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ANDERSON ECONOMIC GROUP

The Economic Impact of Fermilab's Flagship Long-Baseline Neutrino Initiative

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I. Executive Summary

PURPOSE OF REPORT

Fermi National Accelerator Laboratory (Fermilab) is a basic science research facility specializing in high-energy particle physics, located in Batavia, Illinois. Fermilab is now pursuing funding and support for a set of projects that would allow it to stay at the forefront of particle physics by performing cutting-edge research on neutrinos.

Fermilab's flagship long-baseline neutrino initiative would use an upgraded particle accelerator complex to create powerful neutrino beams in the Long-Baseline Neutrino Facility (LBNF) on-site at Fermilab and send them, with precision previously unattained, to the Deep Underground Neutrino Experiment's (DUNE) very large detectors deep underground at the Sanford Underground Research Facility (SURF) in South Dakota. This project, and all of the accompanying capital investments and operations it would involve, would result in hundreds of millions of dollars in new economic activity in the Chicago and western South Dakota regions.

The purpose of this report is to produce a credible and conservative estimate of the economic impact of the construction and operations of LBNF/DUNE in the Chicago and west South Dakota regions through the year 2026.

OVERVIEW OF APPROACH

In this report we estimate the local economic impact of the projected construction and operations of LBNF, DUNE, and all of the related capital projects associated with them, including the Proton Improvement Plan II (PIP-II) and the Integrated Engineering Research Center (IER). Throughout this report, when we refer to the economic and fiscal impact of LBNF/DUNE, we are referring to the economic impact of all of these different components, combined.

Economic Impact Defined

Economic impact is the measure of *net new* economic activity that occurs in a defined geographic region as a result of an investment, event, project, industry, or institution. A direct economic impact stems from the initial spending or investment for that given project, while an indirect economic impact stems from the recirculation of dollars within the defined region. In this report, we measure economic impact in terms of (1) total new economic activity or output, (2) earnings for residents within a region, and (3) number of jobs for residents within a region.

Approach to Estimating LBNF/DUNE's Economic Impact

We estimated the impact of LBNF/DUNE in four geographic regions:

- the Chicago metropolitan area, which includes a nine-county region in Illinois;[1]

- the West South Dakota Economic Development region, which includes a thirteen-county region in South Dakota;[2]
- the State of Illinois; and
- the State of South Dakota.

For each geographic region, we were careful to count *only* the portion of expenditures expected to occur in the region that would not occur in the region without LBNF/DUNE. Specifically, we worked with Fermilab to determine whether the vendors for various types of spending would be located in the regions of interest. We also considered the source of funds for these expenditures, and excluded them from our analysis if we anticipated that they were likely to occur in the region even in the absence of LBNF/DUNE.

We estimated the economic impact of the project for each year through 2026. Assumptions for spending by year are based on the CD-1R budget profile discussed with the U.S. Department of Energy in 2015. It is possible that delays in initiation of the project or in the project schedule will result in spending occurring in later years than those estimated here.

See "Appendix A. Data and Methodology" on page A-1 for a complete description of our economic impact analysis methodology.

OVERVIEW OF FINDINGS

LBNF/DUNE would result in large impacts for all the regions we considered. Our research and analysis resulted in the following major findings:

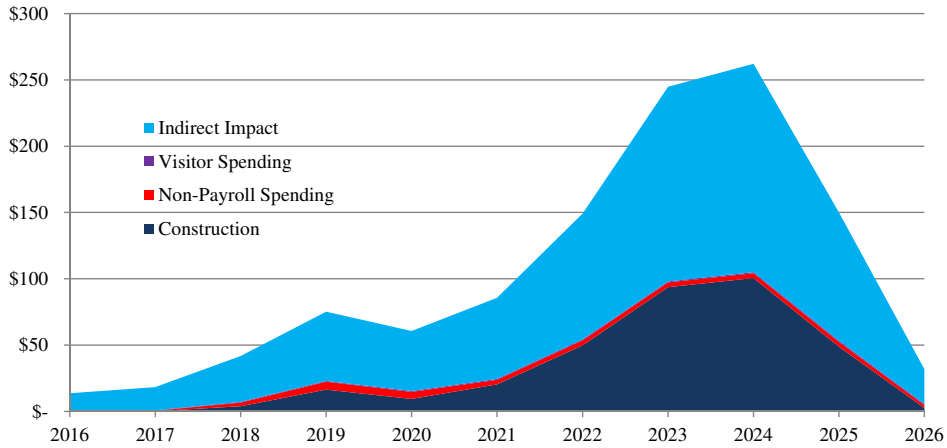
1. *From 2016 to 2026, the economic impact of LBNF/DUNE in the Chicago region will total $1.1 billion in output and $570 million in earnings for local residents. The impact on jobs for local residents will peak at nearly 2,000 in the year 2024.*

To construct the facilities necessary to allow for LBNF/DUNE to go forward, Fermilab would spend several hundred million dollars on construction in the Chicago region alone over the next 10 years. Also, there would be additional payroll at Fermilab totaling nearly $30 million annually in the Chicago area and some nonpayroll expenses to local vendors. We estimate that the total economic impact of this spending would be $1.1 billion from the year 2016 to 2026, combined. In the year 2024, we predict that the impact of LBNF/DUNE on employment would peak at 2,000 jobs for residents in the Chicago region.

1. The Chicago region includes the counties of Cook, DeKalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, and Will.
2. The western South Dakota region includes the counties of Bennett, Butte, Custer, Fall River, Haakon, Harding, Jackson, Lawrence, Meade, Pennington, Perkins, Shannon, and Ziebach.

See Figure 1 below for the total annual impact of LBNF/DUNE on output in the Chicago region in each year from 2016 to 2026. The trajectory of employment and earnings impacts in the region over time are similar. See "Economic Impact in Chicago Region" on page 11 for more details. The economic impact in the state of Illinois, as a whole, is a bit larger and follows the same trajectory, as shown in "Economic Impact in Illinois" on page 17.

FIGURE 1. Total Projected Output due to LBNF/DUNE in the Chicago Region, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory

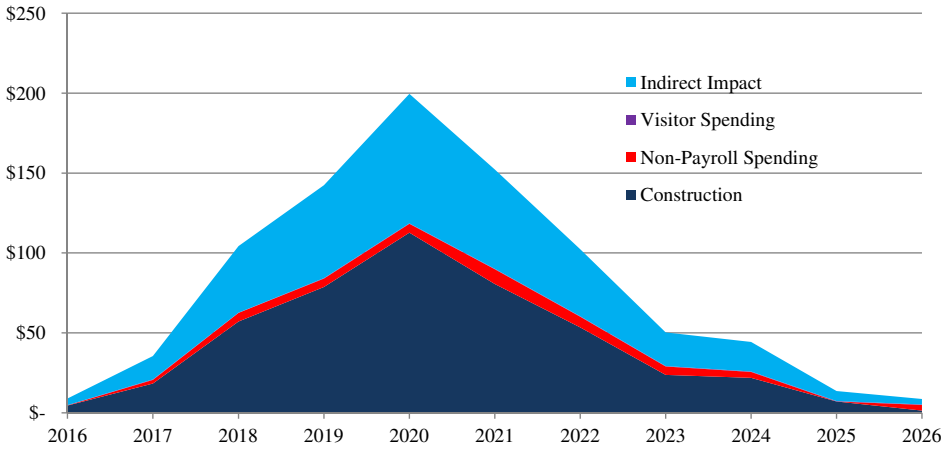
2. *From 2016 to 2026, the economic impact of LBNF/DUNE in the western South Dakota region will total $860 million in output and $330 million in earnings for local residents. The impact on jobs for local residents will peak at nearly 1,800 jobs in 2020.*

In South Dakota, there will be several hundred million dollars in expenditures to construct facilities at SURF that allow for LBNF/DUNE to move forward. These will peak a bit earlier than in the Chicago region, and consist almost exclusively of spending on construction. We estimate that the total economic impact of this spending would be $860 million from the year 2016 to 2026, combined. In the year 2020, we predict that the impact of LBNF/DUNE on employment would peak at 1,800 jobs for residents in the western South Dakota region.

Figure 2 on page 4 summarizes the economic impact of LBNF/DUNE in western South Dakota over time, by source. The trajectory of employment and earnings impacts in the region over time are similar. See "Economic Impact in Western South Dakota Region" on page 14 for more information. The economic impact in the state of South Dakota, as a whole, is a bit larger and follows the same trajectory, as shown in "Total Projected Output due to LBNF/DUNE in

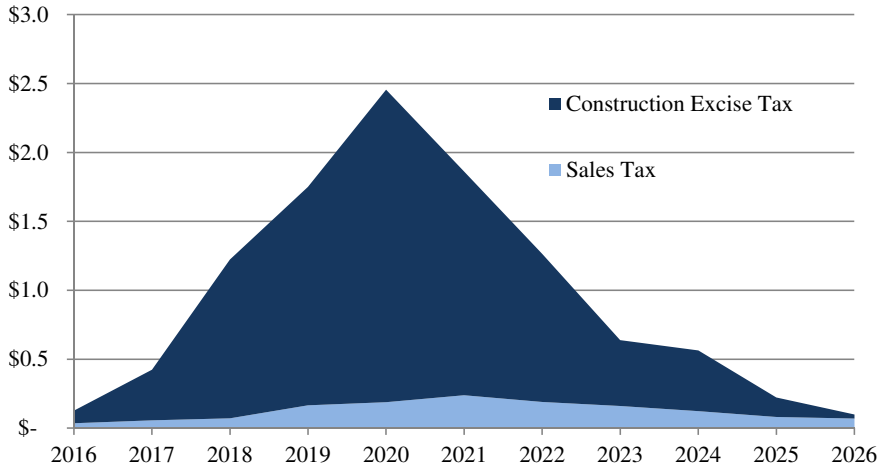
South Dakota, 2016 to 2026 (millions)" on page 18.

