Prince William County, Virginia
Data Center Fiscal Impact Analysis

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Executive Summary

Background

The data center industry is an important part of the Prince William County economy, with approximately 5.5 million square feet devoted to current operations, another 1.8 million square feet under construction, and 5.7 million square feet in the pipeline. Data center developable space is expected to reach 35 million square feet by mid-century. As the Board of County Supervisors examines the impacts of new and existing data centers, it is helpful to analyze the County costs and benefits of the industry.

For this report, PFM identified tax revenue associated with the data center industry: both tax revenue generated by the facilities as well as tax revenue generated by data center employees, and related activities. PFM also analyzed the expenditure side of the County budget, identifying (where possible) expenditures associated with the data center industry, both activities that support the data centers themselves, and activities that support data center employees.

County Revenue Structure

The Virginia county tax revenue structure is limited to those taxes allowed by state statute. As a result, the real property tax is the largest revenue source for the County; it made up nearly two-thirds of general fund revenue in the FY 2021 County budget. Personal property taxes were the second largest source, making up over 20 percent of County general fund revenue in the FY 2021 County budget. Together, they made up 86 percent of County general fund revenue. As a result, any discussion of County revenues should focus on real and personal property taxes.

The data center industry has benefited from a favorable personal property tax structure for computer peripherals and equipment, which were taxed at a rate of $1.25 per $100 of assessed value, while most personal property was assessed at a rate of $3.70 per $100 of assessed value. It is likely that this helped fuel the growth of the County data center industry, although other factors are as, or more important to the industry, including high quality fiber, readily available and reasonably priced electric power, suitable land, proximity to clients and suppliers. In recent years, the County has started to increase the personal property tax rate on computer equipment and peripherals, intending to gradually increase the rate to $2.00 per $100 of assessed value.

Data Center Industry Trends, Impacts, and Key Issues

Virginia (and Northern Virginia in particular) is the largest data center market in the U.S. While Loudoun County has been the epicenter of the Northern Virginia market, Prince William County has made steady progress and, in terms of data center square footage, is now second among comparable Virginia local governments. It is expected that the industry will continue to experience strong growth in the foreseeable future, including within Prince William County.

The industry continues to evolve, and data center characteristics are changing. For example, facilities are becoming larger and denser. It appears that data centers are taking longer to equip facilities and are holding that equipment longer. These impact personal property tax revenue from data centers, as the effective tax rate declines for equipment as it ages.

Data Center County Impacts

Besides the revenue impacts (which are substantial) and the effects on land values in certain key areas, there are other characteristics of the data center industry to consider. Many data centers require a lot of land. This relates both to the square footage necessary for equipment and other center components, as well as perimeter for security. In many cases, data centers are part of a larger campus that allows for future additions.

Data centers employ fewer workers than other manufacturing or industrial facilities of similar size. While the number of employees is not as large, the data center jobs are generally high paying, with average salaries of over $100,000. An advantage of the smaller numbers of data center employees is that there is less need for County investments in infrastructure and ongoing operational support for public safety and other services. In fact, data centers generally have their own security, sophisticated fire suppression systems, and relatively few visitors. These all mean that data centers are not large consumers of basic County services. Data centers are significant consumers of certain resources, such as electric power and water. There may also be concerns about noise pollution and other environmental impacts.

Data Center Cost Benefit Analysis

Conducting a cost benefit analysis on an entire industry is an inexact science. Among other things, data centers vary widely in how long they have been in operation, their business model, and the equipment they house. As a result, the analysis focuses on broad characterizations of the industry, which will not identify issues associated with individual facilities.

This exercise generally employs an input-output economic impact model. These models identify the millions of interconnected transactions that occur within an economy, in this case focused on the data center industry. PFM used the IMPLAN model, which is a commonly used tool for this analysis.

Tax Revenue

For the benefit component of the analysis, the project team primarily relied on the direct property tax revenue associated with data centers. While this will also include sales and use tax revenue, the Commonwealth of Virginia exempts much of this for qualified data centers.

Besides the direct revenue, the analysis also takes into consideration indirect revenue, which is associated with purchases by firms supplying goods and services to the data centers, and induced revenue, which is associated with spending by data center employees. This would include their share of consumption taxes, such as the sales and use tax.

County Expenditures

For the data center industry, PFM used what is known as the **average cost** approach, where costs assigned to a new or existing development are based on the average cost of providing the service per unit (i.e., per household, student, or employee) multiplied by the number of service units. Because the data center industry is well established in the County, the costs of providing service to the industry are already reflected in existing County average costs of service.

There are generally two methods for expressing government cost of providing services, on a **per capita basis** or as a **value-added ratio.** The per-capita model classifies expenditures as either education or non-education related and uses these to create ratios to determine the costs and revenues to the County based on the number of employees related to the industry. The value-added ratio methodology uses ratios based on expenditure classifications identifying costs as people-related or business-related.

PFM found the per-capita multiplier methodology to more realistically capture the County's net costs associated with data centers. Under this approach, the current cost of public services per resident, household, or pupil is multiplied by the expected increase in population, housing units or school-aged children the data center industry has or will create.

The Northern Virginia Technology Council's (NVTC) biennial study of the Impact of Data Centers on the State and Local Economies of Virginia also used the per-capita multiplier approach.[1] This focuses on the largest costs that any business imposes on a local government – the costs associated with providing primary and secondary education, public works, public safety, and other county services to the employees of that industry. The study's authors perform this analysis for Prince William County for 2020 in its most recent iteration of the biennial report. The PFM team replicated the methodology for 2021 and 2022.

The project team has the greatest degree of confidence in the cost benefit analysis of direct fiscal impacts alone. Using this approach, the net benefit to the County was significantly positive, $9.67 per $1.00 of investment in 2020, $11.76 in 2021, and $13.41 in 2022.

There are limitations associated with this (or any) methodology. As previously noted, combined costs and benefits will generalize some costs that, for some facilities, are a bigger issue for residents and other businesses than for the industry as a whole. Additionally, as with many commercial or industry activities, there will be externalities associated with it. In discussions with internal and external stakeholders, it was noted that data centers may impact on residential sight lines, create noise pollution, and generate CO2 emissions. These are all notable concerns, but they are not readily quantifiable, and they have not been assigned a cost for this analysis.

Summary
The key high-level findings that are addressed throughout the report include:

- The data center industry within Virginia, Northern Virginia, and Prince William County is a significant economic driver.
- Prince William County has experienced rapid growth within the Northern Virginia data center concentration.
- It is likely that the data center industry will continue to grow in the coming years.
- Taxes paid by the data center industry have shown similarly large growth in recent years.
- Data center County service needs are less intense than many other commercial activities.
- Many other data center service needs are paid for by the individual facilities.
- There are negative externalities associated with data centers that are not conducive to quantitative cost benefit analysis.
- Qualitative impacts are difficult to quantify and were not attempted for this analysis. Applying cost benefit analysis is easier for a specific facility and more difficult for an entire industry.
- Even though the exact ratio of costs to benefits varies by methodology, this and previous studies generally conclude that the data center industry is a net benefit to the County.

[1] In addition to its biennial studies on behalf of the NVTC, Mangum Economics uses this approach in its analysis of the potential impact of large data center development in Maryland on behalf of the Maryland Chamber Foundation. See Maryland Chamber Foundation, "Potential Impact of Large Data Center Development in Maryland," (March 2020). Accessed electronically at https://netchoice.org/wp-content/uploads/2020/07/Maryland-Data-Center-Report-2020.pdf

1. Introduction and Project Background

Background

The data center industry is an important part of the Prince William County (County) economy, with approximately 5.5 million square feet devoted to current operations, another 1.8 million square feet under construction, and 5.7 million square feet in the pipeline. In 2021, the Board of County Supervisors initiated a Comprehensive Plan Amendment (CPA2021-00004) to study the impacts of creating a "Digital Gateway" along Pageland Lane. This project includes multiple tasks, including a data center market study completed in October 2021 that estimated the economic impact of the data center industry.

PFM conducted an earlier study for the County that touched on the data center industry. As part of the 2019 County budget process, PFM reviewed revenue alternatives, including a proposal by then-Chair of the Board of Supervisors Corey Stewart to increase the County tangible business personal property tax on computer equipment from $1.25 to $3.70 per $100 of assessed value – nearly a 300 percent increase. At that time, PFM's analysis concluded that the proposed tax increase would likely have a negative impact on the existing data center industry and prospects for industry growth in the County.

Issue

As the County considers additional land use applications, it is helpful to understand the general return on investment for the County related to data center locations. To do so, it is necessary to identify both the revenues generated by the data center industry and the County service costs for these facilities.

This would include direct revenues (primarily real and personal property taxes) as well as revenue generated by data center employees and related data center activities. In addition, these revenues should, if possible, be categorized by the types of data centers to determine if certain types of facilities are preferable from a revenue generation perspective.

Data center costs to the County would include direct costs (such as fire and rescue services, police protection, street maintenance, etc.) as well as necessary infrastructure and other investments to support the industry, and indirect costs associated with data center industry employees. An example of an indirect cost from employees would be school division costs for data center employee's children in public schools.

Project Scope of Work[2]

The following were identified as the key activities and deliverables for the fiscal impact analysis:

- Interviews with stakeholders and subject matter experts.[3]
- Review of Prince William County real and personal property tax records for existing data centers.
- Analyze the types of tax generated to determine the methodology.
- Determine the fiscal costs to the government for a data center (i.e., schools, police, fire and rescue services, etc.).

[2] A summary of the PFM team's project approach is provided in Appendix A.
[3] A list of interviews conducted by the PFM team is provided in Appendix B.

The PFM project team wishes to thank the many individuals from Prince William County government and other County stakeholders who shared their knowledge and insight related to the issues addressed in this report. They contributed much of their time and provided the project team with a solid understanding of the issues the County has faced and will continue to deal with in the present and future. Of course, the findings and recommendations should not be attributed to any of those individuals, and any errors or omissions are the sole responsibility of the PFM project team.

2. Prince William County Profile

Overview

Throughout most of its history since its founding in 1731, Prince William County has been a farming community. Its economy diversified in the 20th century; Marine Corps Base Quantico opened after World War I, and the National Park Service opened Prince William Forest Park. Following World War II, the County accelerated its development as a suburb of the nation's capital. At present, approximately 19 percent of County land is federally owned.

Prince William County has had a County Executive form of government since 1972. It has eight County Supervisors elected to four-year terms, seven of whom represent individual districts and one at-large chair.. They appoint a County Executive to serve as the chief administrative officer and execute the County Supervisors' policies.[4]

Economic and Demographic Indicators

The following table provides a summary of key County demographic and economic characteristics; additional detail is provided in the sections that follow.

Table 1: Prince William County Economic and Demographic Characteristics

2021 County Population	488,629
Land Area	348 square miles
Per Capita Personal Income	$43,388
Median Household Income	$107,132
Total Employment	139,704
Unemployment Rate	5.2%
Poverty Rate	5.8%
Public School Enrollment	89,991
County and School FTE	16,509
Bond Ratings	Moody's: Aaa S&P: AAA Fitch: AAA

Source: Prince William County Department of Information Technology Annual Population Estimates, Prince William County FY 2022 Adopted Budget, Prince William County Public Schools FY 2022 Approved Budget, ESRI Demographic and Income Profile: Prince William County, ESRI Population Summary: Prince William County

Population

The County has a history of steady growth. The County population increased by 15.7 percent between 2010 and 2021, from 402,002 to 488,629 individuals, which is a compound annual growth rate (CAGR) of 1.8 percent.[5] It is projected to grow to 530,300 by 2030, increasing 0.9 percent per year.[6]

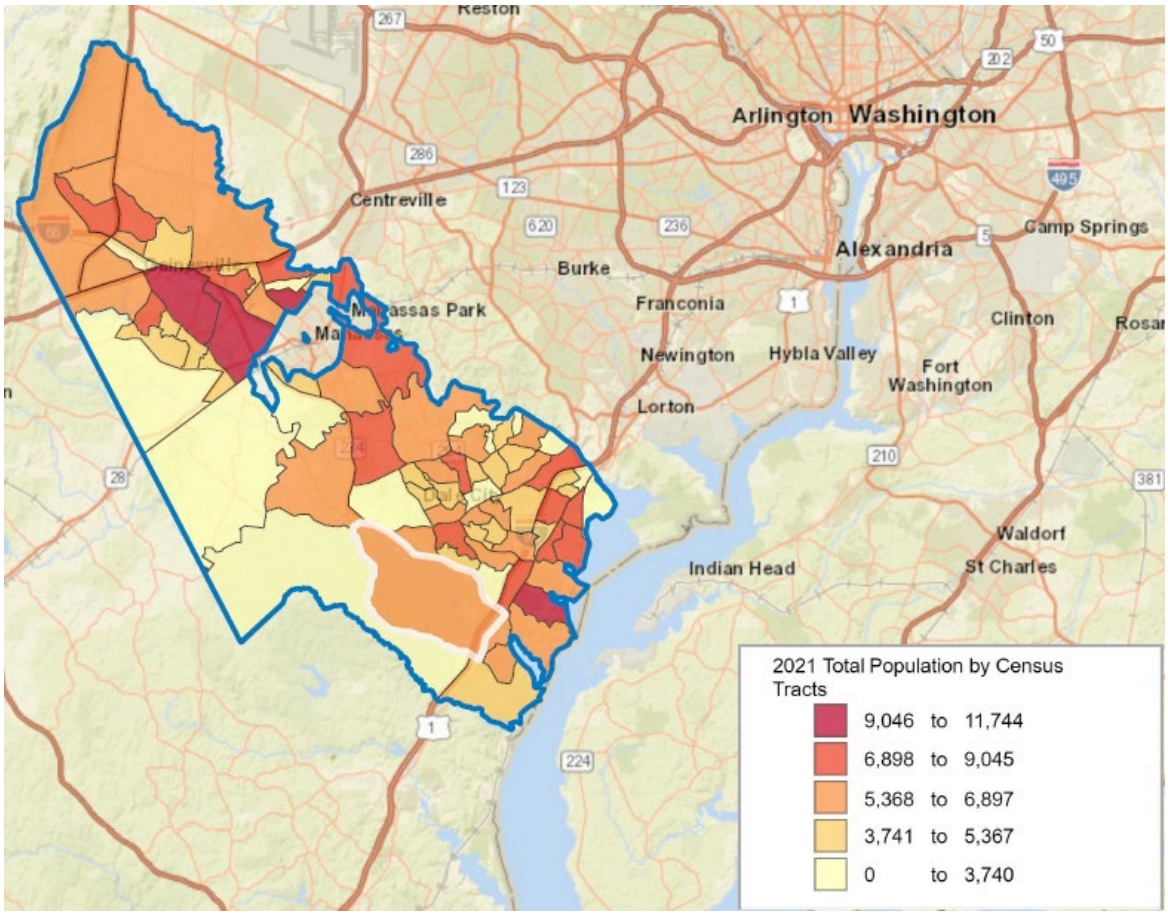
[4] PWC Adopted Budget and PWCS Adopted Budget, FY 2022.

[5] The Compound Annual Growth Rate (CAGR) is the mean annual growth rate over a specified period of time longer than one year.

[6] Prince William County Department of Information Technology Annual Population Estimates.

Prince William's current population ranks it as the second largest Virginia county. Most of the County's population is concentrated towards the center and eastern edge of the County, outside of its "rural crescent" (mostly shown in yellow in Figure 1).

Figure 1: Prince William County 2021 Population by Census Tracts



Source: ESRI 2021 Total Population by Census Tracts: Prince William County, VA

In 2021, Prince William County's daytime population was less than its total population. During the day, it contained approximately 189,000 workers and 230,000 residents. This suggests that more residents commute outside the County to their place of employment than those who enter the County to work.[7] It is an open question as to whether the work from home (WFH) changes brought on by the COVID-19 pandemic will lead to permanent structural changes in the migration patterns for workers who live in the County. There is evidence that a far larger share of the workforce will not have to commute to their place of employment – if not permanently, at least not as often as pre-pandemic. If this is the case, the daytime population may grow. This may also impact certain types of revenue collections within the County, where workers are making fewer taxable purchases of goods and services during the workday outside of the County.

[7] ESRI Market Profile: Prince William County, VA

Industry and Employment
More than two-thirds (68.9 percent) of Prince William County's labor force works in "white collar" professions, including professional services (28.1 percent), and management, business, and finance (22.1 percent). Of employed individuals over 16 years of age, 16.3 percent work in "blue collar" professions, including transportation and material moving (6.1 percent) and construction and extraction (5.4 percent).[8]

As of 2020, the County's top ten employers (by number of employees) were:[9]

1. Prince William County School Board
2. Prince William County
3. U.S. Department of Defense
4. Walmart
5. Morale Welfare and Recreation
6. Sentara Healthcare
7. Target Corporation
8. Wegmans Store #07
9. Northern Virginia Community College
10. MJ Morgan Group

One of the notable features of County employment is that companies in the data center industry are not major employers. This is a characteristic for the industry as a whole – it is associated with large capital investments (and property tax payments), but little direct employment. At the same time, the data center permanent employees are generally paid above the County average wage, and there may be associated support industries that will locate in the County to be near their data center customers.

