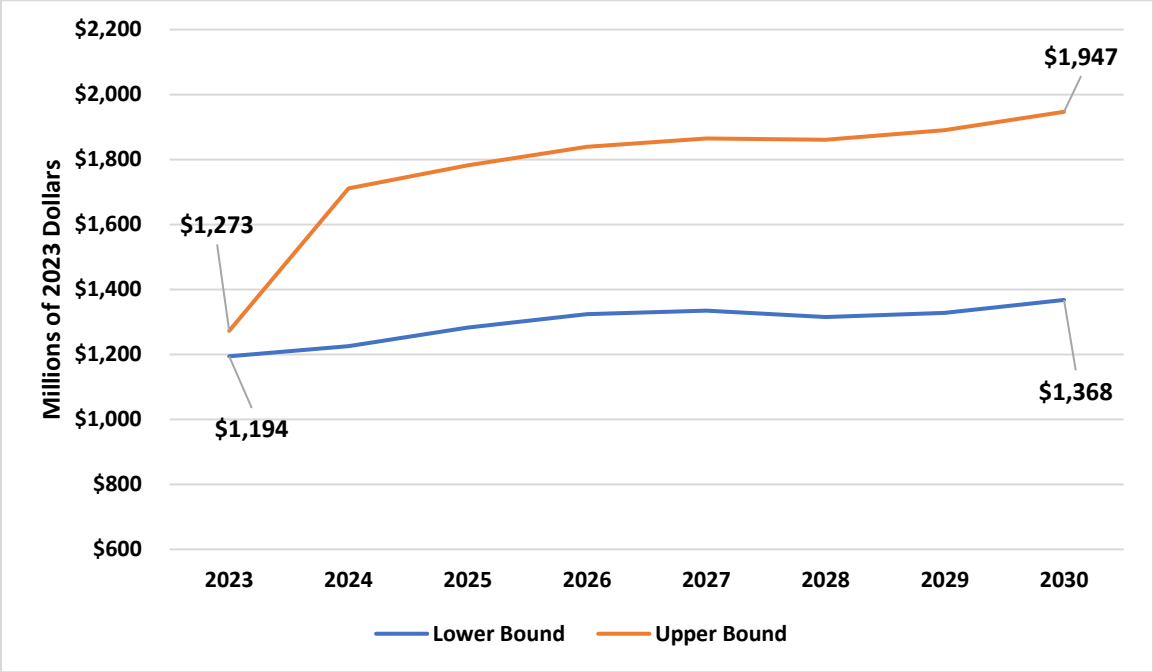
Source: Virginia Commercial Space Flight Authority. Projections of capital spending are not authoritative projections of actual spending.

We assume that employment and non-payroll federal spending increase at an annual rate of 3% per year relative to 2022. We argue this is a reasonable assumption given the number of projected launches is expected to increase from nine in FY 2023 to 30 in FY 2028. Even if the number of launches falls short of 30 in FY 2028, there are a host of other activities at Wallops

Island that are likely to continue to generate sustained economic impact in the coming years. We use FY 2022 non-payroll federal spending as the basis for federal projections and assume a 3% level of real expenditure growth. Our estimates are contained in Figure 18.

Figure 18 – Projected Annual Gains in Gross Output, Virginia

FY 2023 – FY 2030



Source: Dragas Center for Economic Analysis and Policy.

We project that, on average, the WIAC will generate more than 3,500 jobs annually for Virginia over the remainder of the decade. On average, labor income in Virginia will increase annually by more than $450 million. With respect to industry output, based on our assumptions, we project that the economic impact of the Wallops Island Aerospace Cluster may approach $2

billion annually at the end of the decade, if assumptions about launch cadence, capital spending, and employment are borne out.

Table 9 – Economic Impact: Cluster Employment (Without Engineering)

Wallops Island Industry Cluster, 2018 - 2022

Year	Direct Cluster Employment	Total Increase in Employment	Total Increase in Labor Income from Employment (Millions)	Total Increase in Value Added from Employment (Millions)	Total Increase in Gross Output from Employment (Millions)
2018	539	1680	$246.5	$673.6	$958.2
2019	455	1418	$208.1	$568.6	$808.8
2020	470	1464	$214.9	$587.4	$835.5
2021	473	1474	$216.3	$591.1	$840.8
2022	449	1399	$205.3	$561.3	$798.2
Average	**477**	**1487**	**$218.2**	**$596.4**	**$848.3**

Source: Dragas Center for Economic Analysis and Policy (2020). Estimates are in 2023 dollars. Estimates include direct, indirect, and induced impacts and assume that the multipliers are constant for the period of analysis. IMPLAN industry 357 (Guided missile and space vehicle manufacturing) is used for direct employment. Return on investment is equal to total increase in gross output divided by state appropriations to the Virginia Commercial Space Flight Authority.