FIGURE 2. Total Projected Output due to LBNF/DUNE in the Western South Dakota Region, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory

FIGURE 3. Fiscal Impact of LBNF/DUNE in South Dakota, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory, and data from the BLS Consumer Expenditure Survey and the State of South Dakota

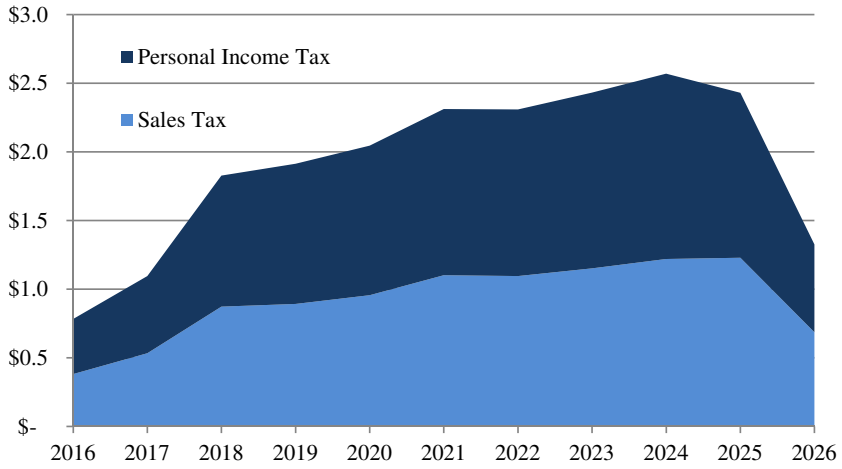
3. The total fiscal impact of LBNF/DUNE for the State of South Dakota would be $10.6 million in tax revenue from 2016 to 2026, peaking at $2.5 million in annual revenue in 2020.

These projects will increase state tax revenues by generating new earnings and economic activity. The State of South Dakota will collect an estimated $10.6 million in total additional tax revenue over the period from 2016 to 2026. Of this revenue, $9.2 million will come from the construction excise tax and $1.3 million will come from the state sales tax. The new revenue will ramp up sharply until reaching $2.5 million in 2020, before sharply ramping down again. Figure 3 on page 4 shows tax revenue the State will collect each year, by source. See "Fiscal Impact" on page 20 for more details.

4. The total fiscal impact of LBNF/DUNE for the State of Illinois would be $21.0 million in tax revenue from 2016 to 2026, peaking at $2.7 million in annual revenue in 2024.

The State of Illinois will see $21.0 million more in revenue as a result of this project. Of this revenue, $10.9 million will come from the personal income tax and $10.1 million will come from the state sales tax. In 2024, annual State of Illinois tax revenue due to LBNF/DUNE will peak at $2.7 million. Unlike South Dakota, Illinois will see a steady rise in new revenue that will then level off. Figure 4 below shows tax revenue the State will collect each year as a result of the project. See "Fiscal Impact" on page 20 for more information.

FIGURE 4. Fiscal Impact of LBNF/DUNE in Illinois, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory, and data from the BLS Consumer Expenditure Survey and the State of Illinois

ABOUT ANDERSON ECONOMIC GROUP

Anderson Economic Group, LLC is a boutique research and consulting firm, with offices in Chicago, Illinois; East Lansing, Michigan; and Istanbul, Turkey. The experts at AEG specialize in economics, public policy, business valuation, and industry analyses. They have conducted nationally-recognized economic

and fiscal impact studies for private, public, and non-profit clients across the United States.

The team at Anderson Economic Group has a deep understanding of advanced economic modeling techniques and extensive experience in a variety of industries in multiple states and countries. Work by AEG has been utilized in legislative hearings, legal proceedings, and public debates, as well as major planning exercises and executive strategy discussions. For more information, please see "Appendix B. About the Authors" on page B-1 or visit www.AndersonEconomicGroup.com.

II. About Fermilab's Long-Baseline Neutrino Initiative

In this section, we first present a short history of Fermilab and its neutrino research to date. We next discuss the different components of LBNF/DUNE, and their role in advancing the frontiers of knowledge in particle physics.

BRIEF HISTORY

Fermilab was founded by an act of Congress in 1967, to pursue primary research in advanced physics. Currently operated under contract with the U.S. Department of Energy (DOE) and the Fermi Research Alliance, LLC—itself a joint partnership between the University of Chicago and the Universities Research Alliance (URA)—Fermilab has become one of the premiere particle accelerator laboratories in the world.[3] From 1983 to 2011, Fermilab was home to the Tevatron, the highest energy particle accelerator in the world until the startup of the Large Hadron Collider (LHC) in Geneva, Switzerland. Fermilab remains a strong partner with the LHC, contributing significant components to that accelerator's construction and leading in the analysis of LHC data.

Neutrinos have been an important subject of study at Fermilab throughout its history. Subatomic particles that have very low mass, neutrinos are extremely non-reactive when passing through other matter, making them difficult to study. The current flagship neutrino experiment at Fermilab, NOvA, measures the oscillations between flavors of neutrinos sent in a beam between the near detector in Batavia and the far detector 500 miles away near the Minnesota-Ontario border. NOvA began operations in 2014 and is expected to complete its primary experiment during the installation of LBNF/DUNE in the 2020s.

SCIENTIFIC BACKGROUND

Physicists use particle accelerators in order to create high-energy collisions between subatomic particles. In the aftermath of these collisions, scientists are able to observe some of the most fundamental particles in the universe and their behavior. Two of the most famous discoveries at Fermilab include the first observation of the "bottom" quark in 1977 and the "top" quark in 1995. In addition, the third known type of neutrino—the tau neutrino—was first observed by scientists at Fermilab in July 2000.

Neutrinos

In particle physics, beta decay occurs when the nucleus of an atom emits an electron (resulting in the conversion of a neutron to a proton in that nucleus). Physicists realized in the early 1930s that the behavior of electrons emitted during beta decay suggested a third, neutral, and possibly massless particle was

3. URA is a consortium of 83 U.S. and 6 international research universities with member institutions in 32 states and 4 foreign countries. The University of Chicago and 4 other institutions in Northeastern Illinois are members of URA.

also emitted. The neutrino was first proposed by Wolfgang Pauli and later incorporated into the theory of beta decay by Enrico Fermi, the namesake of Fermilab. Neutrinos were discovered in the mid-fifties by observations of beta decay performed by Clyde Cowan and Frederick Reines.[4]

Given the ubiquity of beta decay in our universe (and from the sun, in particular), hundreds of billions of neutrinos pass through every square inch of the earth every second. However, it took a long time to observe a neutrino, and it continues to be difficult to observe neutrinos, because they interact very weakly with matter. According to David Griffiths, a neutrino "of moderate energy could easily penetrate a thousand light-years of lead" before interacting with any of the lead atoms.[5] They similarly pass easily through the detectors that scientists use to observe them.

Neutrinos are important for scientific research for several reasons. First, the fact that they weakly interact allows us to see things in outer space that we might not otherwise see. For example, the core of our galaxy and far-off supernovae are obscured by dense gas and energetic objects. The ability of emitted neutrinos to pass through this debris and arrive at an Earth-based detector unscathed provides us with a new ability to observe these objects.

Secondly, there are several characteristics of the neutrino that have yet to be precisely observed or well-explained because neutrinos are at the frontier of particle research. Among these characteristics are the particle's mass and size (scientists now know that neutrinos are not massless), how neutrinos change among different types ("oscillation"), and differences between neutrinos and antineutrinos (chirality).

DEEP UNDERGROUND NEUTRINO EXPERIMENT

The Deep Underground Neutrino Experiment (DUNE) will answer fundamental questions about the nature of neutrinos, including many of the characteristics described above. It will include observations of neutrinos that are produced at energies and intensities previously unattained. To carry out this experiment, scientists will produce a beam of neutrinos at Fermilab, which then will traverse 800 miles through the Earth to detectors in the Sanford Underground Research Facility (SURF) in South Dakota. Once construction is complete, measurements of incident neutrinos at the detector will be taken around the clock, and the experiment is expected to operate for 20 years or more.

4. Much of the scientific background on the neutrino in this section is from: David Griffiths, *Introduction to Elementary Particles* (Weinheim: WILEY-VCH, 2004).
5. Ibid., 26.

LONG BASELINE NEUTRINO FACILITY

The Long Baseline Neutrino Facility (LBNF) would house the infrastructure necessary to carry out DUNE. It consists of additions to Fermilab's existing particle accelerators, a specialized LBNF service building, and a near detector, all situated at Fermilab in Batavia, Illinois. In addition, it will involve the construction of a far detector apparatus at SURF—deep in a retired gold mine near Lead, South Dakota. Support infrastructure for the experiment at SURF will include cryogenic facilities to maintain the detector.

PROTON IMPROVEMENT PLAN II

The Proton Improvement Plan (PIP-II) represents a significant upgrade in portions of Fermilab's accelerator equipment. Replacing earlier systems that are now decades old, PIP-II would consist of an 800-MeV superconducting linear accelerator that would increase the energy output of proton beams generated at Fermilab.[6] Critical for the success of LBNF/DUNE, PIP-II will allow for a nearly twofold increase in the energy of the neutrino beam generated at Fermilab, from 700 kW to 1200 kW.

NEXT STEPS

The facilities for LBNF/DUNE also allow for other scientific studies to take place, including observations of neutrinos generated by distant supernovae and proton decay. These observations could help us to better understand the process by which neutron stars and black holes form, among other phenomena. Experiments carried out at LBNF/DUNE will contribute to the growing body of research in particle physics and shed light on some of the unanswered questions regarding the origin and ultimate fate of our universe. While the possible practical uses of neutrinos are extremely speculative and far off, these discoveries may someday contribute to the use of subatomic particles in communication and observation.