Prince William County Revenue Structure
Prince William County is similar to other local governments in Virginia: its primary tax revenue source is the real property tax. Real property tax is the largest tax revenue source for local governments throughout the Commonwealth and for the U.S. as a whole. Of the County's General Fund budgeted FY 2022 revenue, 56.7 percent comes from real property taxes, and 17.0 percent comes from other general property taxes. This is consistent with FY 2021's General Fund revenue as well.[10] The following table summarizes Prince William County's budgeted FY 2021 General Fund revenue sources.

[8] ESRI Market Profile: Prince William County, VA [9]
Prince William County Adopted Budget, FY 2022.
[10] Prince William County FY 2022 Adopted Budget

Table 2: Prince William County Adopted General Fund Revenue by Source, FY 2021 (Amount in Thousands of Dollars)

General Fund Revenue Source	Amount	Percent of Total
Real Estate Taxes	$722,258	66.1%
Personal Property Taxes[11]	$220,440	20.2%
Other Local Taxes[12]	$124,629	11.4%
Additional Revenue Sources[13]	$23,612	2.2%
Interest on Taxes	$1,744	0.2%
Total	**$1,092,683**	**100.0%**

Source: Prince William County FY 2022 Adopted Budget

Real Estate Tax Rate

After remaining constant between Tax Year (TY) 2015 and TY 2020, Prince William County lowered its real property tax rate in TY 2021 and TY 2022.[14]

Table 3: Prince William County Historical Real Property Tax Rates

Tax Year	Real Property Tax Base Rate
2014	$1.148
2015	$1.122
2016	$1.122
2017	$1.125
2018	$1.125
2019	$1.125
2020	$1.125
2021	$1.115
2022	$1.030

Source: Prince William County Department of Finance

Personal Property Tax

Prince William County levies a tax on personal property for both individuals and businesses. In TY 2022, the County levied this tax at $3.70 per $100 of assessed value of personal property as of January 1.[15] A different rate applies to different categories of business general personal property. Computer equipment and peripherals (CEP) used in data centers are taxed at $1.50 per $100 of

[11] Includes vehicles and business tangible property.
[12] Includes 11 local taxes, including BPOL and Local Sales Taxes.
[13] Includes revenue from money and property, state revenue, federal revenue, and miscellaneous revenue. [14] "Tax Rates," Prince William County Department of Finance, accessed electronically at https://www.pwcva.gov/department/finance/tax-rates

[15] Prince William County FY 2022 Adopted Budget

assessed value.[16] The Board of Supervisors has also communicated the intent to raise the rate over time to $2.00 per $100 of assessed value.

This class of personal property has exhibited very strong growth in recent years. CEP personal property tax revenue from data centers has increased by a compound annual growth rate of 35.5 percent between FY 2013 and FY 2022.

Table 4: Prince William County Personal Property Net Tax Revenue Attributable to Data Centers, FY 2013 – FY 2022 (Amounts in Thousands of Dollars)

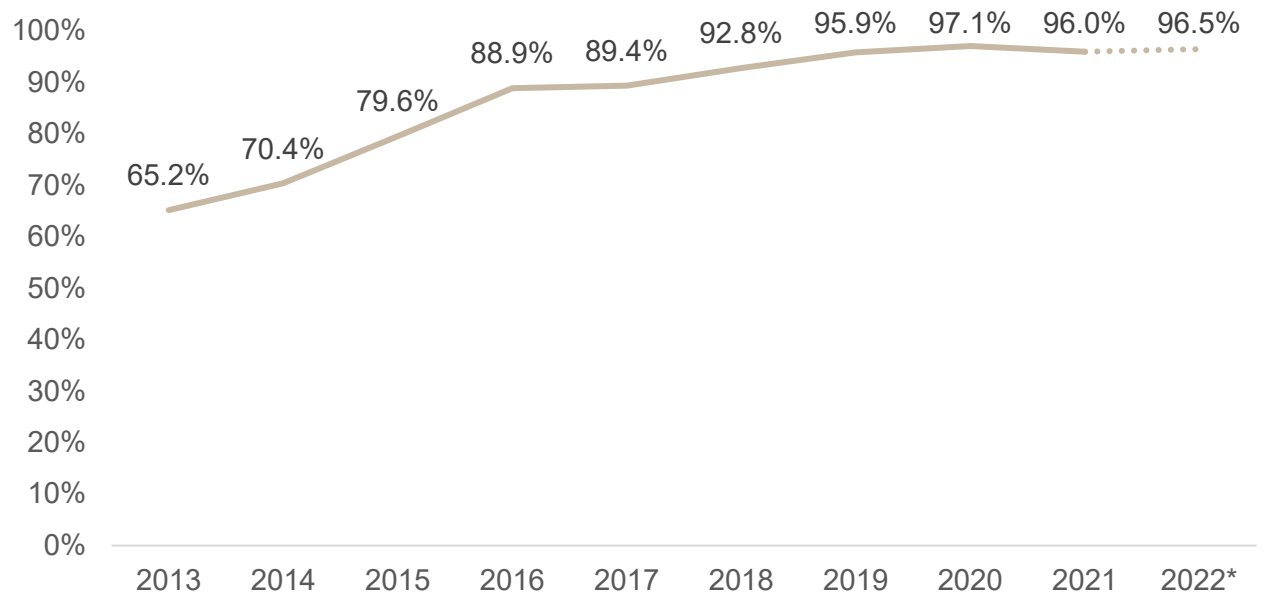
Fiscal Year	Furniture and Fixtures Net Tax Revenue	Computer Equipment and Peripherals Net Tax Revenue	Total Data Center Business Tangible Property Tax Revenue
2013	$467	$2,446	$2,913
2014	$893	$2,949	$3,842
2015	$3,431	$4,115	$7,546
2016	$5,771	$6,926	$12,697
2017	$7,493	$9,290	$16,783
2018	$8,744	$10,830	$19,574
2019	$10,228	$15,625	$25,853
2020	$11,419	$20,879	$32,298
2021	$16,676	$24,876	$41,552
2022*	$20,266	$34,118	$54,384
2013 - 2022 CAGR	**52.0%**	**34.0%**	**38.4%**

**FY 2022 includes preliminary data.*
Source: Prince William County Department of Finance

Over the past decade, the percent of computer equipment and peripherals personal property tax revenue from data centers has increased substantially, and it is forecast to be above 96 percent of total CEP personal property tax revenue in FY 2022.

[16] "Tax Rates," Prince William County Department of Finance, accessed electronically at https://www.pwcva.gov/department/finance/tax-rates

Figure 2: Data Center Tax Revenue Percent of Total CEP Personal Property Tax Revenue



**FY 2022 includes preliminary data.*
Source: Prince William County Department of Finance

The share of personal property tax revenue from data centers has increased over the past decade. Its growth has outpaced all other forms of personal property tax revenue, with a CAGR of 35.5 percent between FY 2013 and FY 2022.

Over the last 10 years, tax revenue from business tangible property has more than doubled as a portion of the County's overall tax revenue. In FY 2013, business tangible property tax revenue was estimated at $19.9 million,[17] or 2.5 percent of total General Fund tax revenue. By FY 2022, it was estimated at $63.4 million, or 5.5 percent of total General Fund tax revenue:

Table 5: Estimated General Fund Revenues by Source
(Dollar Amounts in Thousands of Dollars)

	FY 2013 Amount	% of Total	FY 2022 Amount	% of Total
Real Estate Taxes	$519,369	65.7%	$763,024	66.6%
Other Revenue	$138,244	17.5%	$155,826	13.6%
Other Personal Property Taxes	$112,782	14.3%	$163,620	14.3%
Business Tangible Property Taxes*	$19,903	2.5%	$63,431	5.5%
Total	**$790,298,135**	**100.0%**	**$1,145,901,059**	**100.0%**

Source: Prince William County FY 2013 Revenue Estimates and FY 2022 Adopted Budget
** Including data centers*

[17] Calculated as 15 percent of total personal property taxes; Prince William County FY 2013 Revenue Summary, accessed at: https://www.pwcva.gov/assets/documents/management-budget/13BUD--05--Revenue%20Summary--00.pdf

3. Data Center Industry: History, Trends, and Impacts

Background

Dating to the 1960s, the Internet and the World Wide Web grew out of the need for academic communication and information exchange. Over the next 30 years, this network expanded, became searchable, and reached mainstream audiences through the introduction of Web browsers. By the mid 1990's, major companies launched Internet-based applications, as did Microsoft's Internet Explorer as part of Windows 95. In the 21st century, mobile Internet devices, smart phones and wireless hand-held Internet access all evolved. These developments have led to greatly increased needs for data storage, access, processing, and transmitting.

By the decade beginning in 2010, data usage and needs led to the development of hyperscale data companies. Users and generators of this level of data usage are common household company names, including Microsoft Azure/Office 365, Facebook, Alphabet's Google Cloud, IBM Cloud, Oracle Cloud, Apple, Alibaba, Yahoo!, Uber, LinkedIn, and Dropbox, among others. These data applications continue to expand, driven by e-commerce, wireless networks, social media, streaming content, software-as-a-service (SaaS), artificial intelligence, machine learning, virtual reality, gaming, and machine-to-machine communication, also known as the Internet of Things (IoT).

Everyday life, including banking, communication, health care, recreation, entertainment, education, work, and social lives are increasingly conducted online. Data centers are the generators of much of the digital content that we use. These include personalized shopping recommendations; on-the-fly driving directions; online assistance with selecting a restaurant, hotel, or plane flight; digital retail or online shopping coupons; machine-generated responses to banking and billing inquiries, etc. These are all made possible by data centers.[18]

There is an expectation that these common features of daily life will drive the need for additional data centers well into the future. As uses expand throughout the universe of business applications, an increasing share of businesses will use these services and applications. This drives the need for both cutting-edge hyperscale data centers and online data and access needs requiring more intensive data services. Some data centers are dedicated single tenant/single user facilities, and some are multi-tenant facilities managed by professional data center service providers.

Virginia's Emergence

Virginia is home to the largest concentration of data centers in the world, with Northern Virginia alone accounting for more than 100 (out of 504 known) hyperscale data centers worldwide. The Northern Virginia hyperscale data centers total more than 13.5 million square feet of data center space – and continue to grow. Synergy Research Group estimates that 25 percent of U.S. hyperscale data centers are located in Virginia.

In Northern Virginia, network connectivity traces its roots to the U.S. government's experiments in wide-area fiber optic networking in the 1960s. Today, an intersection of mission-critical fiber backbones connects Virginia to all major markets in the U.S., which includes the highest density of dark fiber in the world.

[18] "The Impact of Data Centers on the State and Local Economies of Virginia," Northern Virginia Technology Council, January 2020, p.4.

Beyond the physical, technological, and demand-based aspects that have supported data center development, Virginia has positioned itself to attract and accommodate data center development through exemptions for sales and use taxes on equipment and software. Virginia exempts from sales and use tax data center equipment purchased (DC Exemption) when a data center investment exceeds $150 million, accompanied by creation of at least 50 new jobs with an average wage of 150 percent of the local wage rate. Even a colocation (non-single user) data center may qualify for the exemption where both the data center and its tenants, combined, would qualify for, and use, the DC Exemption. These tax incentives have substantially supported statewide development of the data center industry. One evaluation determined that only 10 percent of all data center development would have occurred in Virginia without the state sales tax exemption.[19] This has helped make Virginia highly competitive in the development and attraction of data centers.

The Commonwealth has continued to enact legislation that may be considered favorable to the data center industry. During the 2022 session, HB 791 was approved with unanimous votes in both the House and Senate, and Governor Youngkin signed the bill. It provides that if data center fixtures are taxed as part of the real property where they are located, they must be valued based on the cost approach. The bill defines cost approach as assessing value by determining the cost to construct a reproduction or suitable replacement of fixtures and deducting physical, functional, and economic depreciation sustained by such fixtures.[20] The bill takes effect on July 1, 2022.

Virginia data center growth increased rapidly beginning in 2012, which, as previously noted, coincided with the year Virginia significantly revised its data center tax incentive. By 2016, Northern Virginia had become the largest data center market in the U.S., as measured by megawatts of power capacity.[21] This growth has accelerated: Northern Virginia more than doubled its total data center capacity between 2018 and 2021.[22]

The concentration of data centers in Virginia, and its place as industry leader in the U.S., is highly significant, and the data center concentration is highly dense. The Virginia megawatt power capacity of data centers is larger than the concentration of markets two through six in size combined.

This is due in part to the direct fiber Network Access Point (NAP) located in Virginia, as well as the recent installation of undersea fiber cables constructed to enhance network connectivity between North America, Latin America, South America, and Europe. These new cables are major

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[19] "The Impact of Data Centers on the State and Local Economies of Virginia," Northern Virginia Technology Council, January 2020, p. 2.

[20] Under HB 791, fixtures would include generators, radiators, exhaust fans, and fuel storage tanks; electrical substations, power distribution equipment, cogeneration equipment, and batteries; chillers, computer room air conditioners, and cool towers; heating, ventilating, and air conditioning systems; water storage tanks, water pumps, and piping; monitoring systems; and transmission and distribution equipment. Computer equipment and peripherals would not be considered fixtures.

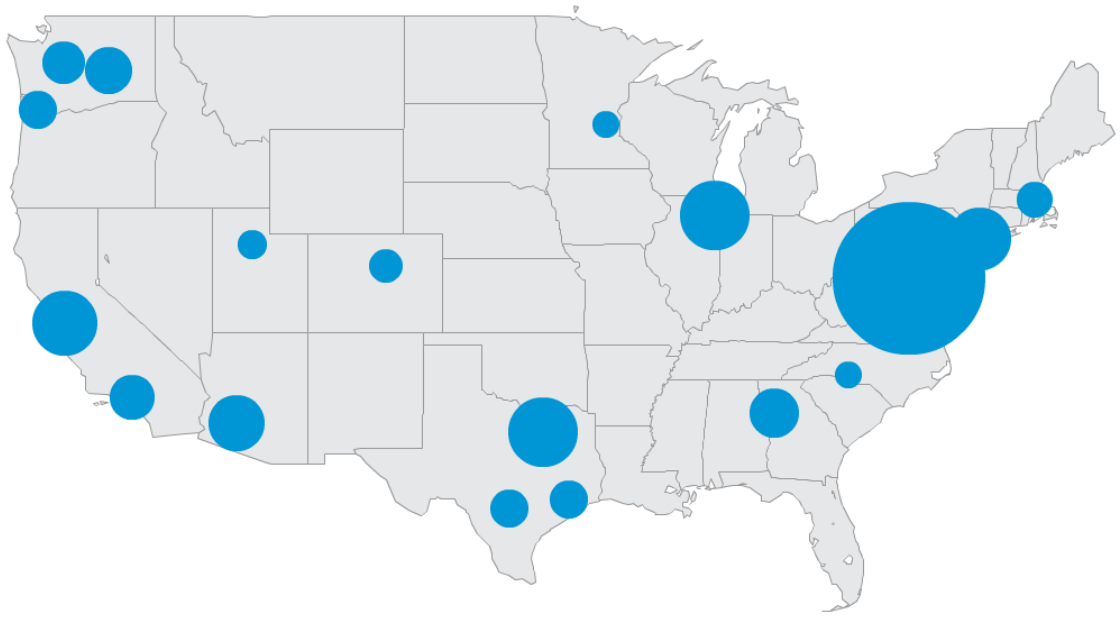
Under current law, localities may tax the listed items as either real or personal property. There are three methods that may be used for assessing real estate: (1) the sales comparison method; (2) the replacement cost less depreciation method; and (3) the capitalization of income method. If these items are taxed as personal property, they are valued by means of a percentage or percentages of original cost. See HB 791 Fiscal Impact Statement, Virginia Department of Taxation, accessed electronically at https://lis.virginia.gov/cgi-bin/legp604.exe?221+oth+HB791FER161+PDF

[21] CBRE, Large Supply Pipeline Sets Stage for Market Growth in 2019 North American Data Center Report H1 2019

[22] "The Impact of Data Centers on the State and Local Economies of Virginia", Northern Virginia Technology Council, March 2022, p.6.

advancements in communications infrastructure. These lines land in Virginia Beach and terminate in Richmond, providing enhanced network connections in parts of Virginia that are outside of the Northern Virginia region. This positions Virginia to remain an industry leader while providing opportunities for data center growth elsewhere throughout the state, outside of Northern Virginia alone.

Figure 3: Relative Sizes of Largest U.S. Data Center Markets (MW capacity), 2021



Source: The Impact of Data Centers on the State and Local Economies of Virginia, Northern Virginia Technology Council, March 2022

Employment

While data centers do not have high levels of ongoing employment, most of Virginia data center employment (88 percent of statewide employment in the industry) is located in Northern Virginia (an additional 6 percent is in Southern Virginia, 5 percent in Central and Coastal Virginia, and 1 percent in the Valley and Western Virginia).[23] Data center employment has grown in Northern Virginia since 2012, to 10,663 jobs in 2018, when Northern Virginia provided 75 percent of all private data center employment statewide.