Table 10 - Economic Impact: Cluster Employment (With Engineering)

Wallops Island Industry Cluster, 2018 - 2022

Year	Direct Cluster Employment	Total Increase in Employment	Total Increase in Labor Income from Employment (Millions)	Total Increase in Value Added from Employment (Millions)	Total Increase in Gross Output from Employment (Millions)
2018	1289	3115	$377.7	$841.8	$1,226.6
2019	1232	2905	$344.1	$742.9	$1,087.0
2020	1120	2708	$328.7	$733.2	$1,068.2
2021	1047	2572	$316.8	$719.9	$1,046.3
2022	916	2293	$287.1	$665.9	$965.3
Average	**1121**	**2719**	**$330.9**	**$740.7**	**$1,078.7**

Source: Dragas Center for Economic Analysis and Policy (2020). Estimates are in 2023 dollars. Estimates include direct, indirect, and induced impacts and assume that the multipliers are constant for the period of analysis. IMPLAN industry 357 (Guided missile and space vehicle manufacturing) and IMPLAN industry 457 (Architectural, engineering, and related services) are used for direct employment.

Table 11 - Economic Impact: Non-Employee Federal and State Spending

Wallops Island Industry Cluster, 2018 - 2022

Year	Estimated Spending	Total Increase in Employment	Total Increase in Labor Income from Employment (Millions)	Total Increase in Value Added from Employment (Millions)	Total Increase in Gross Output from Employment (Millions)
2018	$240,365,145	1880	$213.69	$292.13	$368.49
2019	$340,418,407	2662	$302.64	$413.72	$521.88
2020	$141,404,980	1106	$125.71	$171.86	$216.78
2021	$304,235,148	2379	$270.47	$369.75	$466.41
2022	$174,763,566	1367	$155.37	$212.40	$267.92
Average	$240,237,449	1879	$213.6	$292.0	$368.3

Source: Dragas Center for Economic Analysis and Policy (2020). Estimates are in 2023 dollars. Estimates include direct, indirect, and induced impacts and assume that the multipliers are constant for the period of analysis. Spending obtained from USASpending, state agencies, and interviews. Assumes place of performance directly correlates with Wallops Island Industry Cluster. Since federal spending is greater than 90% of total spending, we use IMPLAN code 11001 for the institutional spending pattern.

Table 12 – Total Economic Impact: Wallops Cluster (Without Engineering)

Virginia, 2018 - 2022

Year	Total Increase in Employment	Total Increase in Labor Income from Employment (Millions)	Total Increase in Value Added from Employment (Millions)	Total Increase in Gross Output from Employment (Millions)
2018	3,560	$460.19	$965.73	$1,326.69
2019	4,080	$510.74	$982.32	$1,330.68
2020	2,570	$340.61	$759.26	$1,052.28
2021	3,853	$486.77	$960.85	$1,307.21
2022	2,766	$360.67	$773.70	$1,066.12
Average	**3,366**	**$431.79**	**$888.37**	**$1,216.60**

Source: Dragas Center for Economic Analysis and Policy (2020). Estimates are in 2023 dollars. Estimates include direct, indirect, and induced impacts and assume that the multipliers are constant for the period of analysis. IMPLAN industry 357 (Guided missile and space vehicle manufacturing) and IMPLAN industry 457 (Architectural, engineering, and related services) are used for direct employment.

Table 13 – Total Economic Impact: Wallops Cluster (With Engineering)

Virginia, 2018 - 2022

Year	Total Increase in Employment	Total Increase in Labor Income from Employment (Millions)	Total Increase in Value Added from Employment (Millions)	Total Increase in Gross Output from Employment (Millions)
2018	4,995	$591.39	$1,133.93	$1,595.09
2019	5,567	$646.74	$1,156.62	$1,608.88
2020	3,814	$454.41	$905.06	$1,284.98
2021	4,951	$587.27	$1,089.65	$1,512.71
2022	3,660	$442.47	$878.30	$1,233.22
Average	**4,597**	**$544.45**	**$1,032.71**	**$1,446.98**

Source: Dragas Center for Economic Analysis and Policy (2020). Estimates are in 2023 dollars. Estimates include direct, indirect, and induced impacts and assume that the multipliers are constant for the period of analysis. IMPLAN industry 357 (Guided missile and space vehicle manufacturing) and IMPLAN industry 457 (Architectural, engineering, and related services) are used for direct employment.