6. MeV stands for mega-electron volts, a unit of energy used to describe the energy of subatomic particles.

III. Economic Impact

In this section, we discuss the projected economic impact of LBNF/DUNE for Illinois and South Dakota residents, both statewide and within the regions where construction will take place. We also discuss the benefits that stem from those who visit the different sites of the experiment for conferences, research, and other activities.

ECONOMIC IMPACT DEFINED

We define the net economic impact of LBNF/DUNE as the additional activity within a defined geographic area due to all construction, operations, and other activities that would not happen in the absence of LBNF/DUNE. In estimating the net impact, we follow a careful methodology that considers only the spending or employment that would be *net new* to the regions due to LBNF/DUNE. Economic activity that is net new is activity that would not have happened in the absence of the project—in other words, activity that does not displace other local spending or employment. We estimate the economic impact of the project in terms of output (spending), employment, and earnings.

LBNF/DUNE would have direct impacts, such as new jobs at Fermilab and SURF and additional expenditures for construction and professional services vendors in the area. As those that benefit from this new spending increase their own expenditures, more funds will circulate throughout the region, resulting in additional indirect impacts. LBNF/DUNE would involve a unique set of expenditures and pay for them with revenues from sources outside of the state, resulting in a significant economic impact. See "Economic Impact Analysis" on page A-1 for a complete description of our methodology.

Impact Areas. In this analysis we specifically assess LBNF/DUNE's economic impact on four regions:

- the Chicago metropolitan area in Illinois, including the counties of Cook, DeKalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, and Will;
- the western South Dakota region, including the counties of Bennett, Butte, Custer, Fall River, Haakon, Harding, Jackson, Lawrence, Meade, Pennington, Perkins, Shannon, and Ziebach counties, covering roughly the westernmost third of the state.
- the state of Illinois as a whole; and
- the state of South Dakota as a whole.

SOURCES OF ECONOMIC IMPACT

To understand the economic impact that LBNF/DUNE and accompanying facilities would have on the states of Illinois and South Dakota requires first understanding the various sources of economic activity caused by the project. Fermilab provided data on each of these areas of expenditure for fiscal years 2016 through 2026.[7]

Visitors

As a major experiment investigating the frontiers of physics, LBNF/DUNE and its associated facilities will attract visiting members of the scientific community to both collaborate on the experiments and to participate in conferences and symposia. These visitors will spend on food, accommodation and entertainment while in the study regions.

Construction

The components of LBNF/DUNE require a series of massive, complex, and extremely precise scientific instruments, the creation and installation of which will take years of effort. During the construction phase, millions of dollars that would not otherwise have been spent in the target regions will go primarily to local contractors, many of whom will hire local workers and may source raw materials from nearby.

Payroll

The payroll numbers represent all of the compensation for employees of Fermilab and SURF that would not have had jobs within the regions without these projects. Compensation includes direct wages and the monetary value of benefits (primarily health insurance) received by those employees in the study period. We exclude any funding for retirement plans, as those funds will be effectively sequestered until withdrawn by current workers many years hence, and therefore will have little effect on the local economy now.

Professional Services

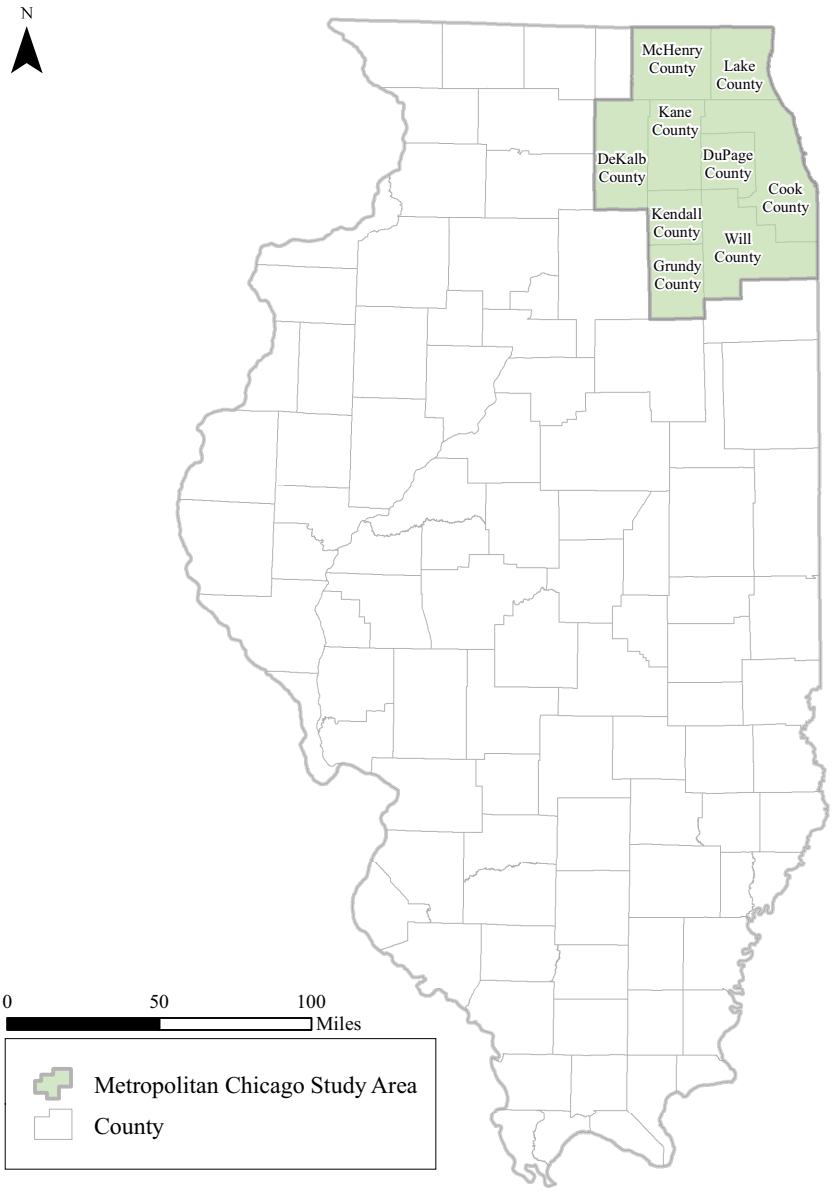
Over the course of construction and initiation of the experiment, Fermilab and SURF will hire professional services firms in the area. Some examples of professional services necessary to carry out this project include legal services, architecture and engineering services, computer systems design, and scientific research and development.

ECONOMIC IMPACT IN CHICAGO REGION

We define the Chicago region in this report as the Illinois counties of Cook, DeKalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, and Will. This is the portion of the Chicago metropolitan area that is in Illinois. See Figure 5 on page 12.[8]

7. The fiscal year for Fermilab ends in September 30 of each year. When we refer to the years in which a certain amount of spending or economic impact occurs in this report, we are generally referring to the corresponding fiscal year that ends in that calendar year.
8. The Chicago metropolitan area is defined by the U.S. Census Bureau.

FIGURE 5. Chicago Region



Source: ESRI, Inc.

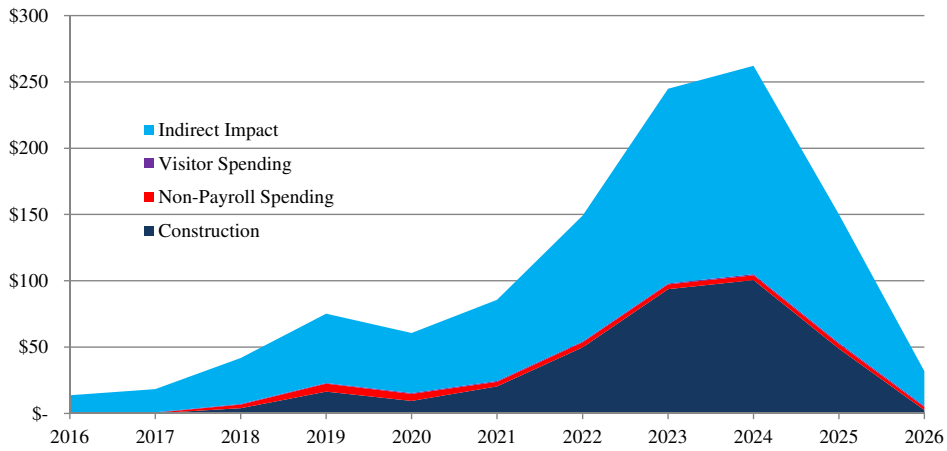
Within the region, direct spending for LBNF/DUNE by Fermilab and visitors would total $10 million in fiscal year 2016. This total is expected to grow to a peak of $132 million in 2024 before declining to $21 million in 2026.

These total expenditures are composed of four categories: spending directly on construction, spending on the compensation of Fermilab employees, spending by visitors brought in to collaborate on the project, and other nonpayroll spend-

ing, which predominantly consists of spending for professional services and some utilities as the experiment becomes fully operational.

Total output encompasses the cumulative impact of the projects spending in the Chicago regional economy in each fiscal year. As shown in Figure 2, the total annual output due to LBNF/DUNE climbs from a 2016 value of $14 million in economic activity to a peak of $262 million in 2024 before declining to $32 million in 2026. The total impact on output in the Chicago region would be $1.1 billion from 2016 to 2026.

FIGURE 6. Total Projected Output due to LBNF/DUNE in the Chicago Region, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory

Direct employment—people directly employed by Fermilab to work on this project—during the construction phase in the Chicago region is expected to rise and fall in a similar pattern as total output. It starts at 98 jobs in 2016 and rises to a peak of 210 in 2022 before declining to 100 by the end of the construction phase in 2026. Spending by Fermilab will also result in indirect employment as companies providing goods and services for LBNF/DUNE spend their money hiring employees and paying vendors in the local economy. Total employment, taking into account these indirect jobs, follows a similar trajectory as direct employment, reaching its apex slightly later in 2024 at 1,984 jobs.