Industry Growth Prospects

More and more, the U.S. (and world) economy is centered around information. The data center has a key role in that economic transformation. While some believe that new advances may render data centers less critical, there is little present evidence of that. One recent market research report noted that cloud, technology, and social media companies continue to drive near-record levels of demand across the globe.[24] Power consumption is one indicator of increased demand. This market research report noted that U.S. data center construction ramped up from 611.8 MW in the end of 2020 to

[23] "The Impact of Data Centers on the State and Local Economies of Virginia", Northern Virginia Technology Council, March 2022, p.6

[24] "H1 2021 Data Center Outlook: Insight into the Industry's Top Trends in the First Half of 2021," JLL Research, September 8, 2021

680.8 MW in the first half of 2021. Another study found that more than 527.6 MW of capacity was under construction in primary markets at the midway point of 2021, up 42 percent from the same period in 2020. Over half of that construction was located in Northern Virginia.[25]

Most market trends reports indicate that the data center industry will continue on a strong growth trajectory. For example, one research study on the data center construction market forecasts that by 2027, the market size will nearly double in comparison to 2019 – growing from $64.2 billion to $121.6 billion.[26] Another research report forecasts that the data center construction market will achieve a compound annual growth rate of 11.6 percent from 2021 to 2026.[27]

Industry Trends

The data center market is relatively fluid, and hot markets can cool rapidly. Data center utilization, location, and relocation can be volatile. The purchase of new equipment, ongoing real estate and business property taxes, technology changes and the evolution of connectivity requirements and availability, among other factors, can influence and create significant uncertainty in the durability and sustainability of data center concentrations in any one location. The proximity of Virginia Beach to the previously discussed undersea fiber cables is a new comparative advantage for that region in comparison to Northern Virginia, and these ebbs and flows may occur going forward.

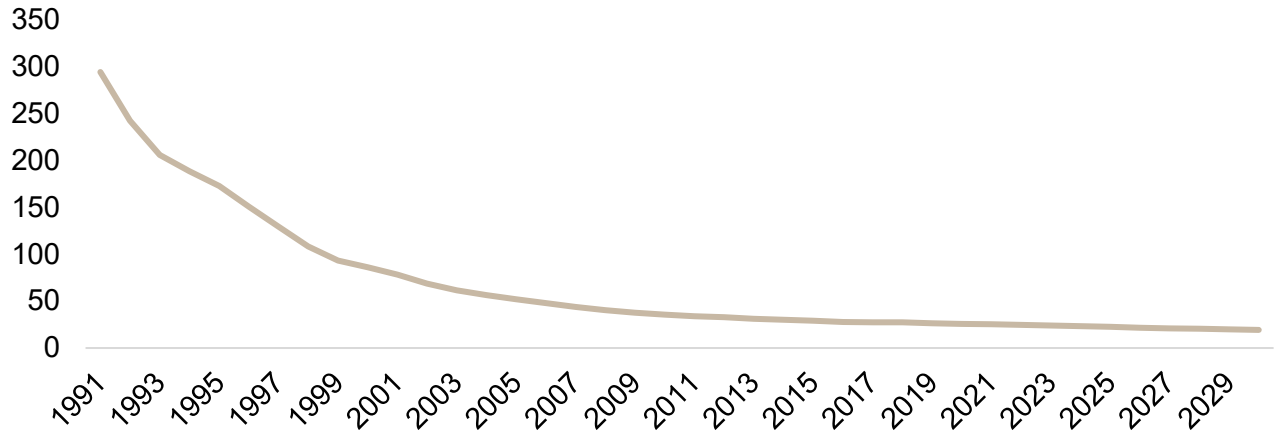
Several data center industry developments also have the potential to impact Prince William County's tax revenue. Major trends identified by the project team through research and interviews with industry representatives involve data center equipment pricing, equipment refreshment rates, and equipment density.

Equipment Pricing

The price of equipment used in data centers has trended down, as technology has improved, and the equipment has become more affordable. This is expected to continue in the future, as shown on the following chart. The price of equipment is expected to continue to decrease slowly over the next decade, as forecasted by Moody's Analytics.

[25] "Digital Infrastructure in 2021: The Search for Land, Space, Power and Connectivity," CBRE Research, 2021.
[26] "Data Center Construction Market: Market Estimates and Trend Analysis to 2027," Grand View Research, 2020.
[27] "United States Data Center Construction Market – Growth, Trends, COVID-19 Impact, and Forecasts (2021-2026), Mordor Intelligence, 2021.

Figure 4: Computers and Equipment Producer's Price Index



Source: U.S. Bureau of Labor Statistics and Moody's Analytics Forecast

Equipment Replacement/Refresh Rates

Data centers are beginning to extend replacement rates for their equipment, meaning they are holding onto it longer. This is driven primarily by the performance of new data center equipment, which is improving at a slower rate than in the past. A common expectation in the data computing world has been that the performance of microchips would improve significantly, while the cost would continue to decline. This historic trend is referred to as Moore's Law.[28] However, in recent years, this trend has not matched prior performance. Moore's law relies on putting more circuitry on smaller and smaller microchips. However, the newest Intel fabrication plant, meant to build chips with minimum feature sizes of 10 nanometers, was much delayed, delivering chips in 2019, five years after the previous generation of chips with 14-nanometer features. Numerous other prominent computer scientists have declared Moore's Law dead, and in 2019, the CEO of the large chipmaker Nvidia agreed.[29]

As a result, firms replace equipment later, because there is little to no performance improvement by purchasing new equipment. As an example, in its public filing,[30] Amazon noted it has officially extended the useful life of its server equipment from three to four years as of January 1, 2020.[31] As this trend continues, it may reduce tax revenues as the amount of older equipment assessed at lower personal property tax rates increases, and less new equipment is added.

[28] Moore's Law refers to Gordon Moore's perception that the number of transistors on a microchip doubles every two years, though the cost of computers is halved. Moore's Law states that we can expect the speed and capability of computers to increase every couple of years, and they will cost less. Another tenet of Moore's Law asserts that this growth is exponential. Accessed electronically at https://www.investopedia.com/terms/m/mooreslaw.asp

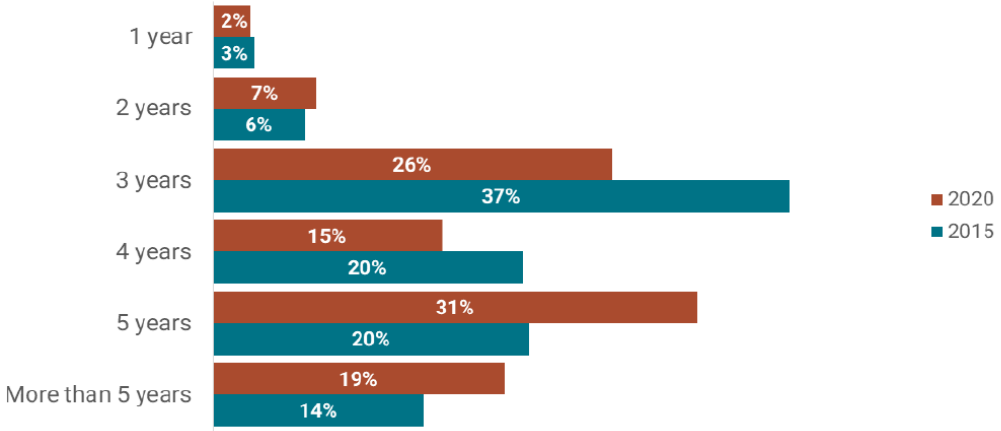
[29] David Rotman, "We're Not Prepared for the End of Moore's Law," MIT Technology Review, February 24, 2020, accessed electronically at https://www.technologyreview.com/2020/02/24/905789/were-not-prepared-for-the-end-of-moores-law/

[30] A U.S. Securities and Exchange Commission (SEC) Form 10-K is a required annual report that gives a comprehensive summary of a company's financial performance.

[31] Amazon, Form 10-K, 2020, Page 43, accessed electronically at: https://www.sec.gov/ix?doc=/Archives/edgar/data/1018724/000101872421000004/amzn-20201231.htm

A 2020 survey by the Uptime Institute related to data center operations supports this trend toward longer refresh rates. In fact, data center respondents in 2020 listed 5 years as their average length of time, compared to 3 years in 2015.[32]

Figure 5: Data Center Equipment Refresh Rates, 2020 and 2015

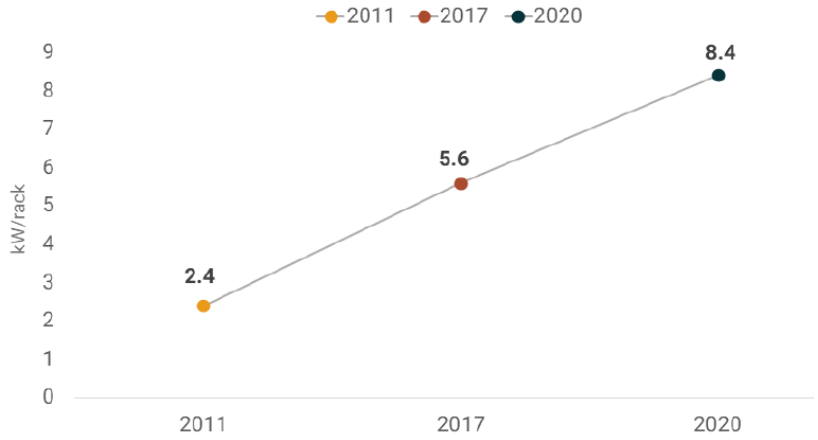


Source: Uptime Institute

Equipment Density

The density of equipment in data centers has increased significantly over the last decade. One survey of data center operators found average server rack density increased at an annual rate of 15 percent between 2011 and 2020, as shown in the following figure.[33]

Figure 6: Average Overall Server Rack Density (kW/Rack)



Source: Uptime Institute

[32] Uptime Institute, "Rack Density is Rising," December 7, 2020, accessed electronically at: https://journal.uptimeinstitute.com/rack-density-is-rising/#:~:text=Eliminating%20respondents%20with%20above%2030,provisioned%20range%20of%20most%20facilities

[33] Uptime Institute, "Rack Density is Rising," December 7, 2020, accessed electronically at: https://journal.uptimeinstitute.com/rack-density-is-rising/#:~:text=Eliminating%20respondents%20with%20above%2030,provisioned%20range%20of%20most%20facilities.

This suggests that when equipment is replaced, more equipment takes its place. This trend may partially offset the potential declines in tax revenue driven by declining prices and delayed replacement of equipment.

Development Lead Time
Development of physical building space may not coincide with growth in the assessed value for tax revenue forecasting purposes. This is due to the lag in the time from a building being completed for occupancy, to tenant leasing or occupancy, and then to equipment outfitting. Based on recent discussions with data center industry executives, outfitting and full building utilization generally takes 12 months from completion to full occupancy. However, full utilization and outfitting may, in some instances, take as long as 36 months. This depends on business conditions, customer demand, and the construction/timing of advanced facilities and facilities planning needed to provide services as quickly as possible when demand arises.

A trend that may be developing relates to longer planning time periods for data centers. Data center users and operators may pre-position buildings well in advance of need. This is so the time delay between when tenants or demand occurs to when functional data center space can be delivered may be a few weeks to a few months, compared with the time and advance planning needed to construct buildings and facilities, which may take a year or more. This was a point of discussion in project interviews. This has also been an area of concern - that data center land purchases are crowding out other possible land use.

Environmental Issues
Data centers consume a significant amount of natural resources. It is estimated that data centers account for approximately 1.8 percent of electricity used in the U.S. Large amounts of water are also required to operate data centers, both directly for liquid cooling, and indirectly to produce electricity. Approximately 0.5 percent of total U.S. greenhouse gas emissions are attributed to data centers.[34] These are U.S. totals and not solely attributable to data centers in Prince William County or the Commonwealth of Virginia.

Firms operating data centers are often seeking to become more efficient and environmentally friendly, as it can reduce input costs. Google and Microsoft have each shared plans to reduce waste associated with data center operations.[35] Data centers are moving away from planned obsolescence and toward longevity where possible. Server equipment will be increasingly designed for repairability to extend useful life, furthering the trend of later replacement of equipment.

Because of their power needs, data centers are also increasingly locating in and/or advocating for increased use of renewable energy, which may be less susceptible to certain types of supply disruption and may also reduce the overall carbon footprint of the industries through use of electricity generated by wind and solar power sources.

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[34] Md Abu Bakar Siddik, Arman Shehabi, and Landon Marston, "The Environmental Footprint of Data Centers in the United States," Environmental Research Letters, May 21, 2021, accessed electronically at https://iopscience.iop.org/article/10.1088/1748-9326/abfba1/pdf

[35] Microsoft, "Microsoft Commits to Achieve 'Zero Waste' Goals by 2030," August 4, 2020, accessed electronically at: https://blogs.microsoft.com/blog/2020/08/04/microsoft-direct-operations-products-and-packaging-to-be-zero-waste-by-2030/
Google, "A Circular Google," June 2019, accessed electronically at: https://services.google.com/fh/files/misc/circular-google.pdf

Of course, there are many data centers that have been in place for 10 or even 20 years. Many of these older facilities will not have the same levels of environmental efficiency. This is another example of why the performance of individual data centers will differ from aggregate measures.

4. Prince William County Data Center Key Issues

Prince William County Data Center Trends

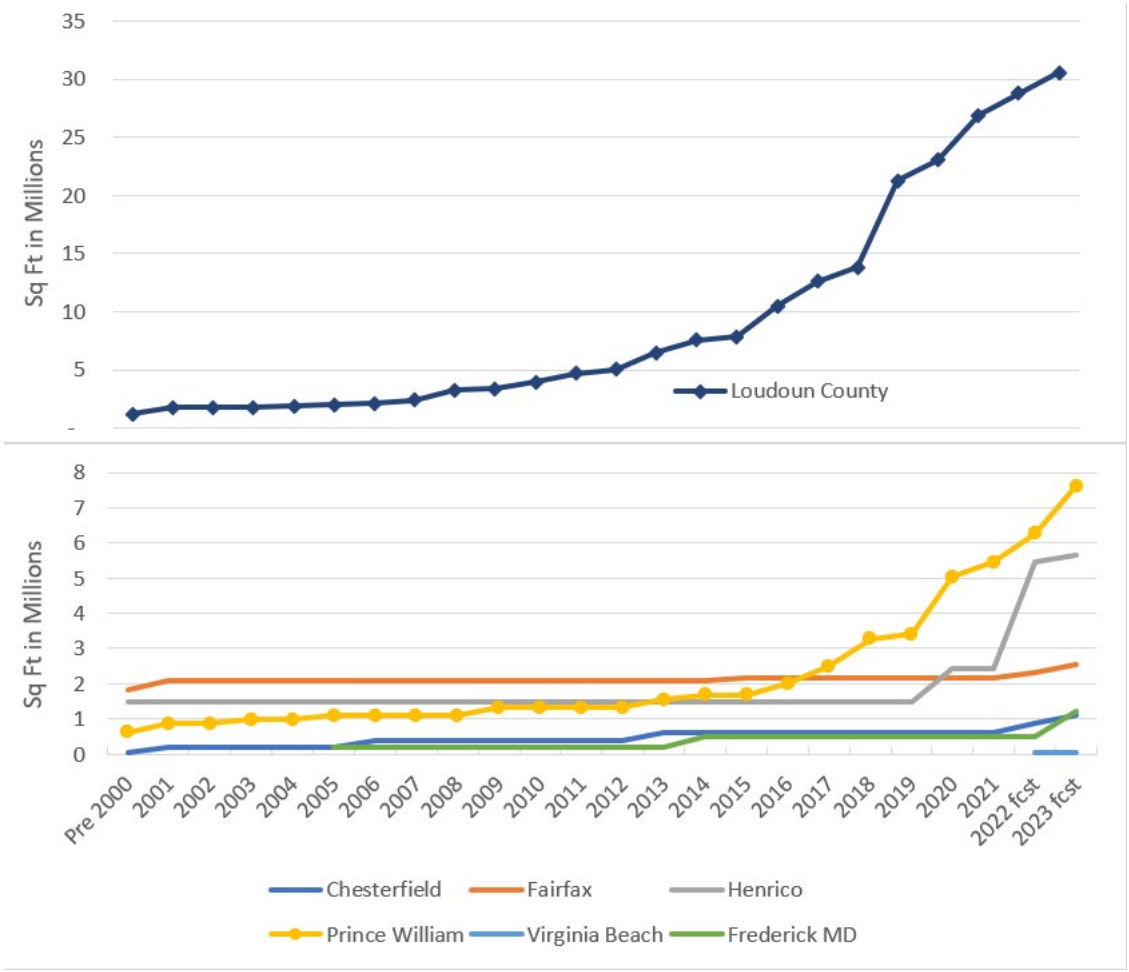
The County has made a concerted effort to attract data centers. This is evidenced by several reductions in the business tangible personal property tax rate for computer equipment and peripherals. In 1999, the rate was decreased from $3.70 to $1.50 per $100 of assessed value; in 2001, the rate was lowered again, to $1.25. As the industry has matured and the County has become a more significant industry location, the Board of County Supervisors has elected to gradually increase the tax rate. On April 28, 2020, the rate was increased to $1.35 for FY 2021, and $1.50 for FY 2022. The adopted FY 2023 budget includes an increase in the rate to $1.65 per $100 of assessed value.[36]

Additionally, in 2016, the County designated approximately 9,000 acres of land as a Data Center Opportunity Zone Overlay District. This zoning permits the development and operation of data centers in all industrial, office, and commercial zoning within the District (by-right zoning). It also promotes fast-track rezoning approvals for data centers within the district.

The success of these efforts is evident, as Prince William County's data center square footage is second in the Commonwealth only to that of Loudoun County (expected to reach 30 million square feet by 2023), which had something of a head start. The following compares square footage in key data center markets:

[36] This is a common approach in the use of tax policy to attract a nascent industry. The reduced rate for computer equipment and peripherals was a consideration for data centers locating in the County. Once a sort of 'critical mass' of the industry within the County is reached, it is reasonable to gradually increase the tax rate to reflect costs associated with a more mature industry.