Table 14 - Economic Impact: Virginia Spaceport Authority

Compensation and Capital Spending, 2018 - 2022

Year	Total Increase in Employment	Total Increase in Labor Income from Employment (Millions)	Total Increase in Value Added from Employment (Millions)	Total Increase in Gross Output from Employment (Millions)	Estimated Return on Taxpayer Investment based on Industry Output
2018	230	$20.5	$34.4	$54.9	3.0
2019	390	$31.6	$50.7	$83.6	4.6
2020	182	$18.0	$31.8	$49.3	2.8
2021	188	$18.5	$32.3	$50.1	1.9
2022	197	$19.7	$34.7	$53.6	2.3
Average	**238**	**$21.7**	**$36.8**	**$58.3**	**2.9**

Source: Dragas Center for Economic Analysis and Policy (2020). Estimates are in 2023 dollars. Estimates include direct, indirect, and induced impacts and assume that the multipliers are constant for the period of analysis.

11. Conclusion and Recommendations

There should be little argument that the Wallops Flight Facility and Wallops Island Aerospace Cluster have generated positive economic impacts for the Commonwealth of Virginia. With an average annual economic impact between $888.3 million and $1.03 billion, one might argue that Wallops Flight Facility and Wallops Island Aerospace Cluster should command greater attention in discussions on how to create higher paying jobs for the residents of the Commonwealth of Virginia. With the recent addition of Rocket Lab, the ongoing activities of Northrop Grumman, the continuing activities of NASA and the U.S. Navy, as well as the goods and services produced by members of the Wallops Contractors Association, there is a window of opportunity to address issues that may constrain future growth of the flight facility and industry cluster.

We must recognize that the potential of Wallops Island is not yet fully realized. With the anticipated growth in unmanned systems, the advent of the Neutron Rocket from Rocket Lab, the revitalized Antares rocket, and ongoing operations of other public agencies and private firms, Wallops should be a hub of innovation activity linked into the regional economy in Hampton Roads and further into Maryland. One might conclude that the Wallops Flight Facility is “out of sight, out of mind” unless a significant launch is happening, a perception that was mentioned in several interviews. There is a natural complementarity between the defense industrial base in Hampton Roads and Wallops Island, but the connections (and labor flows) between the Eastern Shore and Hampton Roads are limited, at best. More fully engaging Accomack and Northampton counties in regional planning in Hampton Roads is an obvious first step.

Over the remainder of the decade, the Commonwealth, through the Virginia Commercial Space Flight Authority, expects to invest significantly in upgrading and expanding the facilities at Wallops Island. In FY 2023, nearly $41 million of projects are approved and underway, with another $24 million in projects slated for FY 2024. If Virginia sees the wisdom of investing in Wallops and commercial aerospace and defense activities, these investments could top $300 million by the end of the current decade. We should also not forget that private firms are investing in Wallops, a market-based signal of the commercial applications and return-on-investment of activities related to this facility.

While data are limited, our interviews suggest that space tourism provides benefits to the communities surrounding the Wallops Flight Facility. We only need to point to Florida and Texas as examples of how space tourism can inject dollars into communities. It is not only tourists coming for launches, however, as launch providers informed us that they often bring in additional personnel to support launch activities. Here again, the lack of temporary housing, especially during the summer season, creates difficulties for employers at Wallops Island. While there is no "quick fix" to this issue, we argue that economic development should take a more expansive view and assist local governments in developing workforce housing to ameliorate these issues.

However, we would be remiss not to note that expanding activities at Wallops Island is not without challenges. The Commonwealth should take a more expansive view of economic development with regard to the lack of housing near the facility. In numerous interviews, we hear a common theme: there is insufficient permanent housing and a lack of temporary housing, especially during the summer months. The lack of housing, coupled with sparse amenities like childcare, may limit the ability of employers to attract and retain high-skill talent over time. Given

the growth of the commercial aerospace industry in the United States in recent years (and its projected growth over the coming decade), the competition for this labor is only set to increase.

Given the spillovers benefit Maryland also, the two states should work together to improve transportation, broadband, and other public infrastructure to support the activities of the industry cluster. This is not a new suggestion and echoes the recommendations of the 2019 ODU study. Our estimates suggest that increasing activities at Wallops Island will generate significant positive spillovers, not only in terms of direct employment and spending, but also with regard to local incomes and business activity. Policy makers at the state and local level should work with institutions of higher education to grow and sustain the talent pipeline. These institutions can also attract research and investment dollars. Given the potential for crewed spaceflight in coming decade, the states should work together to position Wallops Island as a national and global destination for aerospace, defense, unmanned systems, sensors, as well as climate science and national security.

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