Total earnings (taking into account both direct and indirect impacts) rise and fall roughly with employment. They start in 2016 at $13 million before rising to a peak of $109 million in 2024. By 2026, total annual net earnings due to LBNF/DUNE in the Chicago region will be $1 million. Over the entire time period from 2016 to 2026, we expect that earnings for Chicago residents due to the LBNF/DUNE project would total $570 million. For more details, see Table A-2

on page A-6.

TABLE 1. LBNF/DUNE Economic Impact in the Chicago Region, 2016 to 2026 (all dollar amounts in millions)

Year	Total Direct Expenditures in Chicago Region	Total Output in Chicago Region	Total Earnings in Chicago Region	Total Employment in Chicago Region
2016	$9.6	$13.7	$12.8	210
2017	$13.0	$18.3	$17.6	268
2018	$26.3	$41.7	$32.0	479
2019	$41.5	$75.1	$42.2	703
2020	$35.3	$60.6	$38.9	637
2021	$48.5	$85.7	$50.6	808
2022	$78.0	$149.2	$70.3	1,260
2023	$122.8	$244.8	$101.4	1,866
2024	$131.5	$262.1	$108.5	1,984
2025	$79.2	$150.0	$72.8	1,220
2026	$21.0	$31.9	$24.5	339
Total	**$606.5**	**$1,133.2**	**$571.7**	

Source: Fermi National Accelerator Laboratory, Finance Department
Analysis: Anderson Economic Group, LLC

ECONOMIC IMPACT IN WESTERN SOUTH DAKOTA REGION

We defined the western South Dakota region as the counties of Bennett, Butte, Custer, Fall River, Haakon, Harding, Jackson, Lawrence, Meade, Pennington, Perkins, Shannon, and Ziebach in South Dakota. This is how the South Dakota Office of Economic Development defines the West South Dakota region.[9] See Figure 7 on page 15.

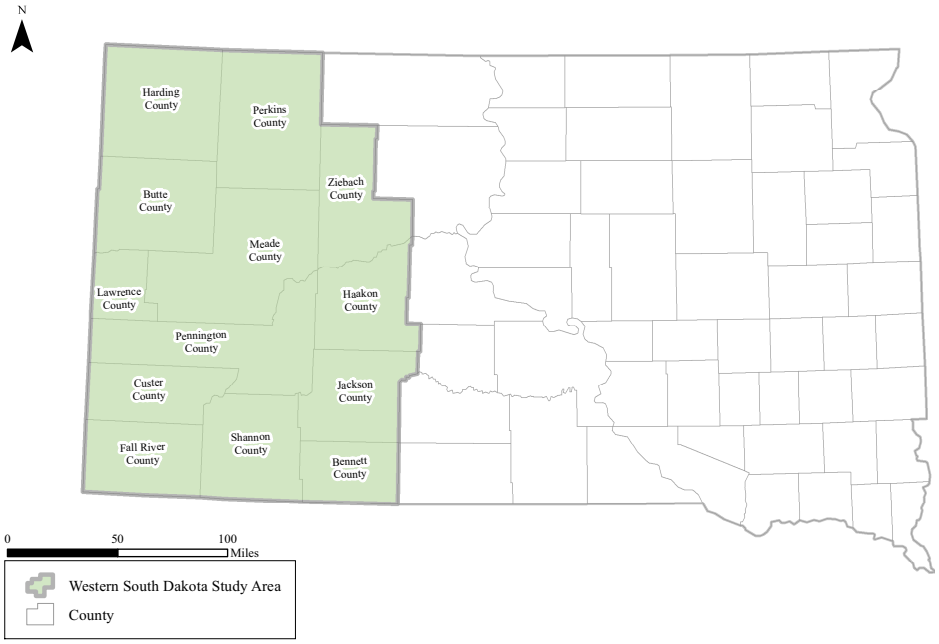
Within the region, direct spending for LBNF/DUNE by Fermilab and visitors at SURF would total $6 million in fiscal year 2016. This total is expected to grow to a peak of $123 million in 2020 before declining to $6 million in 2026.

These total expenditures are composed of four primary categories: spending directly on construction, spending on the compensation of Fermilab and SURF employees, spending by visitors brought in to collaborate on the project, and other non-payroll spending, which predominantly consists of spending for pro-

9. Business Development Map, Governor's Office of Economic Development, South Dakota, http://sdreadytowork.com/SouthDakota/media/SouthDakota/docs/NewPDFsFolder/Rep-Map.pdf.

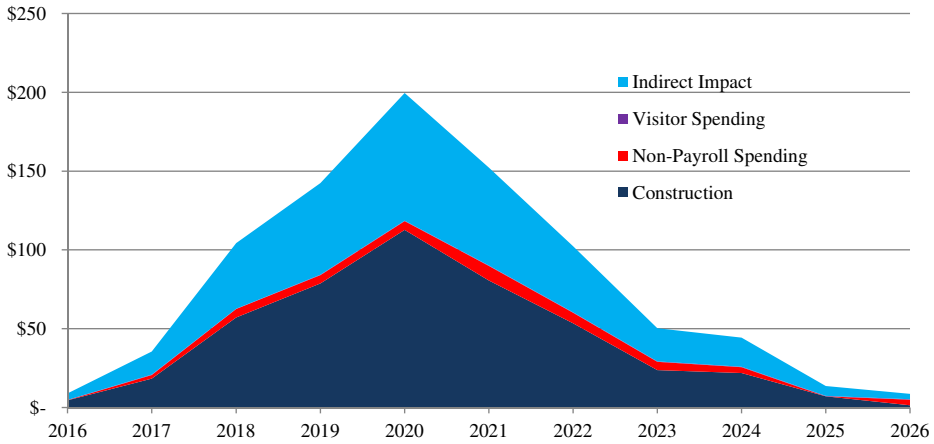
fessional services and some utilities as the experiment becomes fully operational.

FIGURE 7. Western South Dakota Region



Source: ESRI, Inc.

FIGURE 8. Total Projected Output due to LBNF/DUNE in the Western South Dakota Region, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory

As shown in Figure 2 above, the total annual output due to LBNF/DUNE climbs from a 2016 value of $9 million in economic activity to a peak of $200 million

in 2020 before declining to $9 million in 2026. We estimate that the total impact on output in the western South Dakota region would be $862 million from 2016 to 2026.

Direct employment—people employed by Fermilab and SURF specifically to work on LBNF/DUNE and related projects at SURF—during the construction phase in the western South Dakota region is expected to rise and fall in a similar pattern as total output. It starts at four jobs in 2016 and rises to a peak of 29 in 2021 before declining to 10 by the end of the construction phase in 2026. Total employment, after taking into account the indirect effects of Fermilab and SURF spending in the region, is much higher. The total employment impact of LBNF/DUNE in western South Dakota reaches its apex in 2020 at 1,787 jobs.

Total earnings rise and fall roughly with employment. They start in 2016 at $4 million before rising to a peak of $74 million in 2020. By the end of the construction phase in 2026 total annual net earnings due to LBNF/DUNE in the western South Dakota region will still be $3 million. In aggregate, from 2016 to 2026, LBNF/DUNE would increase earnings for residents in the western South Dakota region by $326 million. See Table A-3 on page A-7 for more details on what contributes to this economic impact in the region.

TABLE 2. LBNF/DUNE Economic Impact in the Western South Dakota region, 2016 to 2026 (all dollar amounts in millions)

Year	Total Direct Expenditure in Western SD Region	Total Output in Western SD Region	Total Earnings in Western SD Region	Total Employment in Western SD Region
2016	$5.8	$8.8	$4.1	86
2017	$21.8	$35.4	$13.5	324
2018	$63.7	$104.3	$37.2	914
2019	$88.0	$142.4	$53.2	1,280
2020	$122.6	$199.6	$73.7	1,787
2021	$94.2	$152.3	$57.4	1,374
2022	$62.9	$102.3	$38.9	939
2023	$31.5	$50.3	$20.2	475
2024	$27.7	$44.2	$17.6	417
2025	$9.2	$13.7	$6.7	142
2026	$6.4	$8.6	$3.4	65
Total	**$533.9**	**$861.9**	**$325.9**	

Source: Fermi National Accelerator Laboratory, Finance Department
Analysis: Anderson Economic Group, LLC

ECONOMIC IMPACT IN ILLINOIS

Almost all of the direct spending and employment for the LBNF/DUNE project in the state of Illinois would occur in the Chicago region that we define in Figure 5 on page 12, according to Fermilab projections. Because of that, the general trend and scale of the economic impact in Illinois is similar to that in the Chicago region—just bigger. The indirect impact of the spending is higher since the larger region captures more of the recirculated spending by vendors and employees directly impacted by LBNF/DUNE. We summarize the economic impact of LBNF/DUNE in Illinois in Table 3 below and Figure 9 on page 18.