Figure 7: Data Center Square Footage Comparison, Select Jurisdictions



Source: PFM, CoStar, Prince William County and Loudoun County Economic Development Departments

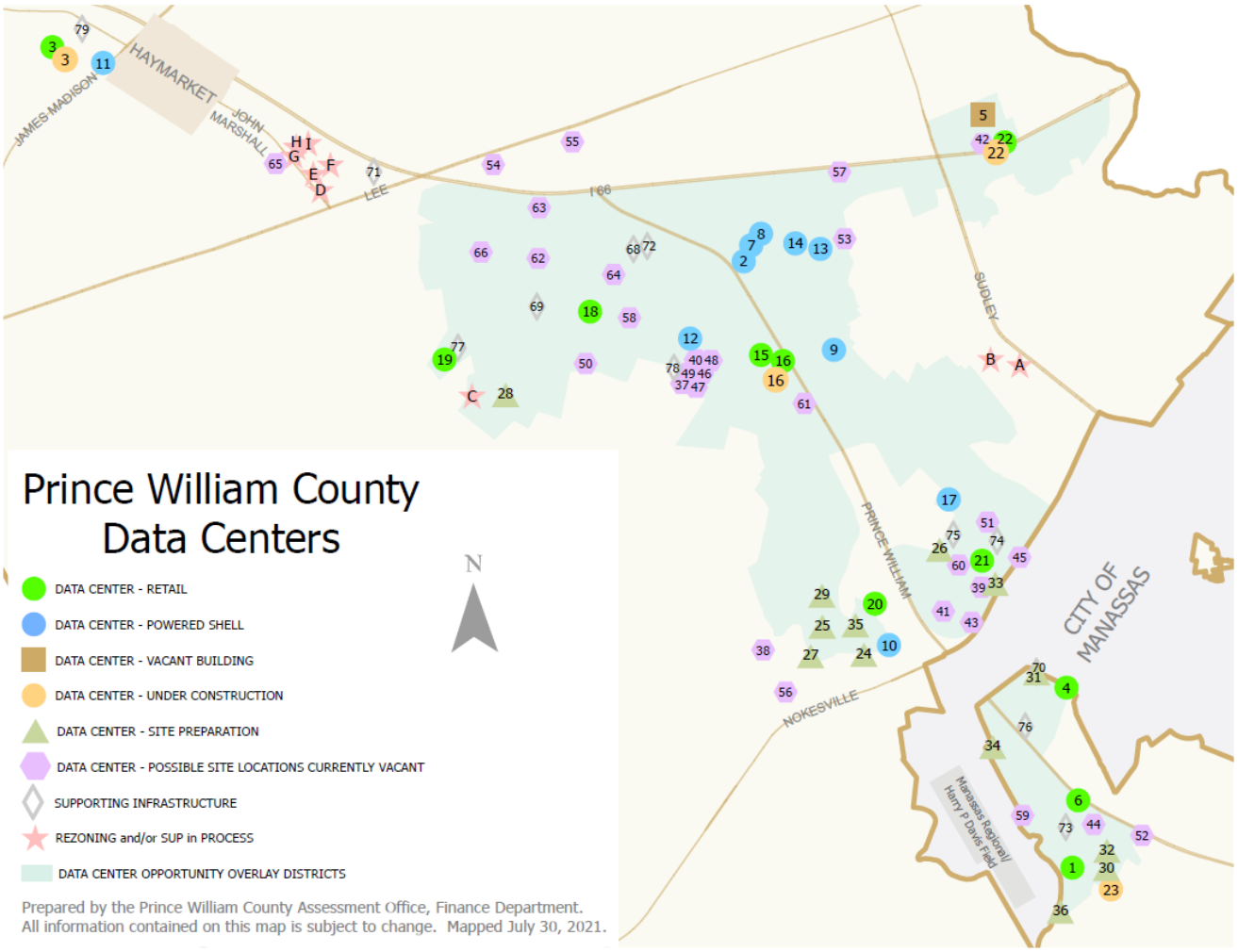
Table 6: Data Center Square Footage Comparison, Select Jurisdictions

	Chesterfield	Fairfax	Henrico	Loudoun	Prince William	Virginia Beach	Frederick MD	All Benchmark Areas
Prior 2000	33,440	1,827,960	1,470,053	1,211,384	626,771			5,169,608
2001	191,840	2,083,960	1,470,053	1,778,897	874,324			6,399,074
2002	191,840	2,083,960	1,470,053	1,778,897	874,324			6,399,074
2003	191,840	2,083,960	1,470,053	1,778,897	983,867			6,508,617
2004	191,840	2,083,960	1,470,053	1,879,018	983,867			6,608,738
2005	191,840	2,083,960	1,470,053	1,966,578	1,093,667		206,838	7,012,936
2006	384,435	2,083,960	1,470,053	2,115,295	1,093,667		206,838	7,354,248
2007	384,435	2,083,960	1,470,053	2,402,160	1,093,667		206,838	7,641,113
2008	384,435	2,083,960	1,470,053	3,263,784	1,093,667		206,838	8,502,737
2009	384,435	2,083,960	1,470,053	3,379,720	1,317,839		206,838	8,842,845
2010	384,435	2,083,960	1,470,053	3,924,559	1,317,839		206,838	9,387,684

	Chesterfield	Fairfax	Henrico	Loudoun	Prince William	Virginia Beach	Frederick MD	All Benchmark Areas
2011	384,435	2,083,960	1,470,053	4,690,289	1,317,839		206,838	10,153,414
2012	384,435	2,083,960	1,470,053	5,040,110	1,317,839		206,838	10,503,235
2013	626,477	2,083,960	1,470,053	6,494,858	1,556,973		206,838	12,439,159
2014	626,477	2,083,960	1,470,053	7,541,937	1,684,673		506,838	13,913,938
2015	626,477	2,177,960	1,470,053	7,850,297	1,684,673		506,838	14,316,298
2016	626,477	2,177,960	1,470,053	10,497,376	1,996,219		506,838	17,274,923
2017	626,477	2,177,960	1,470,053	12,618,527	2,503,802		506,838	19,903,657
2018	626,477	2,177,960	1,470,053	13,834,810	3,277,415		506,838	21,893,553
2019	626,477	2,177,960	1,470,053	21,287,239	3,404,415		506,838	29,472,982
2020	626,477	2,177,960	2,420,053	23,064,893	5,029,868		506,838	33,826,089
2021	626,477	2,177,960	2,420,053	26,905,148	5,456,681		506,838	38,093,157
2022 fcst	876,477	2,316,420	5,455,053	28,808,588	6,261,274	31,000	506,838	44,255,650
2023 fcst	1,126,477	2,556,420	5,645,053	30,591,309	7,607,302	31,000	1,206,838	48,764,399

The map on the following page identifies the locations of existing data centers in Prince William County, which are largely clustered around Prince William Parkway (Virginia Route 234):

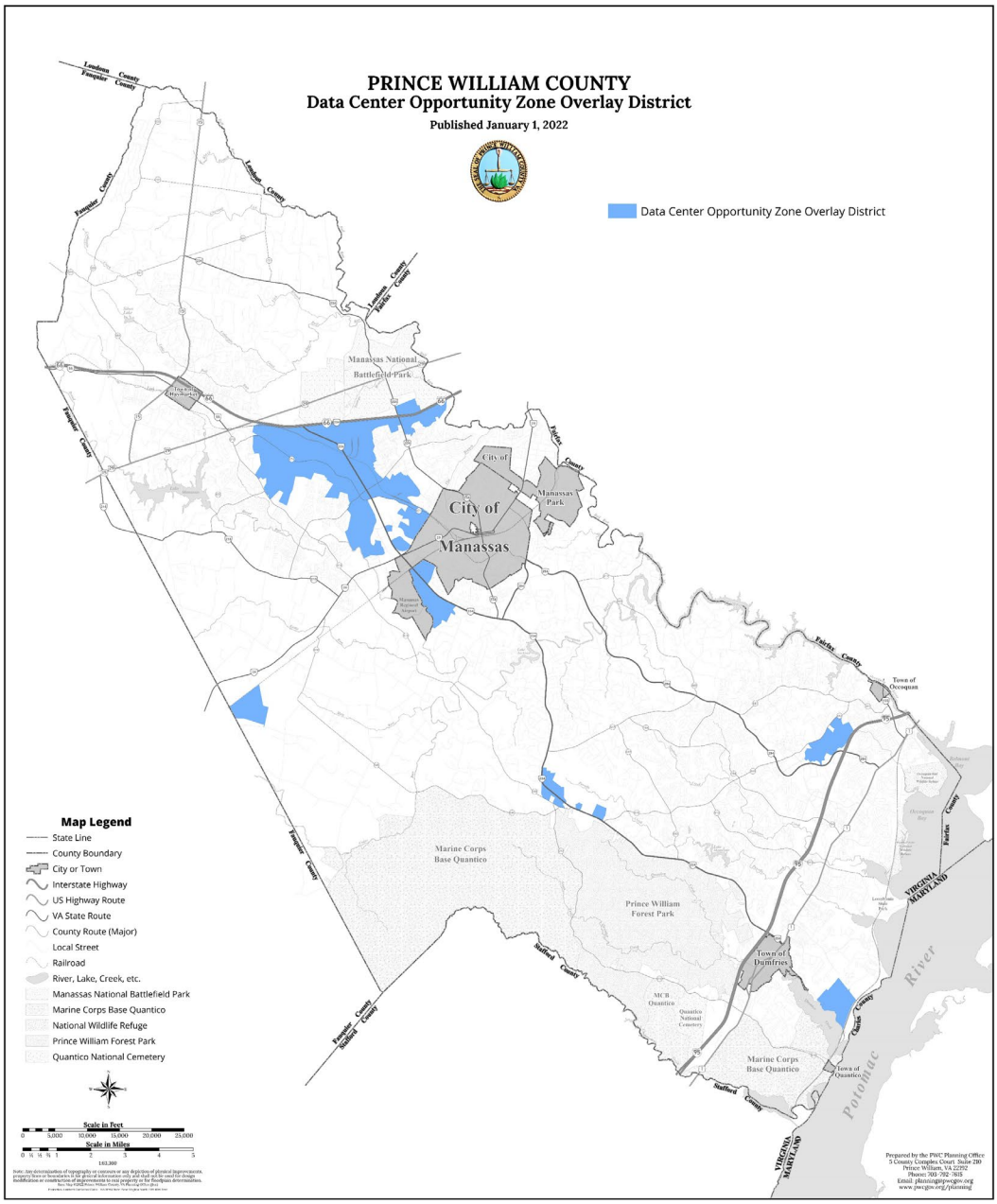
Figure 8: Prince William County Data Center Locations



Source: Prince William County Finance Department

The map on the following page identifies the existing Prince William Opportunity Zone Overlay District:

Figure 9: Map of Prince William County Opportunity Zone Overlay District



For the Prince William County Opportunity Zone Overlay District, local tax incentives are no longer a mechanism for attracting or retaining individual data centers or the data center industry. Instead, the primary advantage relates to by-right zoning and fast-track re-zoning approvals. This is important when discussing cost benefit analysis, as there are no tax incentives that would have to be deducted from taxes paid by the data centers within the County.

As it relates to available land, one of the advantages of the Overlay District is that it allows more structural density on properties located within it. The allowable floor area ratio (FAR)[37] within the District is 1.0, while outside the District it is 0.5. In essence, a structure within the District can have twice as much building square footage to property square footage as outside the District. Given that there is a need for access roads, parking, and perimeter security, a FAR of or approaching 1.0 would require a multi-floored building, and this is occurring more often.

Historically, the FAR for data centers has been in the range of 0.3 to 0.5, but that number is trending higher, and most new construction is for multi-floor facilities. Given the high price of land, it makes sense for the industry to look toward greater density. In this case, the limiting factor (besides the 1.0 FAR) becomes the ability to provide sufficient power to support the more-dense data center operation.

There is interest in Prince William County in expanding the primary locations for data centers. There has been put forward a Zoning Text Amendment to evaluate the expansion of the Data Center Opportunity Zone Overlay District and a Comprehensive Plan Amendment (Amendment) to create an additional Digital/Technology Corridor along Pageland Lane. Property owners and developers have also submitted various applications for data center projects outside of the Overlay District, and some have been approved. One rationale for these applications for development of data centers outside of the overlay area is these sites are already served with high voltage power transmission lines, which are critically necessary to power and serve data centers.

Historic Data Center Development in Prince William County

Over the past 25 years, Northern Virginia has evolved into the epicenter of the data center industry. Despite data center facilities expanding nationally and globally, Northern Virginia maintains its leadership position in terms of the inventory of facilities.

As has been noted, Prince William County is among the leading locations for the data center industry. The industry is both comparatively new and subject to rapidly changing technological demands and advancements. This places significant pressure on these businesses to remain competitive. The industry is also comparatively decentralized in terms of the number of industry establishments and participants. The combination of the pace of recent development and emergence of the industry, combined with the diversity and decentralization of industry players, makes detailed tracking of the industry difficult. Adding to the complexity of reporting and data tracking, the industry is generally reluctant to reveal functional details that may affect their competitive standing.

Finally, data center development and utilization are not “one size fits all”. For example, data centers are developed by internet service providers, such as AOL or Yahoo. Telecommunications companies such as Verizon and CenturyLink also provide data center services. Systems software companies such as Microsoft and Apple develop very significant data center operations. Expansive and fast-growing e-commerce companies such as Amazon and Google rely heavily on data

[37] Floor area ratio, or FAR, is the total amount of usable floor area that a building has, or has been permitted to have, and the total area of the lot on which the building stands. A higher ratio indicates more density – and structures with more than one floor can significantly increase the ratio, as each floor’s square footage is part of the calculation.

centers. Further, the digitization of health care records and services requires large scale secure data centers.

In addition, “retail” data centers provide data center services and facilities for rent to multiple tenants, each with data storage, e-commerce, and processing requirements to be fulfilled by data centers. The landscape of the types of data center industries is generally termed “enterprise” for those single tenant or self-owned data centers and the remainder are termed “colocation” data centers, where data center space is rented out on a retail basis.

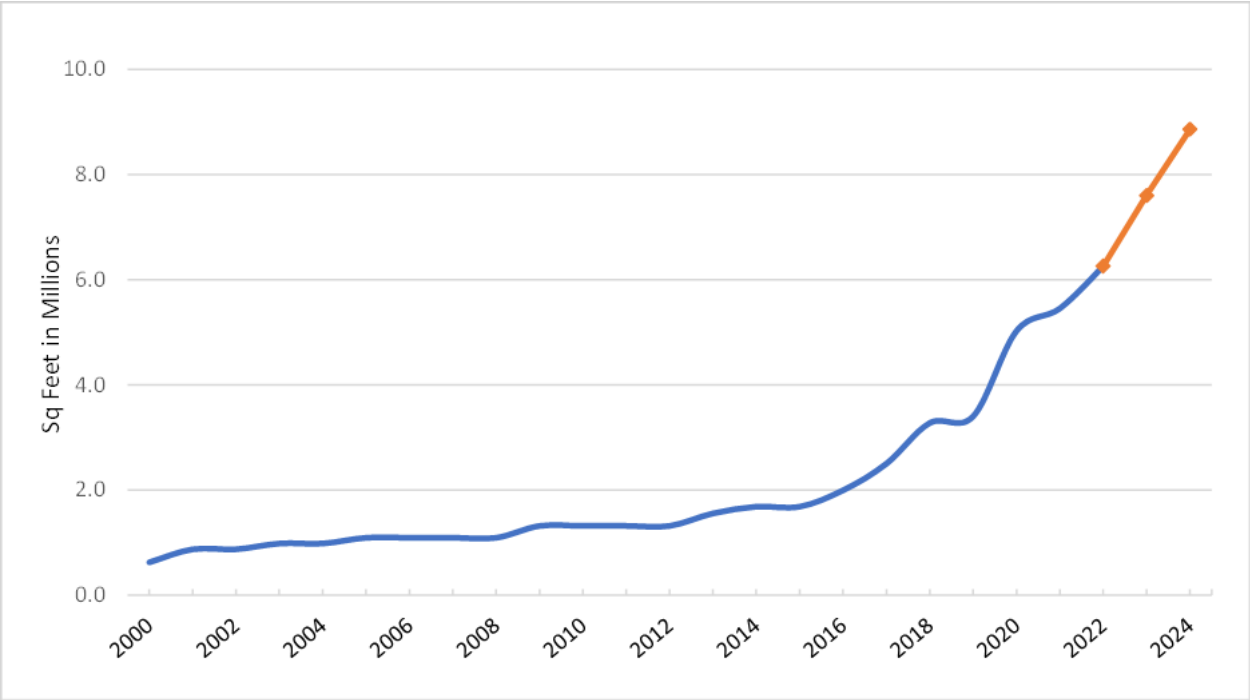
As a result, characteristics of data centers vary both from place to place and according to the mix of users (enterprise or colocation). While the U.S. Bureau of Labor Statistics has a designated industry category for data centers, data center employment may also be found within telecommunications, e-commerce, software, and other employment categories. As a result, government reporting of data center employment, wages, and establishments is spread among these industries as well as many others. Further, some industries reporting under NAICS code 518210 for the data center industry have nothing to do with data centers. As explained in a 2018 Washington State Department of Commerce report, “data centers do not report into a single NAICS category, and the primary category in which they do report (518210 – Data Processing, Hosting, and Related Services) has a lot of other components.”[38]

As a result, the data center employment and wage data used for the Prince William County economic impact analysis in this report is a compiled estimate based on known industry standards, published reports from other organizations, such as the Northern Virginia Technology Council (NVTC), and reported data under NAICS code 518210 from the U.S. Bureau of Labor Statistics (BLS).