TABLE 3. LBNF/DUNE Economic Impact in Illinois, 2016 to 2026 (all dollar amounts in millions)

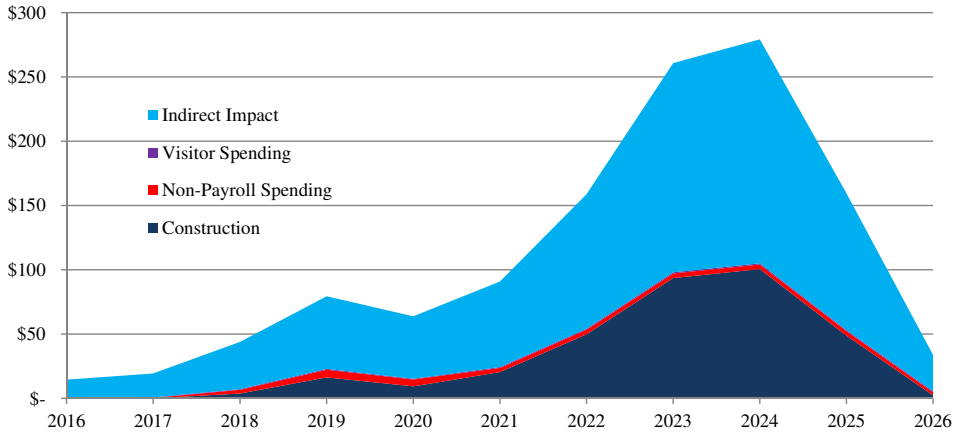
Year	Total Direct Expenditures in Illinois	Total Output in Illinois	Total Earnings in Illinois	Total Employment in Illinois
2016	$9.6	$14.5	$13.0	213
2017	$13.0	$19.4	$17.9	272
2018	$26.3	$44.0	$32.6	491
2019	$41.5	$79.4	$43.5	726
2020	$35.3	$63.9	$39.8	654
2021	$48.5	$90.9	$52.1	836
2022	$78.0	$158.7	$73.2	1,314
2023	$122.8	$260.8	$106.3	1,959
2024	$131.5	$279.3	$113.8	2,084
2025	$79.2	$159.6	$75.7	1,274
2026	$21.0	$33.8	$25.1	348
Total	**$606.5**	**$1,204.2**	**$593.0**	

Source: Fermi National Accelerator Laboratory, Finance Department
Analysis: Anderson Economic Group, LLC

ECONOMIC IMPACT IN SOUTH DAKOTA

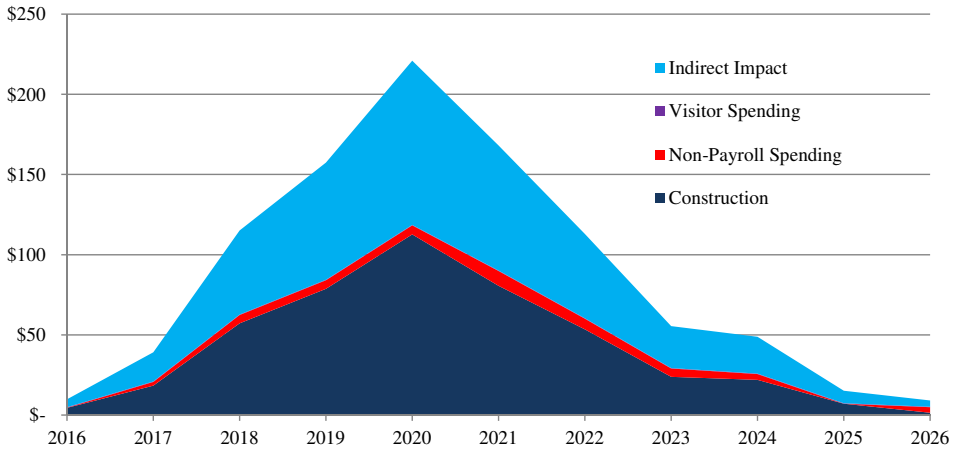
Almost all of the direct spending and employment for the LBNF/DUNE project in the state of South Dakota would occur in the western South Dakota region that we define in Figure 7 on page 15, according to Fermilab projections. Because of that, the general trend and scale of the economic impact in South Dakota is similar to that in the western South Dakota region—just bigger. The indirect impact of the spending is higher since the larger region captures more of the recirculated spending by vendors and employees directly impacted by LBNF/DUNE. We summarize the economic impact of LBNF/DUNE in South Dakota in Figure 10 on page 18 and Table 4 on page 19.

FIGURE 9. Total Projected Output due to LBNF/DUNE in Illinois, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory

FIGURE 10. Total Projected Output due to LBNF/DUNE in South Dakota, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory

TABLE 4. LBNF/DUNE Economic Impact in South Dakota, 2016 to 2026 (all dollar amounts in millions)

Year	Total Direct Expenditures in South Dakota	Total Output in South Dakota	Total Earnings in South Dakota	Total Employment in South Dakota
2016	$5.8	$9.8	$4.2	89
2017	$21.8	$39.1	$14.1	337
2018	$63.7	$115.1	$38.9	951
2019	$88.0	$157.5	$55.7	1,331
2020	$122.6	$221.0	$77.1	1,859
2021	$94.2	$168.1	$60.0	1,427
2022	$62.9	$112.9	$40.6	976
2023	$31.5	$55.4	$21.1	493
2024	$27.7	$48.8	$18.4	433
2025	$9.2	$15.2	$6.9	147
2026	$6.4	$9.1	$3.5	67
Total	**$533.9**	**$952.0**	**$340.6**	

Source: Fermi National Accelerator Laboratory, Finance Department
Analysis: Anderson Economic Group, LLC

IV.Fiscal Impact

In this section, we present our estimates for the fiscal impact of LBNF/DUNE in the states of Illinois and South Dakota. Specifically, we estimate the total amount of tax revenue collected by state government from various sources due to the increased economic activity caused by LBNF/DUNE in Illinois and South Dakota.

FISCAL IMPACT OVERVIEW

As economic activity increases earnings and sales in the regions of interest, this will result in an increase in tax collections. Using our economic impact estimates of earnings and projected Fermilab spending, we estimate the additional tax revenue in each state from a variety of taxes. We only consider the increase in tax collections for state government, though it is likely that some local government would also see benefits due to higher incomes for and spending by residents and local businesses.

FISCAL IMPACT IN SOUTH DAKOTA

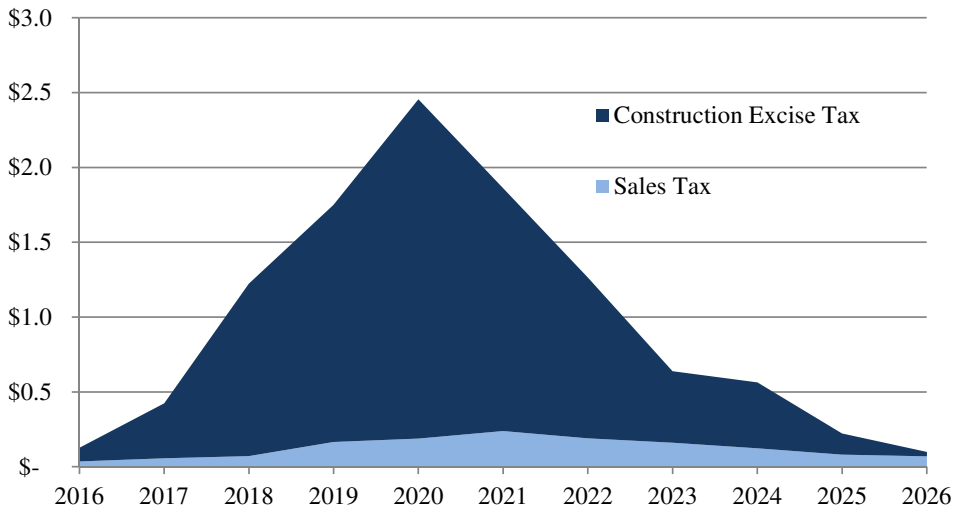
Sources of Fiscal Impact

South Dakota has a unique state tax structure. Much of South Dakota's tax revenue comes from a broad-based sales tax. In addition, South Dakota has an excise tax on construction services. Our fiscal impact estimates consider sales taxes on new purchases from both net new direct earnings and indirect earnings. In addition, we include the excise tax that would be collected on net new direct construction spending (direct spending on construction by Fermilab), as well as indirect construction spending (spending on construction induced by an increase in business activity and earnings in the region).

Fiscal Impact Estimates

We estimate the total fiscal impact of the projects in South Dakota to be $10.6 million over period from 2016 to 2026. This includes $9.2 million of construction excise taxes and $1.4 million in sales taxes. Figure 11 on page 21 below shows the additional revenue generated by the project each year. At the peak, South Dakota will receive $2.5 million in additional tax revenue in 2020.

FIGURE 11. Fiscal Impact of LBNF/DUNE in South Dakota, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory, and data from the BLS Consumer Expenditure Survey and the State of South Dakota

FISCAL IMPACT IN ILLINOIS

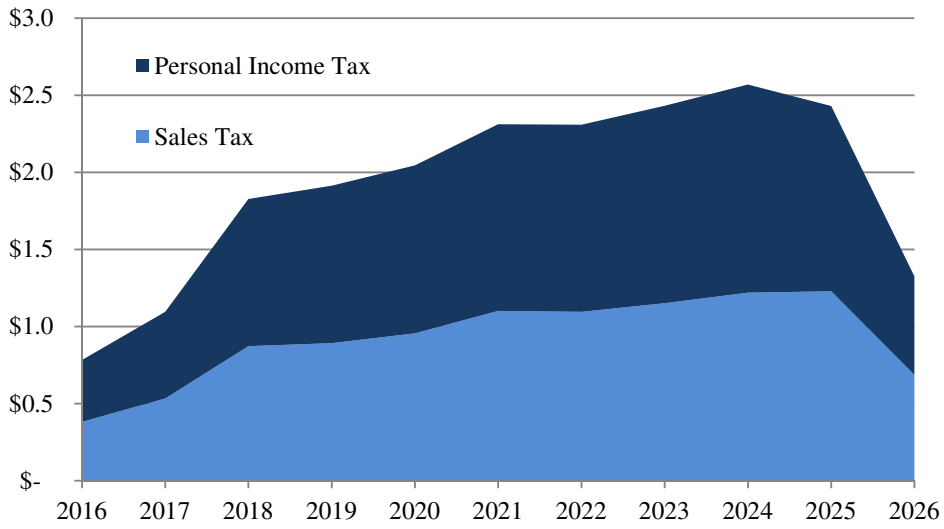
Sources of Fiscal Impact

Unlike South Dakota, Illinois has a common tax structure including both a personal income tax and sales tax. Our fiscal impact estimates consider individual incomes taxes paid on net new direct earnings and indirect earnings, as well as sales taxes paid on new purchases made using these earnings.

Fiscal Impact Estimates

We estimate the total fiscal impact of the projects in Illinois to be $21.0 million over the period from 2016 to 2026. This includes $10.9 million of personal income taxes and $10.1 million in sales taxes. Figure 12 on page 22 shows the additional revenue generated by the project each year. Tax revenue peaks in the year 2024, when Illinois will receive $2.7 million in additional tax revenue.

FIGURE 12. Fiscal Impact of LBNF/DUNE in Illinois, 2016 to 2026 (millions)



Source: AEG Analysis, based on data provided by Fermi National Accelerator Laboratory, and data from the BLS Consumer Expenditure Survey and the State of Illinois

V. Other Benefits of Fermilab's Long-Baseline Neutrino Initiative

In the last few chapters, we showed that the LBNF/DUNE project would have a significant impact on the economies of western South Dakota and the Chicago region. There are many benefits of this project, however, that we are unable to quantify, either because data is not available or it does not take the form of a short-term economic impact. In the following section, we elaborate on some other benefits that LBNF/DUNE provides to the region and the country, as a whole. We focus, in particular, on LBNF/DUNE's impact on local talent and education, on scientific and technological progress, and on the region and country's role in the global scientific community.

LOCAL EDUCATION AND TALENT

There are three ways in which Fermilab and the Sanford Underground Research Facility (SURF) in South Dakota—where the far detector of LBNF/DUNE would be placed—support regional education and talent development.

First, they partner with local universities to provide venues for research and an exchange of ideas and expertise. Graduate and undergraduate students in physics from the University of South Dakota and the South Dakota School of Mines and Technology have long used SURF to perform research and gain valuable experience in experimental physics. Chicago is home to more than 50 colleges and universities, including the University of Chicago and Northwestern. Rather than traveling to Europe and elsewhere to perform research, cutting edge research at Fermilab gives physics students the opportunity to stay close to home in Illinois and consider starting a career there.

Second, they engage with local public schools, from kindergartners to high schoolers, to encourage interest in science. SURF hosted nearly 1,000 K-12 students from South Dakota alone in the past two years, almost all of which were from surrounding Black Hills county. Similarly, Fermilab hosts more than 15,000 students each year.

Third, they host researchers from all over the world who would likely never set foot in the region. Attracted by the Tevatron particle accelerator at Fermilab, Italian students in physics, engineering, and computer science have participated in the laboratory's research program each summer for more than 20 years. While establishing research and construction partnerships for the LBNF/DUNE project, Fermilab intends to establish similar exchange programs with partner countries in South America, Europe, and Asia. Nearly 200 researchers have visited SURF over the past couple years, and that lab anticipates over 300 researchers per year would visit if the LBNF/DUNE project goes forward. Fermilab projects about 700 researchers from all over the world will collaborate on LBNF/DUNE and the supporting facilities in the Chicago region each year.

LBNF/DUNE AND TECHNOLOGY

Particle accelerators are now broadly used for a variety of applications worldwide. Most of these applications grew from decades-old accelerator technology originally developed for physics research. Accelerators have long been used to produce specialized materials and for medical diagnosis and treatment.

The PIP-II particle accelerator (see "Proton Improvement Plan II" on page 9) requires superconducting radio-frequency technology (SRF). SRF technology is expected to be at the core of the next generation of particle accelerators. The next generation of applications includes the delivery of safe, carbon-free energy with low waste; sterilization of polluted air and water; delivery of more targeted cancer treatments with low side effects; and development of new materials. Particle accelerators also make good inspection tools, strengthening national security and improving the search for fossil fuels, among other applications.

Practical uses for neutrino beams could be long-distance observation and communication. Their unique characteristics allow us to observe phenomena in outer space that are otherwise obscured by debris or gravitational distortion. Though the practical use of neutrinos for communication is speculative and far off, proof of principle of the use of neutrinos for communication was completed in 2012 by scientists at Fermilab when they sent data via a neutrino beam through 240 m of earth.[10]

LBNF/DUNE AND THE GLOBAL SCIENTIFIC COMMUNITY

Cutting-edge research in science is an international endeavor across many fields. The global community of scientists performs an iterative process. They propose theories to explain observed phenomena, perform experiments to test those theories, and respond to the outcomes of those experiments with new theories or with other experimental possibilities. This iterative process has little consideration for national borders. This is particularly true in particle physics, where the technology and facilities required to perform research are massive and require enormous investment. These facilities tend to be shared by researchers working at the frontier of their field from all over the world.

Thanks to the Tevatron at Fermilab, the Chicago region was one of the premiere locations for ground-breaking research in particle physics until just a few years ago. That is no longer the case. While the United States and Fermilab provide major contributions to the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN) in Switzerland, the country has failed to invest in similar facilities on this side of the Atlantic. It takes decades of planning to establish the type of megaprojects required for advancement in certain areas of particle physics. While other countries plan the next big supercollider,

10. Stancil, et al., "Demonstration of Communication Using Neutrinos," *Modern Physics Letters A*, vol. 27, iss. 12 (May 2012).

the prominence of the United States in the particle physics world will shrink without further action.

LBNF/DUNE and the facilities that support it would be the only ones of their kind in the world. With it, the United States and the Chicago region would ensure that cutting-edge research is still performed in the area, benefiting local contractors and researchers. It will also ensure that researchers in the United States can conduct research more efficiently and choose neutrino research as a practical endeavor without moving out of the country. Finally, LBNF/DUNE would maintain the United States' reputation as a trusted partner in the global community of particle physics research.

Appendix A. Data and Methodology

In this section, we provide a detailed description of our methods and data sources. We also describe important assumptions and limitations of our analysis.

ECONOMIC IMPACT ANALYSIS

In order to estimate the economic impact of LBNF/DUNE, we used an input-output model that translates an increase in regional demand (e.g. new spending in a region) into total economic impact, which can be expressed in output, earnings and employment. The specific model we used incorporates multipliers from the U.S. Department of Commerce Regional Input-Output Modeling System (RIMS II). We identify our assumptions for inputs, substitution effects, and multipliers in the following section.

Estimating Employment, Output and Earnings

We estimated the net economic impact of Fermilab's LBNF/DUNE projects in the state of Illinois and in the nine-county Chicago-Naperville-Joliet Metropolitan Division, which we call the "Chicago Region" in our analysis. We also estimated the net economic impact of the LBNF/DUNE projects in the state of South Dakota and in the thirteen-county western South Dakota business development region. We define net economic impact as the difference in employment, output, and earnings in two scenarios: (1) the scenario where Fermilab is awarded grants to construct and operate the facilities necessary to support LBNF/DUNE in the Chicago and western South Dakota regions, and (2) a counterfactual scenario, in which LBNF/DUNE never happens and its accompanying facilities are never built. We used the following methodology when estimating net economic impact.

1. Identified the impact region for the analysis.
   The first step in estimating the economic impact of a new project is to select the region for the analysis where additional output, earnings, and employment will occur. In this analysis we looked at four regions: The state of Illinois; the Chicago Region of Illinois (Cook, DeKalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, and Will Counties); the state of South Dakota; and the western South Dakota business development region, as defined by the Governor's Office of Economic Development (Bennett, Butte, Custer, Fall River, Haakon, Harding, Jackson, Lawrence, Meade, Pennington, Perkins, Shannon, and Ziebach Counties).
2. Assessed the expenditure base.
   Next we assessed the expenditures that are projected to occur in the impact regions in FY 2016 to FY 2026 as a result of the LBNF/DUNE project. Projected payroll, operating, and capital expenditure data was obtained from Fermilab and SURF, and analyzed to measure where the expenditures were being directed. We also used information on visitors to and international collaborators with the laboratories to estimate spending by out-of-region visitors who make expenditures while in the market.

3. Determined substitution.
   We determined substitution for the project using revenue source information and professional judgement based on the availability of other comparable uses for production inputs elsewhere in the market. Revenue data showed that funding for the project would come almost exclusively from Department of Energy grants and in-kind support from international collaborators. This, along with the fact that there is no ready substitute in the state, and in many cases the country, for Fermilab's and SURF's services, led us to assume that few if any of the expenditures would occur in the region if the projects were not built in the region. Thus, substitution was very low in our model.
4. Estimated economic impact.
   To estimate LBNF/DUNE's impact (in terms of total earnings, employment and output), we multiplied the net new demand (expenditures) by RIMS multipliers. These multipliers are industry specific, estimated by the U.S. Department of Commerce, and are customized to the region. We then chose the RIMS industry category that most closely corresponded to the industries that the expenditures were being directed to.

To see more details about the categories of spending taken into account, the estimated levels of substitution, and the multipliers we used, see the attached exhibits, Table A-2 on page A-6 through Table A-5 on page A-9.

FISCAL IMPACT ANALYSIS

To estimate the fiscal impact, we first identified the relevant state taxes, estimated the marginal increase in the base for that tax due to LBNF/DUNE, and determined the appropriate *effective* tax rates for each tax. In South Dakota, we estimated the fiscal impact based on state sales tax and construction excise tax. In Illinois, we estimated the fiscal impact based on the personal income tax and state sales tax.

Marginal vs Average Effects

One of the bases for an increase in tax collections by the state is an increase in personal income due to economic activity caused by LBNF/DUNE. We consider separately how sales taxes and personal income taxes will increase due to a *marginal* increase in a family's income (in which case we use a marginal rate), as opposed to whole new family receiving income in the region that otherwise would not (in which case we use average income).