While industry employment and wages may be difficult to determine, some data center industry information is better known and documented, such as the square footage inventory of data center space. Data center square footage used in this report has been compiled and reconciled using information from CoStar Inc., the Prince William County Real Estate Assessment Office, the Prince William County Office of Management and Budget, and the Prince William County Department of Economic Development. Figure 10 shows the historic development through 2021 and short-term development outlook through 2024 of the inventory of data center square footage in Prince William County.

[38] “State of the Data Center Industry,” Washington State Department of Commerce, Office of Economic Development and Competitiveness, January 2018, Page 18.

Figure 10: Prince William County Data Center Growth (in square feet)



Source: PFM, Prince William County, CoStar Inc.

As of 2021, there were 5.5 million square feet of data center space in Prince William County. This inventory includes more than 2.0 million square feet of building space added during 2020 and 2021 combined. The short-term outlook for the data center inventory includes space that is planned, announced, or currently under construction. Over the short-term, the County inventory is expected to grow by 3.4 million square feet of data center space through 2024. This represents annual data center space additions of over 1.0 million square feet per year.

Outlook for Data Center Development in Prince William County

As this study was nearing completion, in May 2022 Camoin Associates released its Targeted Industry Land Need Analysis for Prince William County. The study's findings are blended into the following discussion related to the outlook for data center development.

PFM determined that known data center land sales, currently owned parcels, and known acreage amounts in the data center planning overlay district include approximately 1,600 acres of land developable for future data center space. Full buildout of this space may take from 20 to 30 years, depending on industry demand, the building density per acre, and technological advances of data storage and data processing computer equipment.

PFM estimates that under the current conditions of known developable land inventory and development patterns, Prince William County is likely to host more than 35 million square feet of data center inventory space at buildout. In its study, Camoin Associates developed high, midrange and low demand scenarios. Under their high demand scenario, demand exceeds **current** buildout capacity by 2029. In the high demand scenario, demand exceeds **future** buildout capacity by 2034.

Under their midrange demand scenario, data center demand would exceed current buildout capacity by 2034.[39]

This development outlook does not include potential changes/additions to future developable lands inventory. There are development regulation changes under discussion and evaluation. If approved, they may significantly increase the future development capacity within the County. These considerations may include the expansion of the Data Center Overlay planning designation; additional flexibility added to future land use designations or zoning categories; and designation of proposed new data center development areas known as the "Digital Gateway." Changes in any or all these areas will increase the expected maximum development capacity of data centers in the county.

Data Center Operational Employment in Prince William County

The BLS reported just over 300 full time Prince William County data center jobs during year 2021, in the dedicated data center industry NAICS code 518210. It is known that this employment figure under-represents all data center employment in the County due to enterprise and telecommunications industries, which also generate data center employment.

The Northern Virginia Technology Council estimated that in 2020 there were 500 full time direct data center employees in Prince William County.[40] This corresponds with approximately 9,000 square feet per employee. The 9,000 square feet per employee average is a representative average for the data center industry in Prince William County. It is consistent with recently announced data center facilities, including Apple in Waukee, Iowa, with announced facility expectations of 8,000 square feet per employee, and a new Facebook data center in Huntsville, Alabama, with announced facility expectations of 10,000 square feet per employee. These are both similar to the types of facilities found in Prince William County. Finally, the 2021 BAE Urban Economics Data Center Market Study for Prince William County prepared an impact analysis of a prototypical Northern Virginia data center using as its model a facility with 9,000 square feet per employee, based on consensus research conducted by BAE.[41]

Taking these data into consideration, PFM estimates that in 2022 there are 650 permanent data center employees working in Prince William County. This is based on the 2022 estimated data center inventory of 6.3 million square feet of data center building space, at 9,000 square feet per employee, adjusted for estimated vacancy. Figure 10 on page 34 illustrates the history of the growth of data center building space in Prince William County.

Based on these data, 125 new direct data center employees have been added in the County since 2020. This represents a 24 percent increase in data center industry employment in just two years in the County.

[39] "Targeted Industry Land Need Analysis, Prince William County, VA," Camoin Associates, May 2022, p. 5.

[40] "The Impact of Data Centers on the State and Local Economies of Virginia," Northern Virginia Technology Council, March 2022, Page 24.

[41] "Data Center Market Study Prepared for Prince William County, Virginia," BAR Urban Economics, October 20, 2021, pages 4 and 25.

Examining wage data from the BLS, the BAE study, and the 2022 NVTC study, PFM estimates average annual employee compensation, representing wages, salaries, and benefits, exceeds $150,000 per year.

Single Tenant and Colocation Facilities

Data center buildings may be characterized by a single user occupying the building (enterprise data centers), for example a large technology company such as Facebook/Meta, or Google/Alphabet. Among large single users, very large companies with extensive digital capability needs may also fully occupy a building or multiple buildings. These users would include the U.S. government, national security agencies or the U.S. Military. Alternatively, there are "retail" data center operators who build data center space and lease out portions of buildings to smaller users with data center needs. These retail or colocation data centers are characterized by multiple tenants housed with a single building.

PFM has summarized the mix between single tenant and colocation data centers using the data available. This includes data from the Prince William County Real Estate Assessments Office and CoStar, Inc. Based on these data, the project team estimates that the 2022 mix of data centers is 67 percent single tenant and 33 percent multi-tenant/colocation space.

The outlook for future space through 2024 is less certain, because final ownership/occupancy may not be announced until after building completion. Experience suggests this tends to bias characterization of future space toward multi-tenant/colocation space. However, since 2016, development has trended away from enterprise/single user facilities to large hyperscale cloud facility providers, with buildings occupied by multi-tenant users. As a result, the mix of future space, as is currently known, is 91 percent multi-tenant/colocation space and 9 percent single tenant. With an additional 2.6 million square feet planned between 2022 and 2024 (more than a 40 percent increase over 2022 levels) the single/colocation mix is expected to shift to 50 percent colocation and 50 percent single user by 2024, if all planned space is occupied as is currently projected.

Table 7: Current and Future Data Center Footage by Type (In Thousands)

	Existing as of 2022		Future - 2023-2024		Total Through 2024	
Multi-Tenant/Colocation	2,046	33%	2,360	91%	4,406	50%
Single User	4,216	67%	243	9%	4,459	50%
Total	**6,261,274**	**100%**	**2,603,408**	**100%**	**8,864,682**	**100%**

Source: PFM; Prince William County; Costar

5. Data Center Cost Benefit Analysis

As previously noted, PFM was tasked with determining (1) the average real and personal property tax generated by data centers; (2) the estimated cost of providing County services (schools, police, fire, etc.) because of data center development; and (3) the net fiscal impact to the County.

The project team used the IMPLAN input/output model for this project. An explanation of input-output economic impact models is included in Appendix D, and the PFM team's revenue model assumptions are provided in Appendix E.

For net fiscal impact, the project team used actual data for 2020, unaudited data for 2021, and the adopted forecast for 2022. It should be noted that in 2020, primarily because of the COVID-19 pandemic, the U.S. economy experienced the sharpest and briefest recession in the nation's history. The ramifications of the changes in the US economy (both during and immediately after the 2020 recession) are generally considered to be wide-ranging, and they may have influenced the data center industry, as it did many other industries throughout the U.S. and the global economy. It is beyond the scope of this study to determine whether the impacts in 2020 are an anomaly for the data center industry, but there is a realistic possibility that the financial and economic data from 2020 may not reflect a typical year.

Calculation of Revenue from Data Centers

Prince William County staff track, at a detailed level, the real and business personal property tax revenues generated by the data centers housed within its borders. PFM relied on this information in estimating the County property tax revenue associated with the industry. Data centers also pay business license taxes; however, they are not included because the small number of data center taxpayers for business license taxes could expose confidential taxpayer liability information. This excluded tax revenue doesn't materially impact the cost benefit analysis.

Table 8: Direct Fiscal Impacts: County Taxes Paid by Data Centers (Numbers in Thousands of Dollars)

Tax Source	FY 2020 (Actual)	FY 2021 (Unaudited)	FY 2022 (Adopted Forecast/Projected)
Real Property Taxes	$20,087	$22,646	$32,294
Business Personal Property Taxes	$32,298	$41,552	$54,384
Computer Equipment and Peripherals	$20,879	$24,876	$34,118
Furniture and Fixtures	$11,419	$16,676	$20,266
Sales Taxes[42]	$249	$272	$307
Total	**$52,634**	**$64,470**	**$86,985**

Source: Prince William County Finance Department; IMPLAN, Direct Effect, County Tax Impacts

Of course, there are additional tax and other revenues that are contributed to the County by the data center industry. As will be explained in the discussion of the economic impact modeling, there is tax revenue associated with data center activities, primarily sales and use tax revenue, that result

[42] Estimate provided by IMPLAN. While the data center industry is exempt from paying sales tax on computer equipment, there are still sales tax revenues from other operations and maintenance expenditures such as software, disaster recovery, continuous power supplies, and physical building maintenance.

from consumption within the County fueled by wages paid to data center employees. These are included within the PFM model and the cost benefit analysis. There are other fees associated with the industry, particularly related to the construction phase of data centers, and they are also captured within the model but are minor in comparison to the property tax and sales and use tax collections. The following table illustrates the enhanced (i.e., indirect and induced) revenue impacts when accounting for indirect and induced tax revenue generation.

Table 9: Indirect and Induced Fiscal Impacts:
Additional County Revenue from Data Centers
(Numbers in Thousands of Dollars)

	2020	2021	2022
Data Center Sales Tax			
Sales Tax Indirect Impact	$381	$417	$469
Sales Tax Induced Impact	$194	$212	$239
Data Center Property Tax			
Property Tax Indirect Impact	$4,008	$4,384	$4,939
Property Tax Induced Impact	$2,009	$2,198	$2,476
Total	**$6,591**	**$7,211**	**$8,122**

Source: IMPLAN

Economic Impacts of Data Centers

In the PFM team's model calculations, both direct and indirect fiscal impacts are derived from data center economic activity. The IMPLAN model provided impact variables for the calculations. In addition, IMPLAN includes the previously mentioned fiscal impacts in its economic output calculations. The combined economic output for data center operations is provided in the following table:

Table 10: Economic Impacts of Data Centers
(Numbers in Thousands of Dollars)

	2020	2021	2022
Direct	$533,400	$579,200	$647,700
Indirect	$283,400	$310,000	$349,100
Induced	$54,500	$59,700	$67,300
Total	**$871,300**	**$948,900**	**$1,064,100**

Source: IMPLAN

Economic Impacts of Data Center Operations Employment

As of 2022, there are an estimated 650 data center operations employees in Prince William County, with estimated average annual wages, salaries, and benefits of over $150,000 per year, per employee. The IMPLAN model estimated the economic impacts of the permanent employment within the Prince William County data center industry. The following table illustrates the direct, indirect, and induced effects of economic activity resulting from the industry's permanent operations. The following table represents the economic impacts of permanent data center operational employment only and does not include impacts of data center construction activity.

Economic impacts for years 2020 and 2021 are found in Appendix F.

Table 11: Economic Impacts of Permanent Data Center Operational Employment, Prince William County, 2022 (Dollar Values in Thousands of Dollars)

Impact	Employment	Labor Income	Output
Direct	650	$103,400	$647,700
Indirect	2,560	$114,900	$349,100
Induced	450	$17,800	$67,300
Total	**3,660**	**$236,100**	**$1,064,100**

Source: PFM; IMPLAN 2022

With permanent operations employment of 650 persons, the data center industry supports an additional 3,010 indirect and induced jobs. For each direct industry job created, an additional 4.6 jobs are supported within the Prince William County economy. Total labor income paid is more than twice the direct industry labor income, with $236.1 million in total labor income from operations, paid annually. Total economic impacts of data center operations reach nearly $1.1 billion annually in Prince William County.

Based on the development pipeline, it is estimated the county's direct industry employment will continue to grow at a compound annual growth rate of 5.6 percent per year, over the long-term industry development horizon.

Calculation of Costs Associated with Data Centers

The local government costs that arise from any economic activity are those directly related to the activity plus any additional expenditures required to support its growth. Direct costs might include public infrastructure expenditures specific to the industry or activity (such as improvements in water and sewer systems and roads) and any incentives, grants or other financial assistance used as an inducement for a prospective business or industry. These direct, project-specific costs can be readily identified.

The other costs associated with the expected growth that will occur due to the industry or specific project will correspond to local budget expenditure categories that might include education, public works, public safety, parks and recreation, public health, social services, etc.

While the tax revenue associated with data centers is relatively straightforward and closely monitored by the County, estimating the County costs associated with data centers is less clearly quantifiable, and multiple methods have been used in prior data center studies of fiscal impacts. The more commonly used methods for estimating costs are based on calculating data centers' **average cost** or **marginal cost**, summarized in the following:

- The **average cost** approach, as its name implies, uses the average cost to provide a service and applies that to new or existing development or activities. It is generally expressed on a unit cost basis (i.e., per household, student, or employee), which is multiplied by the number of service units.

- The **marginal cost** approach takes into consideration the capacity of a jurisdiction's infrastructure, existing capital facilities and unique demand-based requirements in determining the incremental cost of serving an additional unit. This can be useful when

considering the cost of service where there is either rapid industry growth or decline, as the estimates may more accurately represent the actual costs to local government of new development, particularly when there are unique and identifiable costs associated with a specific type of development. An example of a marginal cost factor would be a new development that requires construction, equipping, and staffing of an additional fire station.

PFM determined that the average cost approach was more appropriate for this analysis. The primary determining factor was the data center industry itself, which is well established within the County. Because this cost benefit analysis is not being conducted on a new industry or development, the marginal cost basis would not be appropriate for existing data centers, which have already been factored into the cost of providing County services.

Within the average cost approach, there are two methods that have been used to calculate industry costs to government. These are either a **value-added ratio** or a **per-capita multiplier methodology.** Within these methods, the project team calculated the net benefit of the data center industry to the County both with and without construction budget impacts, which reflects what can be divergent views on data center's impact on the construction industry and its employees. The per-capita model classifies expenditures as either education or non-education related, and it uses these to create ratios to determine the additional costs and revenues to the County based on the number of additional employees related to the industry. The value-added ratio methodology uses ratios based on expenditure classifications and identifies costs as people-related or business-related.

PFM determined that the per-capita multiplier methodology more realistically captures the County's net revenues and expenditures from data centers, both with and without incorporating construction activity related to the industry. For the sake of completeness, the results of the Value-Added Ratio methodology are included in Appendix H.

PFM also determined that it was more appropriate to separate out the construction industry from the calculations of costs and benefits. For the sake of completeness, the cost benefit calculations and discussion including the construction industry are included in Appendix G.

Fiscal Impact Approach: Average Per-Capita Cost Multiplier Technique
The per-capita multiplier, PFM's preferred methodology, is the most common technique used when applying an average cost methodology. Under this approach, the current cost of public services per resident, household, or pupil is multiplied by the population, housing units or school-aged children the industry employs or creates.

The Northern Virginia Technology Council's (NVTC) biennial study of the Impact of Data Centers on the State and Local Economies of Virginia also uses the per-capita multiplier approach.[43] These studies use multiple sources to quantify the budgetary costs that data centers and their employees impose on localities. The analysis uses data from the Virginia Department of Education on local elementary and secondary education expenditures per student, and data from the Virginia Auditor of Public Accounts on local non-education expenditures per county resident. This approach focuses

[43] In addition to its biennial studies on behalf of the NVTC, Mangum Economics uses this approach in its analysis of the potential impact of large data center development in Maryland on behalf of the Maryland Chamber Foundation. See Maryland Chamber Foundation, "Potential Impact of Large Data Center Development in Maryland," (March 2020). Accessed electronically at https://netchoice.org/wp-content/uploads/2020/07/Maryland-Data-Center-Report-2020.pdf

on the largest costs that any business imposes on a local government – the costs associated with providing primary and secondary education, public works, public safety, and other county services to the employees of that business.

In its most recent iteration of the biennial report, the NVTC study's authors performed this analysis for Prince William County for 2020. The PFM team has replicated the methodology for 2021 and 2022, discussed in the following (in other words, 2020 calculations are based on the NVTC study, while calculations for other years are based on PFM analysis).

Predictably, the County's return on investment is highest when including total economic impacts. However, this is not an 'apples to apples' comparison, as economic impacts are included in revenue calculations but cannot be included in expenditure calculations, as IMPLAN does not provide expenditure data. As a result, while the PFM team completed the analysis using the range of inputs, the team preferred using only the direct fiscal impacts to understand the net fiscal impact. The other methodologies are included in Appendices G through I.

Preferred Methodology: Per Capita Multiplier Technique Including Direct Fiscal Impacts Only

PFM's preferred methodology is to include only direct fiscal impacts and exclude construction activity. This is the methodology also used in the NVTC study. **Using this methodology, the County's total fiscal impact is $9.67 per $1.00 in expenditures in 2020, $11.76 in 2021, and $13.41 in 2022.**

Table 12: Data Center Cost-Benefit Analysis of Direct Fiscal Impacts, Per Capita Multiplier Technique

	2020	2021	2022
Education-Related Expenditures			
Data Center Employment[44]	525	570	650
Students per County Employed Resident[45]	.73	.63	.62
Local Education Expenditures per Student[46]	$6,626	$7,125	$7,433
Total Education-Related Expenditures[47]	**$2,552,295**	**$2,551,432**	**$3,000,229**
Non-Education Expenditures			
County Residents per All Employees[48]	3.78	3.45	3.44
Non-Education Costs per Resident[49]	$1,455	$1,491	$1,562

[44] Per Prince William County Department of Economic Development
[45] Per Virginia Department of Education and U.S. Bureau of Labor Statistics. Derived by dividing total county elementary and secondary school enrollment by total county employment. Total County employment for 2022 is projected based on a 1.7 percent growth rate from Moody's Baseline Forecast. 2022 school enrollment is calculated using the 2018-2020 compound annual growth rate as the 2021-2022 growth rate. Numbers may be rounded.
[46] Annual Prince William County Budget Transfer to Schools
[47] Calculated as county private sector employment in data centers x students per County employed resident x per student education expenditures.
[48] Per Prince William County Department of Information Technology Population Estimates and U.S. Bureau of Labor Statistics. Calculated by dividing total county population by total county employment. Model uses 2019-2021 data for the years 2020-2022, respectively.
[49] Per Prince Willliam County FY 2022 Adopted budget, including special revenue funds and component units, and U.S. Census Bureau. Derived by dividing total county non-educational expenditures by total county population.

	2020	2021	2022
Total Non-Education Expenditures[50]	**$2,890,924**	**$2,932,447**	**$3,487,848**
All Data Center Types			
Data Center Revenues	$52,633,784	$64,470,160	$86,984,718
Data Center Expenditures[51]	$5,443,219	$5,483,879	$6,488,077
Net Fiscal Impact	**$47,190,565**	**$58,986,282**	**$80,496,642**
Net Fiscal Impact per $1 in County Budget Expenditures	**$9.67**	**$11.76**	**$13.41**

There are limitations associated with this (or any) methodology. For example, this generalizes some costs that, for some facilities, are a bigger issue for residents and other businesses. Additionally, as with many commercial or industrial activities, there will be externalities associated with it. In discussions with stakeholders, there is an understanding that data centers may impact on residential sight lines, create some level of noise pollution, and generate CO2 emissions. These are all notable concerns, but they are not readily quantifiable and often are site specific. As a result, they have not been assigned a cost for this analysis.

There are also some data limitations. In this analysis, given its reliance on per-capita calculations, employment figures are a critical input but not always readily available or known by the County. In fact, the 2018, 2020, and 2022 NVTC biennial reports use three different data sources to estimate data center employment totals, and the inputs in the most recent report are significantly different than those used in the two prior studies, as shown in the following:

Table 13: Data Center Employment Estimate Comparison, NVTC Biennial Reports

	2018 Report	2020 Report	2022 Report
Employment	252 (2016)	241 (2018)	500 (2020)
Description	County Private Sector Employment in Data Processing, Hosting and Related Services	County Private Sector Employment in Data Processing, Hosting and Related Services	County Private Sector Data Center Employment
Source	Virginia Employment Commission	U.S. Bureau of Labor Statistics	County Department of Economic Development

Of course, this can impact on final outcomes. In general, comparisons of results from differing studies within this realm should be done at a relatively high level. **It is notable, however, that both this study and the ones conducted by the NVTC have demonstrated a positive return on investment for the County from data center industry activities.**

[50] Calculated as county private sector employment in data centers x county residents per employee x per resident non-education expenditures.

[51] Calculated as total education costs + total non-education costs.

6. Summary Findings

The topic addressed within this report is complex, and it has been the subject of similar analysis both in Virginia and around the United States. As a result, the project team approached the subject matter from several angles and identified key high-level findings that are addressed throughout the report. These include:

- **The data center industry within Virginia, Northern Virginia, and Prince William County is a significant economic driver.**
  In virtually any discussion of the data center industry, it is noted that Virginia in general, and Northern Virginia in particular, is the largest concentration of data centers in the United States. The need for data centers is, based on the current move toward an information-based economy, expected to increase in the coming years. While the levels of employment within the industry are not as large as, for example, the manufacturing sector, the jobs on average pay well above the County's average wage. There are also significant construction and support services jobs associated with the industry.

- **Prince William County has experienced rapid growth within the Northern Virginia data center concentration.**
  While Loudoun County has long been considered the Northern Virginia data center epicenter, since 2016 Prince William County has, in terms of square footage of data center space, emerged as the second largest data center concentration in the region. It is notable that discussions with the data center industry suggest an interest in maintaining data centers in both Loudoun and Prince William Counties. Given that neither county provides tax incentives for data centers to locate within their county, this suggests that for many providers, locating in both counties is a form of portfolio balancing.

  Of course, one of the issues that is often identified as a constraint in Loudoun County is the lack of suitable land and/or the cost of land. This is becoming more of a concern in Prince William County as well. This can tilt the equation somewhat for data centers when considering total cost of ownership.

- **It is likely that the data center industry will continue to grow in the coming years.**
  The public appetite for data and information continues to grow, and there is a significant data center construction pipeline within the County. Based on projects that are in the planning or construction phase, it is likely that activity in Prince William County will maintain a similar growth trajectory in at least the next few years. Based on the current conditions of known developable land inventory and development patterns, the County could grow from the 5.5 million square feet of data center space to over 35 million square feet at full buildout.

- **Taxes paid by the data center industry have shown similarly large growth in recent years.**
  Data centers require computer equipment and peripherals that are taxable as business tangible personal property. This has become a significant revenue source for the County, growing from $2.4 million in FY 2013 to over $34.1 million in FY 2022 – a compound annual growth rate of 34.0 percent. This is far greater than for any other tax revenue source over this same period of time. It is also notable that, since 2014, the County has made several reductions in its real property tax rate, going from a rate of 1.1480 per $100 of taxable value

in 2014 to a rate of $1.0300 in 2022.

- **Data center County service needs are less intense than many other commercial activities.**
  Because of the sensitive nature of the data and information stored within data centers, to be commercially viable, they must be extremely stable and secure facilities. As a result, they generally have their own security and are designed to deter intrusion. They have sophisticated fire suppression systems and design. There are comparably smaller numbers of individuals working in or visiting the facilities. As a result, there is less need for public safety, public works, or transportation infrastructure – either in terms of capital investment or operational costs. They are often large, in terms of parcels of land, but they do not generate significant needs for services. This can be contrasted with a similarly large manufacturing facility or retail mall, where there is significant vehicle traffic that must be managed and foot traffic that may often require police, emergency medical, or other assistance.

- **Many other data center service needs are paid for by the individual facilities.**
  As with most local governments in Virginia and the United States, Prince William County assesses a variety of fees for services. Fees differ from taxes in that they are to recover the cost of providing specific services (as opposed to general taxes that support public goods and services). Thus, when a new (or existing) data center requires a County service that is specific to it, a fee is assessed. These include, for example, land or building development fees, zoning or rezoning fees, regular and special inspection fees, etc. Likewise, public utilities will also charge rates and fees for new connections. One of the expressed concerns is that other utility users are subsidizing the resource use of data centers. In discussions with utility representatives, rate setting takes into consideration usage and other factors and is meant to capture the costs of specific services for its customers. It is notable that part of the data center community's interest in expansion in certain areas in Prince William County is because of existing electrical transmission lines.

- **There are negative externalities associated with data centers that are not conducive to quantitative cost benefit analysis.**
  It is not uncommon for the wants and needs of residential and commercial property owners to come into conflict. Nearly every major commercial property will come with activity that some residents find objectionable. It may be the facility obstructing views, it may be increased traffic and other activity in the vicinity of the facility, or it may be various forms of pollution. Most of these are not readily quantifiable for this type of analysis – and in some cases, the level of 'bother' may be offset by other qualitative factors.

  In the case of data centers, issues of traffic and associated activity are minimal. Probably the one qualitative complaint that may rise to a level of material concern is noise pollution. It has been documented that (at least some) data centers emit a noticeable hum that can be bothersome to those in proximity to the data center (and even more so for those within it).[52] There are a variety of techniques that have been developed to mitigate the noise pollution

[52] See, for example, Francesca Remigi, "Data Centers: Noise Modelling and Environment Constraints," International Journal of Innovations in Engineering and Technology, October 2018, accessed electronically at http://ijiet.com/wp-content/uploads/2018/11/2.pdf

associated with data centers, which include acoustic louvres, perimeter sound barriers, use of liquid cooling servers (as opposed to using noisy external chillers), etc. While recommendations are outside the scope of this report, this may be an area where a dialogue with the data center industry regarding future planning for facility construction may be worthwhile.

- **Qualitative impacts are difficult to quantify and were not attempted for this analysis.** Most methods for cost benefit analysis focus on tangible calculations. In this respect, some negative externalities are not captured by the analysis. There are studies that seek to monetize these issues, using surveys and other techniques. However, in the limited time and scope for this report, those factors could not be quantified for inclusion.

- **Applying cost benefit analysis is easier for a specific facility and more difficult for an entire industry.**
  While the revenue associated with the data center industry is readily quantifiable (particularly for real and personal property taxes), the expenditures necessary to service the facilities that make up the industry is harder to accomplish. As the discussion notes, data centers are not homogenous – they differ considerably in size, building design, energy use, location, and a variety of other factors. This analysis becomes practically impossible when seeking to project those needs to future data centers where none of this information is known. On the other hand, determining the costs for a specific location where the building size, design, surrounding infrastructure, etc. is known is a much more focused set of calculations.

  The project team approached the expenditure cost analysis from multiple perspectives that have been used in past studies. Each has strengths and weaknesses. None will get around the issues of concern presented in the previous paragraph. That said, the various methods of determining costs and contrasting them with benefits (described both as revenue to the County and economic activity within it) come to a similar general conclusion.

- **Even though the exact ratio of costs to benefits varies by methodology, this and previous studies generally conclude the data center industry is a net benefit to the County.**
  As previously discussed, the revenue benefits to the County from this industry are substantial. In this report, all of the analyzed scenarios (including the scenario presented in the cost benefit analysis chapter, which the project team finds most useful), determine the data center industry is a net benefit to the County. Even if additional infrastructure were required (and that is not an easy argument to make considering the general characteristics of a data center), these are likely to be one-time costs – many (or most) of which would be incurred by the data center itself. In the long run, these costs would be quickly recaptured by the additional revenue generated by the data center.

  Across the country, many state and local governments are providing significant incentives to attract data centers. For many governments, incentives are primarily offered to attract employment or capital investment. In the case of data centers, there are relatively few (albeit well-paying) jobs associated with them. There is, however, significant capital investment – which advances another important industry (construction) and provides a stable source of

real and personal property tax revenue. There is strong evidence that this is an important factor in providing the industry incentives to locate there**. It is also a real advantage for the County that it does not have to provide incentives to attract and retain this industry**, which is not the case in many competing regions. That alone is a strong argument for maintaining the data center industry within the County.

7. Appendices

Appendix A: Summary of PFM Project Approach

To complete the project, the PFM project team[53] used a three-phased approach:

1. **Information gathering and analysis.**
   The project team gathered and analyzed a significant amount of data and information from the County. These included historic data, analysis and models on both revenues and expenditures. It included comprehensive financial data included in annual reports as well as county budgets.

   On the revenue side of the budget, this included data on real and personal property taxes, including actual collections by class of property, assessed value and actual taxes paid for the last five years, for data centers and in the aggregate. It also included analysis of historic trends in receipts and collection rates for the last five years for data centers and in the aggregate. It also included detailed historic collection data on other revenue sources, as well as analysis of trends in receipts and/or collection rates.

   On the expenditure side of the budget, this included reviewing line-item detail of the County general fund and other fund budget expenditures for the last five years, as well as capital improvement plans and other documents detailing planned expenditures and initiatives.

   As it relates to community and economic development, the project team obtained and reviewed the County Comprehensive Plan, data and information related to the existing Data Center Opportunity Zone, and the County Comprehensive Plan Amendment to study the expansion of the existing Data Center Opportunity Zone. The project team also reviewed data and information provided by the Department of Economic Development related to the data center industry.

   The project team also obtained data and information about the County's data centers, including locations, size in square footage and other unique features. The project team also reviewed existing County and external reports related to the data center industry.

   As the County and external data and information was being provided and analyzed, the project team scheduled and held over a dozen detailed interviews with County leadership, internal subject matter experts and external stakeholders. These interviews helped to clarify or identify existing County policies and practices. They also were an opportunity for the project team to examine the existing County revenue forecasting model. For external stakeholder interviews, they provided additional insight into the data center industry. A list of the County leadership and staff that were interviewed is contained within the Appendices. Because the interviews were conducted for background purposes and remain confidential, a

[53] The project team was led by PFM Group Consulting LLC Director Randall Bauer, who led the 2019 study for Prince William County and also led a 2021 data center study for Loudoun County, Virginia. PFM Financial Advisors LLC Director Sarah Frey, who serves as financial advisor to the County, was an advisor to the project team related to County finances and financial history. The team also included Senior Managing Consultants Deanna Kimball and Stan Geberer, both who were senior members of the project team for the Loudoun County project. Deanna was also a senior member of the project team for the prior Prince William County project. The team also included Senior Analyst Ellen Ramage and GIS Specialist Jackie Berry.

list of external stakeholders is not provided. In several instances, the interviews and analysis of the information led to follow-on requests for data and information, and the County stakeholders were extremely responsive to those requests.

2. **Modeling the data and information for a cost benefit analysis.**
   Based on the information and analysis, PFM worked to construct a cost-benefit model. In the construction, the project team started by reviewing past financial impact models for specific locations or industries it has constructed. To augment its understanding of modeling methods related to the data center industry, PFM also reviewed other approaches by other consulting firms.

   The modeling was supported by other analysis, including a County data center economic impact analysis and review of possible expenditure impacts related to new and existing data centers.

3. **Project draft and final reports and model deliverables.**
   The report's written analysis as well as the resulting model attempts to provide a full analysis of the factors affecting the cost benefit analysis. As is explained in the body of the report, estimating economic impact, particularly on the expenditure side of the County budget, is an assumption-driven process. While many of the features related to direct revenue provided by data centers and the industry are relatively easy to identify (at least historically), the expenditure side is more difficult. For that reason, the project team worked to validate its approach from several perspectives. The constructed model also relies on a set of assumptions, which are clearly identified (and may be altered) within the resulting model. That model, as well as documentation on its use, has/will be provided to the County.

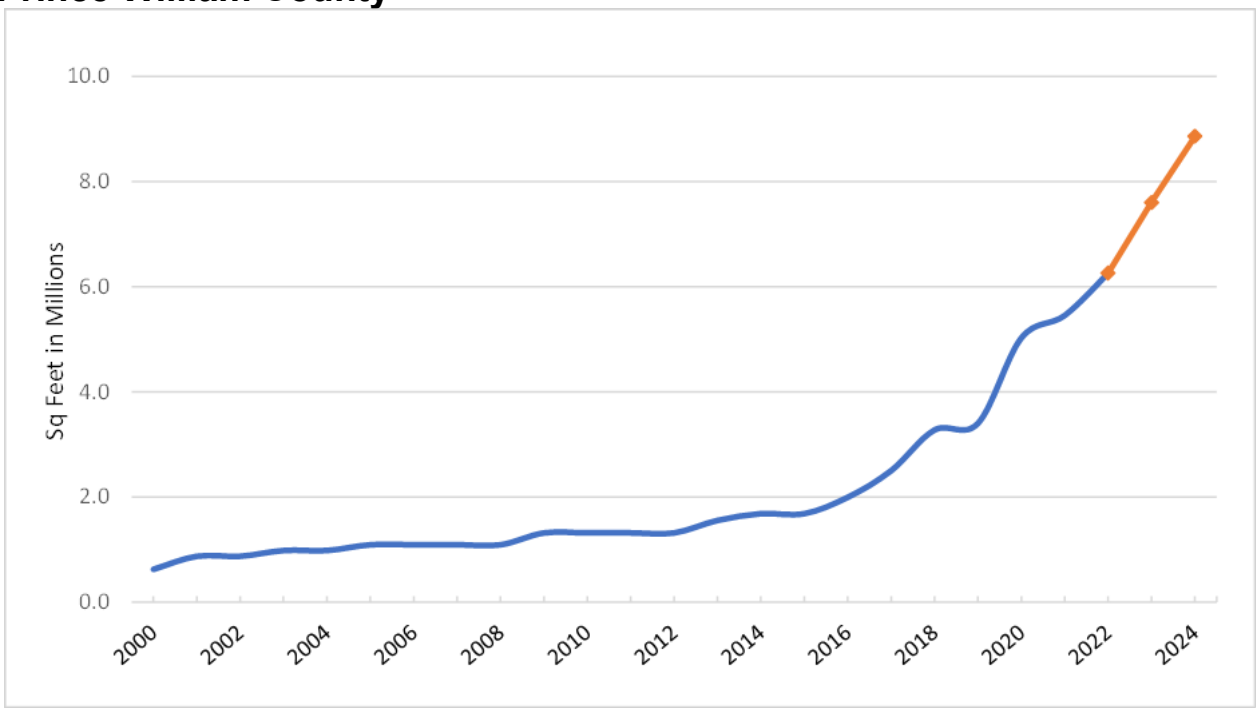
Appendix B: List of Stakeholder Interviews

As noted in the project approach discussion, the PFM team conducted numerous interviews with key stakeholders, including County Department leadership, management, and professional staff as well as external stakeholders representing key components of the County's economy. External stakeholder interviewees were promised complete anonymity, with information provided as background only. As a result, they are not listed here.