To illustrate, if a household's income increases, they increase their spending on goods, but the share of the *marginal* income they spend on goods is likely to be less than the share of their *total* income that they spend on goods. Thus, the percent of income spent on goods and services subject to the sales tax differs depending on whether a household already in the state is receiving marginally more income, or whether a new household moves to the state.

We assume that the *direct* effects of LBNF/DUNE on earnings—earnings actually paid directly by Fermilab—are for households that would not otherwise be

receiving income in the region. On the other hand, we consider indirect earnings—those earned by residents due to increased economic activity in the region—as marginal income for those residents. They result in an increase in earnings for employees and business owners in the state, but not necessarily in significant relocation of residents or businesses.

Determining Tax Base

We applied *average* tax rates to direct earnings and *marginal* rates to indirect earnings. For the construction excise tax, we added direct spending by Fermilab on construction in South Dakota to the indirect impact of LBNF/DUNE on construction, derived from the construction component of the final demand multiplier for each industry impacted.

Determining Tax Rates

To determine the tax rate to apply to each type of tax, we used data from government sources. For sales taxes in each state, we multiplied the following three rates: the sales tax rate, the percentage of income spent on consumption, and the percent of household consumption spent on taxable items. Each of those last two items were estimated using the Consumer Expenditure Survey from BLS and information from the State Tax Handbook and other sources on taxable items in each state.

We estimated the amount of *marginal* income used for consumption by determining the change in total consumption when moving from the third quintile to the fourth quintile of income. We assumed the average amount of income used for consumption corresponded to the ratio of consumption to income for the middle quintile of income in each state.

Finally, for the average personal income tax for Illinois, we used the average effective tax rate based on information from the Illinois Legislature.[11] This information was from a year when the tax rate was lower, so we scaled it proportionally by the change in tax rate.

11. Illinois Department of Revenue, "Individual Income Tax Returns Filed by Adjusted Gross Income - Tax Year: 2013 - Final," accessed at http://www.revenue.state.il.us/AboutIdor/TaxStats/2013/IIT-AGI-2013-Final.pdf

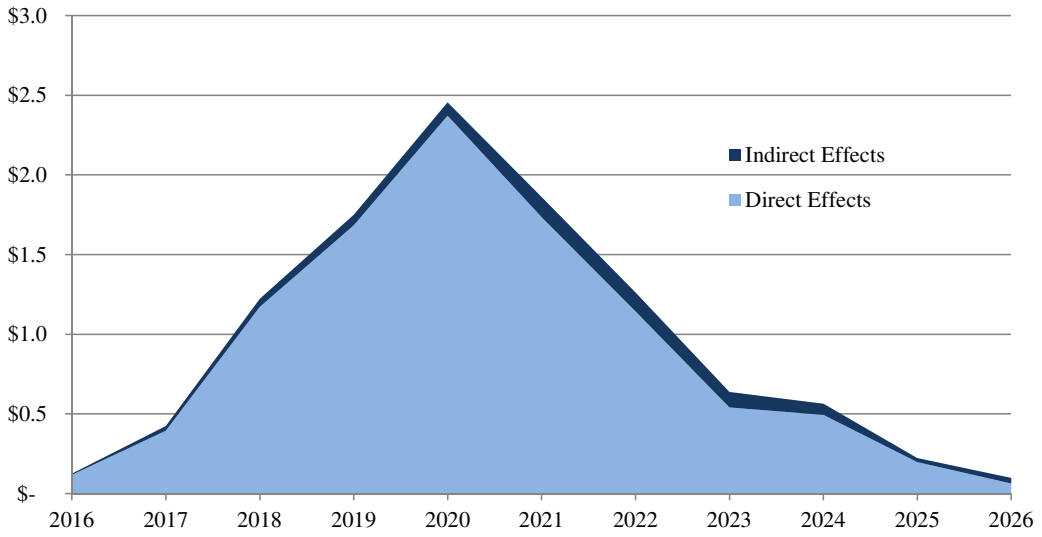
TABLE A-1. Effective Tax Rate Applied to Indirect and Direct Tax Bases

	Direct Tax Rate	Indirect Tax Rate
State of South Dakota Construction Excise Tax	2.0%	2.0%
State of South Dakota Sales Tax	3.0%	1.5%
State of Illinois Personal Income Taxes	2.9%	3.75%
State of Illinois Sales Tax	3.5%	1.8%

Notes: Analysis is based on current law. The State of Illinois income tax will drop in 2025 under current law. This is reflected in our analysis.
Source: Consumer Expenditure Survey, Illinois Legislature, South Dakota Department of Revenue, AEG Estimates.
Analysis: Anderson Economic Group, LLC

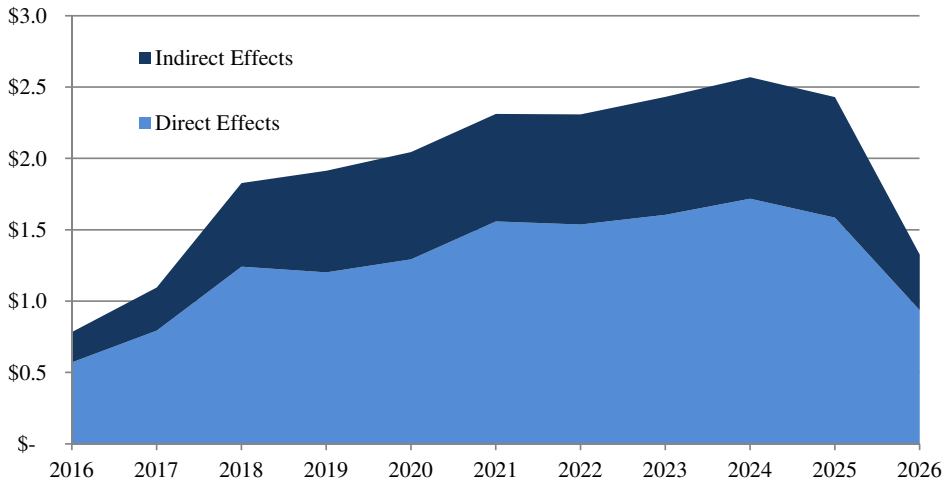
In Figure 11 on page 21 and Figure 12 on page 22, we show the total fiscal impact in each state, respectively, broken down by type of tax. In the figures below and on the following page, we instead show the fiscal impact broken down by direct effect and indirect effects. The direct effect includes taxes collected on direct purchases by Fermilab or earnings made by employees of Fermilab. The indirect effect includes taxes collected on other economic activity caused by those purchases and earnings.

FIGURE A-1. Fiscal Impact of LBNF/DUNE in South Dakota, 2016 to 2026 (in millions)



Source: AEG Analysis, based on data from Fermilab, the Bureau of Economic Analysis, BLS Consumer Expenditure Survey, and the State of South Dakota

FIGURE A-2. Fiscal Impact of LBNF/DUNE in Illinois, 2016 to 2026 (in millions)



Source: AEG Analysis, based on data from Fermilab, the Bureau of Economic Analysis, BLS Consumer Expenditure Survey, and the State of Illinois

Table A-2. Net Economic Impact of LBNF/DUNE in Chicago Region, Peak Year (2024)

	Total Spending in Chicago Region	% Net New in Chicago Region	Net New Spending in Chicago Region (Direct Impact)	Final Demand Multipliers			Indirect Economic Impact		
				Output	Earnings	Employment	Output	Earnings	Employment
Construction	$ 106,849,436	94%	$ 100,491,895	2.15	0.68	14.31	$ 115,565,679	$ 68,012,914	1,438
Construction Spending Impact	***$ 106,849,436***		***$ 100,491,895***				***$ 115,565,679***	***$ 68,012,914***	***1,438***
Professional Services	$ 4,539,905	81%	$ 3,677,323	2.24	0.81	15.83	$ 4,565,029	$ 2,969,438	58
Utilities	$ -	94%	$ -	1.63	0.33	5.80	$ -	$ -	-
Nonpayroll Spending Impact	***$ 4,539,905***		***$ 3,677,323***				***$ 4,565,029***	***$ 2,969,438***	***58***
Salaries and wages	$ 29,340,624	90%	$ 26,479,913	1.36	0.40	11.14	$ 36,105,362	$ 10,560,189	295
Payroll Spending Impact	***$ 29,340,624***		***$ 26,479,913***				***$ 36,105,362***	***$ 10,560,189***	***295***
Visitor Spending									
Hotel	$ 354,000	100%	$ 354,000	1.98	0.57	15.97	$ 347,309	$ 201,568	6
Food	$ 118,000	100%	$ 118,000	2.17	0.65	25.12	$ 138,449	$ 77,255	3
Retail	$ 73,750	100%	$ 73,750	2.10	0.64	22.71	$ 81,479	$ 47,407	2
Transportation	$ 177,000	100%	$ 177,000	2.33	0.79	24.55	$ 235,534	$ 139,122	4
Museums and entertainment	$ 59,000	100%	$ 59,000	2.22	0.81	27.38	$ 71,856	$ 47,501	2
Visitor Spending Impact	***$ 781,750***		***$ 781,750***				***$ 874,628***	***$ 512,852***	***16***

Net Economic Impact			
	Output	Earnings	Employment
Direct Impact	$ 104,950,968	$ 26,479,913	176
Indirect Impact	$ 157,110,697	$ 82,055,394	1,807
Total Net Economic Impact	**$ 262,061,665**	**$ 108,535,307**	**1,984**

Source: Fermi National Accelerator Laboratory, Finance Department
Analysis: Anderson Economic Group, LLC

Table A-3. Net Economic Impact of LBNF/DUNE in Western South Dakota Region, Peak Year (2020)