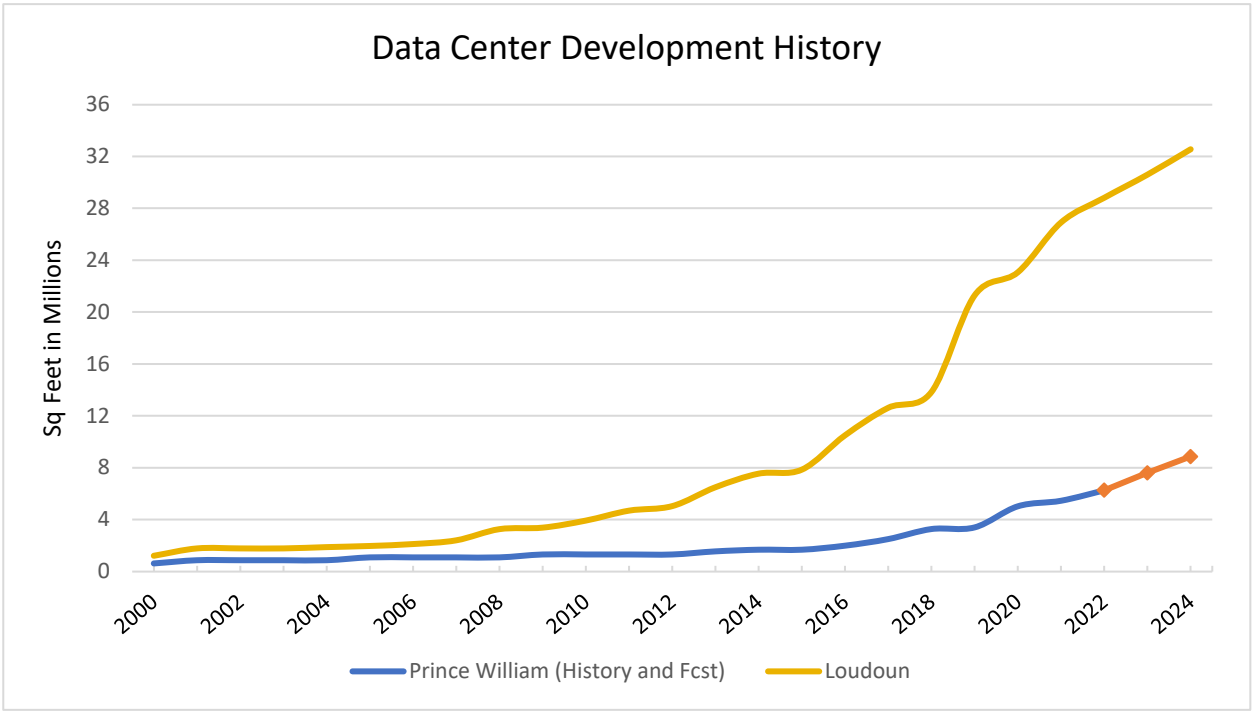
The following are the Prince William County Department leadership, management, and professional staff who were interviewed for the project:

- Christina Winn, Director, Department of Economic Development (Project Co-sponsor)
- Michelle Attreed, Chief Financial Officer(Project Co-sponsor)
- Dave Sinclair, Director, Office of Management and Budget
- Rebecca Horner, Deputy County Executive
- Daniel Alexander, Deputy County Executive
- Tim Leclerc, Deputy Director, Finance Department
- Tom Flynn, Deputy Director, Department of Economic Development
- Jeff Green, Business Development Manager, Department of Economic Development
- Rocio Lamb, Assistant Director of Finance for Tax Administration
- Lillie Jo Krest, Assistant Director of Finance for Treasury Management
- Endora Matei, Principal Fiscal Analyst, Treasury Management
- Robert Fey, Commercial Real Estate Appraiser
- Karem Oner, Assessments Coordinator/Appraisal Manager
- Leslie Stover, Commercial Real Estate Appraiser Supervisor
- Ariel Diaz, Business Tax Auditor, Tax Administration

Appendix C: History of Data Center Building Space Growth in Prince William County



Source: PFM; Prince William County; CoStar



Source: PFM; Prince William County; Loudoun County; CoStar

Appendix D: Explanation of Economic Impact Modeling

Economists use a number of statistics to describe regional economic activity. Four common measures are **Output,** which describes total economic activity and is generally equivalent to a firm or industry's gross sales; **Value Added,** which equals gross output of an industry or a sector less its intermediate inputs; **Labor Income,** which corresponds to wages and benefits; and **Employment,** which refers to jobs that have been created in the local economy.

In an input-output analysis of new economic activity, it is useful to distinguish three types of effects: **direct, indirect, and induced.**

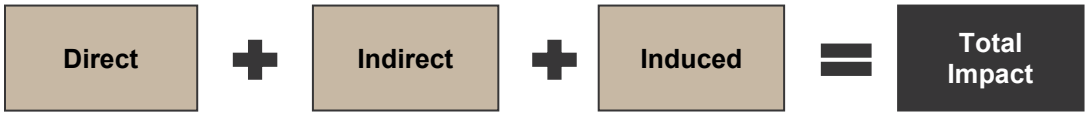
Direct effects are production changes associated with the immediate effects or final demand changes. The payment made by a data center for security services or equipment purchases within Prince William County are examples of direct effects.

Indirect effects are production changes in backward-linked industries caused by the changing input needs of directly affected industries – typically, additional purchases to produce additional output. Satisfying data center demand for security services will require that company to employ staff, purchase and maintain vehicles and other equipment, as will those who sell other equipment or services to the data center. To the extent these downstream purchases affect the economic output of other County merchants, they will be calculated as indirect effects.

Induced effects are the changes in regional household spending patterns caused by changes in household income generated from the direct and indirect effects. Those employed by the data center industry and their suppliers will employ people whose increased income is spent in the local economy.

A multiplier reflects the interaction between different sectors of the economy. An output multiplier of 1.4, for example, means that for every $1,000 injected into the economy, all other sectors produce an additional $400 in output. The larger the multiplier, the greater the impact will be in the regional economy.

The Flow of Economic Impacts



For this project, PFM used IMPLAN. IMPLAN is one of the more commonly used models for this type of analysis and was also used by NVTC in its recent study of the impact of the data center industry on the Commonwealth of Virginia.

Appendix E: Prince William County Data Center Revenue Model Assumptions

- A total of 27.6 million square feet[54] (including 0.6 million added in year 10), with 50 percent attributable to powered shell and 50 percent retail data center
- Powered shell: $160/square foot
- Retail ($/MW): $8.5 million
- kW/square foot: 0.07 (1,000 kW=1 MW)
- C&P/square foot: $6.265
- F&F/square foot: $3.724
- BTP/square foot: $9.989 (TY2021 average)

[54] Square footage is not an optimal method of estimating data center revenue, but it was utilized because power consumption information was not available.

Appendix F: Economic Impacts of Permanent Data Center Operations 2020 and 2021

Economic Impacts of Permanent Data Center Operational Employment: Prince William County, 2020

Impact	Employment	Labor Income	Output
Direct	525	$85,200,000	$533,400,000
Indirect	2,130	$93,000,000	$283,400,000
Induced	375	$14,400,000	$54,500,000
Total	**3,030**	**$195,600,000**	**$871,300,000**

Source: PFM; IMPLAN 2022

Economic Impacts of Permanent Data Center Operational Employment: Prince William County, 2021

Impact	Employment	Labor Income	Output
Direct	570	$92,500,000	$579,200,000
Indirect	2,300	$101,900,000	$310,000,000
Induced	400	$15,800,000	$59,700,000
Total	**3,270**	**$210,200,000**	**$948,900,000**

Source: PFM; IMPLAN 2022

Appendix G: Inclusion of Construction Industry in Impact Calculations

As noted in the report, the economic impacts of the data center construction industry were not considered the best fit for the cost benefit analysis. For comparison purposes, the construction industry impacts were not included in the NVTC's report on data center economic impacts, so this allows a more 'apples to apples' comparison. It is also the case that the construction industry is not siloed, and in the absence of data center construction, it is likely that the industry would engage in other activity within the County. Finally, the industry is relatively mobile, and a significant share of overall activity will be conducted by construction firms located outside of Prince William County. For the sake of completeness, the project team also did a cost benefit analysis that includes the economic impacts of the construction industry.

Economic Impacts of Data Center Construction

Data center construction of 1.0 million square feet per year has been projected to be sustainable in Prince William County over the long-term, build-out horizon. Construction employment is often characterized as temporary, lasting only while the development project is ongoing. In the case of the data center industry in Prince William County, there are multiple known ongoing projects, with planned land development of an estimated 1,600 acres, under direct ownership of data center developers, whether enterprise or colocation facility developers.

In analyzing the industry conditions, it is reasonable to illustrate the economic impacts of data center construction as a permanent industry, with long-term stable expectations to sustain continued construction employment and ongoing annual economic impacts occurring over the long-term.

While the economic impacts of construction are ongoing, growth in the industry does not necessarily continually increase construction employment. Rather, construction employment remains a stable part of the economy as workers transition from one building to the next as new building construction is completed. New roads, new housing and new school stations are not necessarily generated by the ongoing construction employment, in contrast to the infrastructure costs associated with new permanent data center operations. Other fiscal costs associated with data center construction activity, such as support services for the construction industry, are largely private costs or enterprise fund-based, and there is limited new fiscal cost associated with ongoing data center construction employment. For these reasons, construction activity is often illustrated in the economic impacts of the data center industry but not included in the fiscal/budget analysis of data center industry impacts. The NVTC treated data center construction employment activity in this fashion in its most recent report on data centers.

Consensus analysis of earlier U.S. Department of Commerce and 2021 BAE studies indicates construction costs for data centers, excluding computer equipment, is $1,100 per square foot. This includes materials cost for shell construction, plus specialty construction surrounding electrical service, air conditioning, water/water circulation and other aspects of data center construction. Per square foot construction costs have been increasing in recent years as materials and supply chain issues affect price, and the demand for skilled specialty workers impacts wages. Specialty construction wages have increased 10 percent over the period 2017-2021 in Prince William

County.[55] For the purposes of this analysis, construction costs of $1,200 per square foot are used to reflect ongoing supply chain issues and wage rate increases.

It is assumed that 50 percent of construction spending will take place in Prince William County. Under this assumption, the remainder of construction spending will occur outside the County for the purchase of specialty materials, trade specialist labor and other equipment. Recent construction reports have described how new data centers can be built as modular components with segments of buildings manufactured off site, then shipped and assembled on site. This results in less local spending of construction dollars. Given these conditions, of the expected $1.2 billion in construction, the annual direct construction dollar spending in Prince William County is estimated to be $600 million per year for construction, development, and delivery of new data center inventory space countywide.

The IMPLAN model was used to estimate the economic impacts of the $600 million in annual construction spending of the data center industry. The following table illustrates the direct, indirect, and induced effects of the annual construction activity.

Table 14: Direct, Indirect, and Induced effects of Annual Data Center Construction Activity, Prince William County, 2022
(Dollar Values in Thousands of Dollars)

Impact	Employment	Labor Income	Output
Direct	3,200	$240,800	$623,100
Indirect	600	$37,200	$120,400
Induced	850	$33,700	$127,400
Total	**4,650**	**$311,700**	**$870,900**

Source: PFM; IMPLAN 2022

With construction employment of 3,200 persons, the industry supports an additional 1,450 indirect and induced jobs. Thus, in total, the data center construction industry supports 4,650 jobs within the Prince William County economy. Total construction and related labor income are estimated at $311.7 million, paid annually. Total economic impacts of the data center construction industry are estimated to be $870.9 million annually in Prince William County. Notably, because of the expansive data center development pipeline and industry demand, economic impacts of construction activity and the related employment and wages should be viewed (at least in the foreseeable future) as permanent, ongoing activity in Prince William County.

Proposals to add significant volumes of developable lands to the inventory of data center development capacity are currently being contemplated at the County level. These proposals include addition of the Digital Gateway, expansion of lands in the Data Center Overlay and other considerations, such as density increases and other land use flexibility. If some, or all, of these initiatives are successful, economic impacts of data center construction could double on an average annual basis.

[55] Source: “Quarterly Census of Employment and Wages, Prince William County,” Bureau of Labor Statistics.

Appendix H: Alternate Fiscal Impact Approach, Value-Added Ratio

Value-Added Ratio Methodology
In this methodology, County expenditures are classified as related to either people or the data center industry. This methodology was used by the University of Nebraska Lincoln's Bureau of Business Research in 2019 to quantify the fiscal impact of data centers in Sarpy County, Nebraska.[56]

To apply this methodology, PFM allocated County expenditures by whether they could be applied to data center operations, or the additional employees directly associated with the data center. Expenditures were considered in the aggregate on the department level. Departments were selected based on their identification in stakeholder interviews, including the Police, Fire and Rescue, Public Works, Economic Development, and Planning and Zoning Departments.

Identified County expenditures were totaled and multiplied by the ratio of data center employees to total residents to determine total County expenditures related to data center operations. The total operations expenditures were divided by the total value-added sourced from IMPLAN to create a ratio of the increased cost of each dollar of data center business. This ratio was multiplied by the total data center direct impact from IMPLAN to provide total additional expenditures for data center operations.

The same methodology was applied to expenditures related to additional people employed in data centers. The County expenditures related to individuals is calculated by subtracting data center operation expenditures from total County expenditures. The project team used this new total to calculate a cost per capita by dividing total people-related expenditures by the total County population. This ratio was then multiplied by the number of data center employees to generate total expenditures for the individual working in the data centers.

Including data center construction costs, the County's total economic return using this methodology ranges between $1.6 billion in 2020 and $1.9 billion in 2022. These impacts are at the upper range of all economic and fiscal impacts PFM calculates in this report, as this methodology includes total economic impacts and all related construction costs.

Table 15: Data Center Cost-Benefit Analysis, Value-Added Ratio Technique (Inclusive of Construction Activity)

	2020 (Actual)	2021 (Unaudited)	2022 (Adopted Forecast)
Businesses			
County Expenditures	$2,585,374	$2,392,952	$2,469,504
Value-Added	$294,500,000	$321,000,000	$353,400,000
County Expenditures per Economic Value-Added	$0.009	$0.008	$0.007
Impact	$1,028,607,583	$1,118,942,107	$1,241,861,760
Expenditures	**$9,030,001**	**$8,341,354**	**$8,677,937**

[56] "Economic and Fiscal Impacts of Sarpy County Data Centers," Bureau of Business Research, Department of Economics, University of Nebraska-Lincoln, April 8, 2019, accessed electronically at https://www.omahachamber.org/wp-content/uploads/2019/10/Sarpy-DC-Impact-Final-Report.pdf

	2020 (Actual)	2021 (Unaudited)	2022 (Adopted Forecast)
People			
County Expenditures	$3,184,601,584	$3,392,266,027	$3,423,575,737
County Population	473,901	482,204	488,204
Cost Per Capita	$2,735	$2,782	$2,900
Industry Employees	3,725	3,770	3,850
Expenditures	**$10,187,352**	**$10,489,589**	**$11,164,388**
Total Economic Impacts	$1,575,428,250	$1,715,020,339	$1,906,091,780
Total Expenditures	$19,217,353	$10,489,589	$11,164,388
Total Economic Return	**$1,556,210,897**	**$1,696,189,397**	**$1,886,249,456**

As shown in the following table, without including construction costs, this methodology found that the County's total economic return due to data center activity is $866 million in 2020, $943 million in 2021, and $1.1 billion in 2022 (significantly lower than the results when including construction activity).

Table 16: Data Center Cost-Benefit Analysis, Value-Added Ratio Technique (Excluding Construction Activity)

	2020 (Actual)	2021 (Unaudited)	2022 (Adopted Forecast)
Businesses			
County Expenditures	$424,163	$426,345	$501,618
Value-Added	$161,781,934	$175,683,495	$196,435,101
County Expenditures per Economic Value-Added	$0.003	$0.003	$0.003
Impact	$533,407,583	$579,242,107	$647,661,760
Expenditures	**$1,398,498**	**$1,405,361**	**$1,653,874**
People			
County Expenditures	$1,298,213,943	$1,343,643,528	$1,417,681,881
County Population	473,901	482,204	488,204
Cost Per Capita	$2,739	$2,786	$2,904
Data Center Employment	525	570	650
Expenditures	**$3,518,255**	**$4,158,668**	**$4,756,142**
	2020	**2021**	**2022**
Total Economic Impacts	$871,328,250	$948,920,339	$1,064,091,780
Total Expenditures	$2,836,694	$2,993,645	$3,541,390

	2020 (Actual)	2021 (Unaudited)	2022 (Adopted Forecast)
Total Economic Return	**$868,491,556**	**$945,926,694**	**$1,060,550,390**

Source: Prince William County Department of Finance, IMPLAN, Prince William County FY 2022 Adopted Budget, PFM Calculations

Compared to the per capita cost multiplier approach, this is not the project team's preferred methodology. Defining expenditures between businesses and people is not necessarily an exact science and can be open to interpretation. The PFM team defined business-related expenditures as everything related to data center operations. People-related expenditures used to calculate the cost per employee were based on total county expenditures minus the business-related expenditures. This is a broad categorization of data center expenditures.

Appendix I: Alternative Costing Methodologies, Per Capita Multiplier Technique

As noted in the report, this was not the project team's preferred method. It is included here for the sake of completeness.

First, PFM calculated net revenues using the total economic impacts of the data center industry. This did not match the inputs NVTC used; however, this methodology still provides insight on how much the data center industry can impact the County, when considering indirect and induced economic output.

Second, PFM calculated net revenues using all fiscal impacts of the data center industry and related construction activity. This includes the direct, indirect, and induced fiscal impacts.

Third, PFM used the same methodology, but only included the direct fiscal impacts of the data center industry and related construction activity. This mimics the technique NVTC used. NVTC compared per capita costs to direct fiscal impacts only. For the purposes of this study, PFM defines direct fiscal impacts as the sales and property taxes generated by the industry to the County. Property taxes include personal property taxes and taxes on production and imports related to the construction industry. Data center direct fiscal impacts include real property taxes, business personal property taxes, and sales taxes.

Construction and data center-related expenditures will remain constant in each methodology. For the sake of brevity and clarity, PFM shows expenditures for the first scenario only but will show net revenue calculations for all three. PFM considers expenditures in the aggregate, at the department level. County departments were selected based on the project team's experience with County operations and expenditures as well as their identification in interviews with subject matter experts. The selected departments for expenditures supporting the data center industry are Economic Development, Fire and Rescue, Planning and Zoning, Police, and Public Works.

Table 17: Data Center Cost-Benefit Analysis of Total Economic Impacts, Per Capita Multiplier Technique (Inclusive of Construction Costs)

	2020 (Actual)	2021 (Unaudited)	2022 (Adopted Forecast)
Education-Related Expenditures			
Data Center Employment	3,725	3,770	3,850
Students per County Employee	0.73	0.63	0.62
Local Education Expenditures per Student	$6,626	$7,125	$7,433
Total Education-Related Expenditures	**$18,109,144**	**$16,875,259**	**$17,770,588**
Non-Education Expenditures			
County Residents per All Employees	3.78	3.45	3.44

	2020 (Actual)	2021 (Unaudited)	2022 (Adopted Forecast)
Non-Education Costs per Resident	$1,455	$1,491	$1,562
Total Non-Education Expenditures	**$20,511,794**	**$19,395,306**	**$20,658,791**
Total Data Center Costs			
Data Center Economic Impacts (With Construction)	$1,575,428,250	$1,715,020,339	$1,906,091,780
Data Center Expenditures	$38,620,938	$36,270,565	$38,429,379
Total Economic Return	**$1,536,807,312**	**$1,678,749,774**	**$1,867,662,402**
County Return on Investment per $1.00 in County Budget Expenditures	**$40.79**	**$47.28**	**$49.60**

Under the per capita multiplier approach, the County costs associated with the data center industry are estimated to be over $5.4 million in 2020, with $2.6 million attributable to education costs and the remaining $2.9 million attributable to non-education costs, as summarized in the following table:

Table 18: Data Center Cost-Benefit Analysis of Total Economic Impacts, Per Capita Multiplier Technique (Excluding Construction Costs)

	2020 (Actual)	2021 (Unaudited)	2022 (Adopted Forecast)
Education-Related Expenditures			
Data Center Employment	525	570	650
Students per County Employee	0.73	0.63	0.62
Local Education Expenditures per Student	$6,626	$7,125	$7,433
Total Education-Related Expenditures	**$2,552,295**	**$2,551,432**	**$3,000,229**
Non-Education Expenditures			
County Residents per All Employees	3.78	3.45	3.44
Non-Education Costs per Resident	$1,455	$1,491	$1,562
Total Non-Education Expenditures	**$2,890,924**	**$2,932,447**	**$3,487,848**
Total Data Center Costs	**$5,443,219**	**$2,932,447**	**$3,487,848**
Data Center Economic Impacts (Without Construction)	$871,328,250	$948,920,339	$1,064,091,780
Data Center Expenditures	$5,443,219	$5,483,879	$6,488,077
Total Economic Return	**$865,885,030**	**$943,436,461**	**$1,057,603,704**
County Return on Investment per $1.00 in County Budget Expenditures	**$160.08**	**$173.04**	**$164.01**

Source: NVTC and PFM analysis

As previously noted, economic impacts may translate to positive outcomes for the County. However, for comparison purposes in a cost benefit analysis it is more logical to compare revenue to the County to the costs associated with data centers. There isn't necessarily a causal connection between economic impact to the County and County expenditures to support the industry.

Excluding total economic impacts and including only total fiscal impacts instead shows the County's return on investment for the data center industry, including construction, to be much lower, ranging between $1.82 and $2.81 in revenue for every $1.00 in expenditures.

Table 19: Data Center Cost-Benefit Analysis of Total Fiscal Impacts, Per Capita Multiplier Technique (Including Construction Costs)

With Construction	2020	2021	2022
All Data Center Types			
Data Center Revenues (With Construction)	$70,221,227	$82,044,646	$108,121,524
Data Center Expenditures	$38,620,938	$36,270,565	$38,429,379
Net Fiscal Impact	**$31,600,289**	**$45,774,081**	**$69,692,145**
Net Fiscal Impact per $1 in County Budget Expenditures	**$1.82**	**$2.26**	**$2.81**

Excluding construction costs provides a higher return on investment, ranging between $10.88 and $14.66 per $1.00 in expenditures between 2020 and 2022.

Table 20: Data Center Cost-Benefit Analysis of Total Fiscal Impacts, Per Capita Multiplier Technique (Excluding Construction Costs)

Without Construction	2020	2021	2022
All Data Center Types			
Data Center Revenues (Without Construction)	$59,225,196	$71,680,906	$95,106,833
Data Center Expenditures	$5,443,219	$5,483,879	$6,488,077
Net Fiscal Impact	**$53,781,977**	**$66,197,027**	**$88,618,756**
Net Fiscal Impact per $1 in County Budget Expenditures	**$10.88**	**$13.07**	**$14.66**

The most accurate scenario for determining the net fiscal impact of data center construction includes only the direct fiscal impacts of data centers. The following table demonstrates the net fiscal impact of this methodology when factoring in construction costs.

Table 21: Data Center Cost-Benefit Analysis of Direct Fiscal Impacts, Per Capita Multiplier Technique (Including Construction Costs)

With Construction	2020	2021	2022
Education-Related Expenditures			
Data Center Employment	3,725	3,770	3,850
Students per County Employee	0.73	0.63	0.62
Local Education Expenditures per Student	$6,626	$7,125	$7,433
Total Education-Related Expenditures	**$18,109,144**	**$16,875,259**	**$17,770,588**
Non-Education Expenditures			
County Residents per All Employees	3.78	3.45	3.44
Non-Education Costs per Resident	$1,455	$1,491	$1,562
Total Non-Education Expenditures	**$20,511,794**	**$19,395,306**	**$20,658,791**
All Data Center Types			
Data Center Revenues (With Construction)	$55,670,047	$67,623,154	$90,578,382
Data Center Expenditures	$38,620,938	$36,270,565	$38,429,379
Net Fiscal Impact	**$31,600,289**	**$45,774,081**	**$69,692,145**
Net Fiscal Impact per $1 in County Budget Expenditures	**$1.82**	**$2.26**	**$2.81**

From the project team's perspective, these methodologies do not provide the most accurate version of the County's net revenues related to data centers and associated construction activity, because indirect and induced fiscal impacts cannot be accounted for in expenditure calculations. As a result, the final methodology, which includes only direct fiscal impacts, probably more accurately describes the County's overall net revenues using the per capita multiplier methodology.

When including construction impacts, the County's net revenue is the lowest among all six scenarios, ranging from $1.82 per $1.00 in expenditures in 2020 to $2.81 in 2022. It should be noted that 2020, which was significantly impacted by the COVID-19 Pandemic, is often considered an outlier in calculations of economic activity.

Appendix J: Marginal Cost Approach, Comparable Local Government Technique

While the methods already discussed have been most relied upon for this type of cost benefit analysis, there is a marginal cost approach that relies on comparisons of costs to other local governments. The comparable city technique represents a proportional relationship of average expenditures of local governments of various sizes and growth rates, with multipliers based on growth rates and community size. The method estimates increases or decreases in future gross expenditures for basic municipal services.

A March 2018 report commissioned by Eagle Mountain City, Utah assessed the impact of constructing and operating a potential data center, focusing on the effect it would have on the operations of the City and its residents.[57] The impact on local government spending was considered both overall and through more detailed consideration of specific functions. A review of case studies regarding the experiences of other jurisdictions was the focus of the analysis, which examined the following expenditure categories:

- General government operations overall (total general government expenditures, excluding debt service and capital projects, per capita and adjusted for inflation[58]
- General government administrative expenditures per capita, adjusted for inflation[59]
- Public safety operating costs per capita, adjusted for inflation[60]
- Utility Spending

For example, if a government spent $450 per capita in 2007 (the first year of the new data center) for public safety after adjusting for inflation, then constant dollar spending per capita for all years would be divided by $450. The result is expressed as a percentage. A value of 105 percent in 2010 indicates that per capita spending in 2010 was 5 percent higher than in 2007.

The findings from the study led to a recommendation that the City anticipate increases of 2.0-2.5 percent of expenditure levels for general government and public safety; there was no indication that the local school district or fire operations would be affected by the addition of a data center.

A key strength of this approach is that it can be undertaken relatively quickly, given the availability of required data. However, there are shortcomings and limitations associated with using this technique to determine data center fiscal impacts – particularly within Prince William County and other prominent data center locales. For example:

- Prince William County is already well established as a leading community for data center development. The comparable city technique is most applicable when a government has no precedent for the type or scale of development to predict costs.

[57] Eagle Mountain City, “Fiscal Impact of an Eagle Mountain Data Center,” (March 2018). Accessed electronically at https://i84005.com/wp-content/uploads/2018/05/i84005-iNSIDER-Eagle-Mountain-data-center-report-14Mar2018.pdf

[58] General government expenditures do not include business-type activities, such as water and wastewater.

[59] Also included in total general government expenditures

[60] Also included in total general government expenditures

- The technique is intended for communities where population gains or increases in growth rates are likely because of large-scale development or school/municipal redistricting. Given the low employment levels associated with the data center industry, this method is not ideal.

- The validity of expenditure multipliers is questionable because this technique assumes local and capital expenditures related to growth are similar for cities of comparable size and growth rate. These average expenditures may not, however, exactly match those of the community under study.

From the project team's perspective, the limitations of this approach outweigh its advantages, and the project team did not use it for the cost benefit analysis.

Appendix K: Glossary of Terms

Financial and Government

- ACS: American Community Survey, U.S. Census Bureau
- BEA: Bureau of Economic Analysis, U.S. Department of Commerce
- BLS: Bureau of Labor Statistics, U.S. Department of Labor
- BTPPT: Business Tangible Personal Property Tax
- By-right Zoning: Allows projects that comply with zoning standards to not have to go through a discretionary review process
- CAGR: Compound Annual Growth Rate, which is the mean annual growth rate over a specified period of time that is longer than one year.
- DED: Prince William County Department of Economic Development
- Digital Gateway: the area within the County to be added to lands which may accommodate future data centers, however not by right as granted in the data center overlay
- FAR: Floor area ratio, which is the square footage of the structure divided by the square feet of the parcel land area
- FY: Fiscal Year
- GDP: Gross Domestic Product
- IMPLAN: A proprietary input-output model that can be used to determine the economic impact of activities within a county, region, or state. Input-output models are based on statistical information about the flow of goods and services among various industries.
- JLARC: Virginia Joint Legislative Audit Review Commission
- MSA: Metropolitan Statistical Area
- Overlay, the: Prince William County's data center enterprise zone
- PFM: PFM Group Consulting LLC and/or PFM Financial Advisors LLC
- Revenue 1: The Prince William County application that contains the majority of historic tax administration data
- ROI: Return on Investment, a measure of the money that an entity earns as a percentage of the total value of its assets that are invested
- SWOT: Strengths, Weaknesses, Opportunities, and Threats

- TY: Tax Year

Data Centers

- Build to Suit: A term describing a particular property, developed specifically for a certain tenant to occupy, with structural features, systems, or improvement work designed specifically for the needs of that tenant. A build-to-suit can be leased or owned by the tenant. In a leased build-to-suit, a tenant will usually have a long-term lease on the space.
- Cabinet: Device for holding IT equipment, also called a rack.
- Capex: Capital Expense, the cost of purchasing capital equipment.
- Cloud Computing: A general term for anything that involves delivering hosted services over the Internet.
- Colocation Data Center: One data center owner selling space, power, and cooling to multiple enterprise and hyperscale customers in a specific location. Colocation data centers offer interconnection to Software as a Service (SaaS) such as Salesforce, or Platform as a service (PaaS) like Azure. This enables businesses to scale and grow their business with minimum complexity at a low cost. Customers can rent from a fraction of a Cabinet to 100 Cabinets and can house hundreds of individual customers.
- Converged Infrastructure: A modular data center that relies on a specific vendor and the vendor's partners to provide pre-configured bundles of hardware and software.
- Dark Fiber: Unused optical fiber that has been laid but is not currently being used in fiber-optic communications. Fiber optic cable transmits information in the form of light pulses – a 'dark' cable refers to one where light pulses are not being transmitted.
- Data Center: A facility used to house computer systems and associated components, such as telecommunications and storage systems. It generally includes redundant or backup power supplies, redundant data communications connections, environmental controls (e.g., air conditioning, fire suppression) and security devices. Also includes colocation, a subset of data centers.
- Data Center Shell: A building that has been readied for power and telecom access, with or without any other improvements, and amenable to data center development and use. May become a single-tenant property or colocation.
- Dedicated Hosting: The provider operates and/or rents server capacity to single customers. Server space is not shared by multiple customers. Typically, the customer maintains full control over the server, excluding maintenance.
- Deploy: to install, test, and run hardware or software in a live environment.

- Downtime: A period of time, or a percentage of a time span, that a system is unavailable or offline. This is usually a result of the system failing to function because of an unplanned event, or because of routine maintenance.

- Enterprise Data Center: A facility owned and operated by the company it supports; often built on-site but may be off-site. Has anywhere from 10 Cabinets upwards and can be as large as 40+ MW.

- Green Data Center: A data centers that provides greater energy efficiency and sustainability and reduced environmental impact.

- Hosting: The service of running servers on behalf of another party, allowing those organizations to focus on managing their applications, instead of hardware and operating system administration. There are various levels of service and various kinds of hosting offered (for example. dedicated, shared, virtual, etc.).

- Hybrid Cloud: Combining public and private clouds together, allowing for workloads to be processed on public cloud infrastructure, while others are run in private clouds.

- Hyperscale Data Center: A data center owned and operated by the company it supports. They generally have upwards of 500 cabinets and are at least 10,000sq ft. in size. They usually have a minimum of 5,000 servers linked with an ultra-high speed, high fiber count network.

- Infrastructure as a Service (IaaS): Also known as cloud infrastructure services. It provides computer infrastructure as a service, typically via a platform virtualization environment. Rather than purchasing servers, software, data center space or network equipment, clients instead buy those resources as a fully outsourced service.

- Internet of Things (IoT): Describes the network of physical objects (“things”) that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet (ranging from ordinary household objects to sophisticated industrial tools).

- Kilowatt (kW): A measure of power equal to one thousand watts.

- Managed Hosting: A business model where a service provider leases dedicated servers and associated hardware to a single client. The equipment is at the hosting provider's facility and managed there by the service provider.

- Megawatt (MW): A measure of power equal to one million watts. Often used to describe the size of data centers in terms of power capacity.

- Platform as a Service (PaaS): A way to rent hardware, operating systems, storage, and network capacity over the Internet. This allows the customer to rent virtualized servers and associated services for running existing applications or developing and testing new ones.

- Preleased Space: The amount of space in a building that has been leased prior to its construction completion date, or certificate of occupancy date.

- Private Cloud: Computing services provided over the Internet or a private internal network and only to select users instead of the general public. This provides additional control and customization available from dedicated resources over a computing infrastructure hosted on-premises.

- Public Cloud: Cloud infrastructure available to the general public and owned by a large provider of cloud services.

- Rack: Device for holding IT equipment, also called a cabinet.

- Server Cabinets: A cabinet designed to hold a network device that combines hardware and software to provide and manage shared services and resources on the network.

- Server Room: A location specifically designed to house a high concentration of information technology equipment.

- Shared Hosting: A situation where multiple customers share server capacity.

- Software as a Service (SaaS): A software distribution model where a cloud provider hosts applications and makes them available to end users over the Internet. In this model, an independent software vendor may contract with a third-party cloud provider to host the application. Or, with larger companies, such as Microsoft, the cloud provider might also be the software vendor.

- UPS: Uninterruptible Power Supply, a device placed in series with the supply of power from the utility with energy storage so that the supply of power from the UPS is continuous even when the utility supply is removed.

- WPSF: Watts per Square Foot, a unit of power density. In a data center this refers to the total load in a space divided by the total area of that space. This is a design parameter for total capacity of the cooling and power systems.