	Total Spending in Western South Dakota	% Net New in Western South Dakota	Net New Spending in Western South Dakota (Direct Impact)	Final Demand Multipliers			Indirect Economic Impact		
				Output	Earnings	Employment	Output	Earnings	Employment
Construction	$ 119,749,112	94%	$ 112,624,040	1.66	0.58	14.72	$ 74,759,838	$ 65,794,964	1,657
Construction Spending Impact	***$ 119,749,112***		***$ 112,624,040***				***$ 74,759,838***	***$ 65,794,964***	***1,657***
Professional Services	$ 3,621,573	81%	$ 2,933,474	1.63	0.64	15.66	$ 1,837,235	$ 1,879,477	46
Utilities	$ 2,873,000	94%	$ 2,702,057	1.38	0.28	5.23	$ 1,028,403	$ 744,146	14
Nonpayroll Spending Impact	***$ 6,494,573***		***$ 5,635,531***				***$ 2,865,638***	***$ 2,623,623***	***60***
Salaries and wages	$ 4,473,646	90%	$ 4,037,465	0.82	0.27	8.74	$ 3,296,187	$ 1,081,637	35
Payroll Spending Impact	***$ 4,473,646***		***$ 4,037,465***				***$ 3,296,187***	***$ 1,081,637***	***35***
Visitor Spending									
Hotel	$ 127,300	100%	$ 127,300	1.50	0.45	18.47	$ 64,172	$ 56,738	2
Food	$ 50,920	100%	$ 50,920	1.59	0.51	26.19	$ 29,803	$ 25,979	1
Retail	$ 25,460	100%	$ 25,460	1.53	0.50	20.87	$ 13,601	$ 12,679	1
Transportation	$ 57,285	100%	$ 57,285	1.71	0.68	26.95	$ 40,403	$ 39,080	2
Museums and entertainment	$ 12,730	100%	$ 12,730	1.66	0.55	23.07	$ 8,374	$ 6,956	0
Visitor Spending Impact	***$ 273,695***		***$ 273,695***				***$ 156,353***	***$ 141,432***	***6***

Net Economic Impact			
	Output	Earnings	Employment
Direct Impact	$ 118,533,266	$ 4,037,465	28
Indirect Impact	$ 81,078,015	$ 69,641,656	1,759
Total Net Economic Impact	**$ 199,611,281**	**$ 73,679,121**	**1,787**

Source: Fermi National Accelerator Laboratory, Finance Department
Analysis: Anderson Economic Group, LLC

Table A-4. Net Economic Impact of LBNF/DUNE in Illinois, Peak Year (2024)

	Total Spending in Illinois	% Net New in Illinois	Net New Spending in Illinois (Direct Impact)	Final Demand Multipliers			Indirect Economic Impact		
				Output	Earnings	Employment	Output	Earnings	Employment
Construction	$ 106,849,436	94%	$ 100,491,895	2.30	0.72	15.20	$ 130,378,185	$ 72,665,689	1,527
Construction Spending Impact	***$ 106,849,436***		***$ 100,491,895***				***$ 130,378,185***	***$ 72,665,689***	***1,527***
Professional Services	$ 4,539,905	81%	$ 3,677,323	2.30	0.82	16.11	$ 4,775,371	$ 3,030,114	59
Utilities	$ -	94%	$ -	1.74	0.36	6.40	$ -	$ -	-
Nonpayroll Spending Impact	***$ 4,539,905***		***$ 3,677,323***				***$ 4,775,371***	***$ 3,030,114***	***59***
Salaries and wages	$ 29,340,624	90%	$ 26,479,913	1.44	0.42	11.49	$ 38,202,571	$ 11,100,380	304
Payroll Spending Impact	***$ 29,340,624***		***$ 26,479,913***				***$ 38,202,571***	***$ 11,100,380***	***304***
Visitor Spending									
Hotel	$ 354,000	100%	$ 354,000	2.06	0.59	16.34	$ 375,063	$ 208,612	6
Food	$ 118,000	100%	$ 118,000	2.29	0.68	25.66	$ 152,279	$ 80,547	3
Retail	$ 73,750	100%	$ 73,750	2.16	0.66	23.16	$ 85,904	$ 48,823	2
Transportation	$ 177,000	100%	$ 177,000	2.47	0.83	25.56	$ 261,040	$ 146,981	5
Museums and entertainment	$ 59,000	100%	$ 59,000	2.27	0.81	27.07	$ 74,759	$ 47,507	2
Visitor Spending Impact	***$ 781,750***		***$ 781,750***				***$ 949,045***	***$ 532,469***	***17***

Net Economic Impact, Operations			
	Output	Earnings	Employment
Direct Impact	$ 104,950,968	$ 26,479,913	176
Indirect Impact	$ 174,305,171	$ 86,796,183	1,907
Total Net Economic Impact	**$ 279,256,139**	**$ 113,276,096**	**2,084**

Source: Fermi National Accelerator Laboratory, Finance Department
Analysis: Anderson Economic Group, LLC

Table A-5. Net Economic Impact of LBNF/DUNE in South Dakota, Peak Year (2020)

	Total Spending in South Dakota	% Net New in South Dakota	Net New Spending in South Dakota (Direct Impact)	Final Demand Multipliers			Indirect Economic Impact		
				Output	Earnings	Employment	Output	Earnings	Employment
Construction	$ 119,749,112	94%	$ 112,624,040	1.85	0.61	15.33	$ 95,347,512	$ 69,072,324	1,727
Construction Spending Impact	***$ 119,749,112***		***$ 112,624,040***				***$ 95,347,512***	***$ 69,072,324***	***1,727***
Professional Services	$ 3,621,573	81%	$ 2,933,474	1.71	0.66	16.05	$ 2,095,087	$ 1,941,960	47
Utilities	$ 2,873,000	94%	$ 2,702,057	1.41	0.28	5.26	$ 1,101,628	$ 758,467	14
Nonpayroll Spending Impact	***$ 6,494,573***		***$ 5,635,531***				***$ 3,196,716***	***$ 2,700,427***	***61***
Salaries and wages	$ 4,473,646	90%	$ 4,037,465	0.92	0.29	9.03	$ 3,714,468	$ 1,163,194	36
Payroll Spending Impact	***$ 4,473,646***		***$ 4,037,465***				***$ 3,714,468***	***$ 1,163,194***	***36***
Visitor Spending									
Hotel	$ 127,300	100%	$ 127,300	1.50	0.45	18.47	$ 64,172	$ 56,738	2
Food	$ 50,920	100%	$ 50,920	1.59	0.51	26.19	$ 29,803	$ 25,979	1
Retail	$ 25,460	100%	$ 25,460	1.53	0.50	20.87	$ 13,601	$ 12,679	1
Transportation	$ 57,285	100%	$ 57,285	1.71	0.68	26.95	$ 40,403	$ 39,080	2
Museums and entertainment	$ 12,730	100%	$ 12,730	1.66	0.55	23.07	$ 8,374	$ 6,956	0
Visitor Spending Impact	***$ 273,695***		***$ 273,695***				***$ 156,353***	***$ 141,432***	***6***

Net Economic Impact			
	Output	Earnings	Employment
Direct Impact	$ 118,533,266	$ 4,037,465	28
Indirect Impact	$ 102,415,049	$ 73,077,376	1,831
Total Net Economic Impact	**$ 220,948,315**	**$ 77,114,842**	**1,859**

Source: Fermi National Accelerator Laboratory, Finance Department
Analysis: Anderson Economic Group, LLC

Appendix B. About the Authors

ABOUT AEG

Anderson Economic Group, LLC is a boutique consulting firm founded in 1996, with offices in East Lansing, Chicago, and Istanbul. Our team has a deep understanding of advanced economic modeling techniques and extensive experience in multiple industries in multiple states and countries. We are experts across a variety of fields in tax policy, strategy and business valuation, public policy and economic analysis, and market and industry analysis.

ABOUT THE AUTHORS

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Mr. Horwitz is a Senior Consultant at Anderson Economic Group, working in the Public Policy and Economic Analysis practice area. Mr. Horwitz' work includes research and analyses for a range of AEG clients representing both the public and private sectors.

Mr. Horwitz's recent work includes actuarial analysis on changes to pension funding and retirement benefits for state and local government employees, the fiscal impact of state tax changes in Pennsylvania and Michigan, respectively, and the economic impact of large institutions such as museums and universities.

Prior to joining AEG, Mr. Horwitz was the Coordinator of Distribution for the Community Center of St. Bernard near New Orleans, where he oversaw the distribution of donated food, clothes, and household supplies to low-income residents of St. Bernard Parish and New Orleans' Lower Ninth Ward.

Mr. Horwitz holds a Master of Public Policy from the Harris School of Public Policy at the University of Chicago and a Bachelor of Arts in Physics and Philosophy from Swarthmore College.

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Mr. El-Kilani is a Senior Analyst with Anderson Economic Group working in the Public Policy and Economic Analysis practice area.

Mr. El-Kilani's recent work includes economic scope studies for various business and assessments of local tax differentials in local economic development. His work focuses on data analysis and evaluating existing economic research. His background is in health economics and economic analysis.

Prior to working at AEG, Mr. El-Kilani worked at the Michigan Veterans Affairs Agency in the Strategy Division. In addition, Mr. El-Kilani completed a fellowship at the Economics Staff at the Center for Drug Evaluation and Research at the US Food and Drug Administration.

Mr. El-Kilani earned a Master of Public Policy from the Gerald R. Ford School of Public Policy at the University and a Master of Arts in applied economics from the University of Michigan. He also holds Bachelor of Science in Engineering degree in biomedical engineering from the University of Michigan.

CONTRIBUTORS

There were also extensive contributions to the analysis and preparation of this report by David Westlake. Mr. Westlake was an analyst at Anderson Economic Group during the production of this report. His background is in energy and utility policy, as well as economic analysis.