

# Estimated State and Regional Economic Impacts of the Facility for Rare Isotope Beams

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## **The Facility for Rare Isotope Beams**

In December of 2008, the U.S. Department of Energy selected Michigan State University's National Superconducting Cyclotron Laboratory (NSCL) to design, implement and operate the Facility for Rare Isotope Beams (FRIB). This facility will build on MSU's leadership in nuclear physics research and education and will replace an existing federal funding line due to expire in 2016. In many ways, FRIB will complement the rich history of research coming out of the NSCL and expand this research to meet today's science, industry and national research needs.

FRIB represents a significant investment in infrastructure and research on the East Lansing Campus of Michigan State University and will have a discernable, positive impact on regional and state economic activity. The research into this report was funded by the Office of Government Affairs at Michigan State University to estimate the geographic distribution of economic impacts across the state and to update a prior economic impact estimate conducted by the Anderson Consulting Group, LLC undertaken in 2008.

FRIB construction began in 2014, preceded by significant investment in planning and design that invoked leadership from MSU and from scientific, architectural, and engineering circles around the world to build this one-of-a-kind research facility. The actual construction and much of the material inputs are supplied from instate sources, as well as much of the technical inputs and services. However, specialty research-related instrumentation and controls were imported into the region from specialty suppliers around the world, that may have been supplied from industrial suppliers and even other university research centers.

This report was undertaken to better understand the economic impacts of the establishment and operations of FRIB based on expected expenditures. In this, the values of allocated expenditures since the Department of Energy (DOE) approval of FRIB are used to estimate the actual economic impacts between fiscal years 2009 and 2015, and projected expenditures from fiscal years 2016 to 2040. Limiting the analysis to allocated expenditures omits some relevant sources and constraints to estimated impacts as described in this report.

### ***Summary of Findings***

Total federal allocations for the construction of FRIB are expected to total \$635 million, while state investment is expected to total \$94.5 million. Actual construction started in 2014 and is expected to wind down in fiscal year 2021. The DOE has also allocated \$300 million to be distributed annually for the operations of FRIB. This will augment the expected annual operating costs and revenues through research grants and fee for services. Operational impacts are projections starting in fiscal year 2021 through 2040. As of this writing, expenditures up to the end of fiscal year 2015 have been documented. The remaining expenditures represent planned expenditures and may deviate from initial projections in this report. This excludes some potential sources of impacts to the state. Such exclusions include the economic impact of potential spinoff businesses and commercialization of technology developed with the facilities. It also excludes potential gains in research funding that may arise from the presence of the facilities.

Impact estimates were created for two phases of FRIB. The first is a construction phase (fiscal years 2009-2021) for the installation of the new facilities, while the second is for the operational phase (fiscal years 2021-2040). Expenditures were allocated to 14 regions making up the state of Michigan and trade flows across the 14 regions were used to estimate region-specific impacts. Key findings attributed to construction activity of FRIB between fiscal years 2014 and 2019 include:

- Construction expenditures are expected to mostly take place between the fiscal years 2014 and 2019.
- A total of \$730 million will be spent during the construction phases, including \$94.5 million in state investment and \$635.5 million committed by the U.S. Department of Energy.
- About 83 percent of construction expenditures will go directly to Michigan businesses and workers.
- FRIB construction is expected to generate an average of 779 direct jobs through construction expenditures and 1,535 total jobs, when accounting for secondary transactions.
- FRIB construction will raise Michigan total labor income by \$76.8 million annually
- The average in-state annual construction expenditures of \$82.8 million will generate in-state transactions total \$149.0 million per year.

Key findings attributed to operational activity of FRIB between fiscal years 2021 and 2040 include:

- FRIB operations are expected to support 260 full-time equivalent positions at the facility, but when accounting for full- and part-time work and indirect administrative positions, just under 390 direct jobs are expected that give rise to approximately 1,002 jobs state-wide.
- On average, operations will generate \$55.6 million in state-wide labor income
- Average annual operational, in-state expenditures of \$77.3 million are expected to generate \$159.5 million in transactions state-wide.
- Operations of FRIB will likely draw in research investments into Michigan not captured in operational budgets.
- FRIB will contribute to commercial applications and may contribute to business formation not captured in this impact assessment.

This report assesses the overall merit of Michigan public investment in FRIB. In this, key findings include:

- State investment is leveraged by federal investment by the Department of Energy, resulting in high returns to public investment.
- Over the 32 years from development to the planned life of FRIB, this project will generate \$1.7 billion in wage and salary income, contribute \$2.4 billion in gross state product and \$4.4 billion in state-wide transactions. On average 1,001 jobs will be created.

- Accounting for all associated impacts, the \$94.5 million state investment in FRIB is expected to generate \$205.5 million in tax revenues over the 32-year life. Discounted to 2009, this suggests a return of \$100.3 million to the state's initial investment

This report details the methods and finding of the expected economic impact of the construction and operations of FRIB, and breaks expected impacts out by 14 regions making up Michigan. Estimates are limited to budgeted expenditures at the time of this writing and exclude some relevant sources of economic impacts that may increase the total economic value of FRIB. It is not intended to provide a fiscal assessment in terms of the impacts to state tax revenues. Additionally, estimated impacts do not net out state investment of \$94.5 million, but net present value calculations on the public return do net out state expenditures in their calculations.

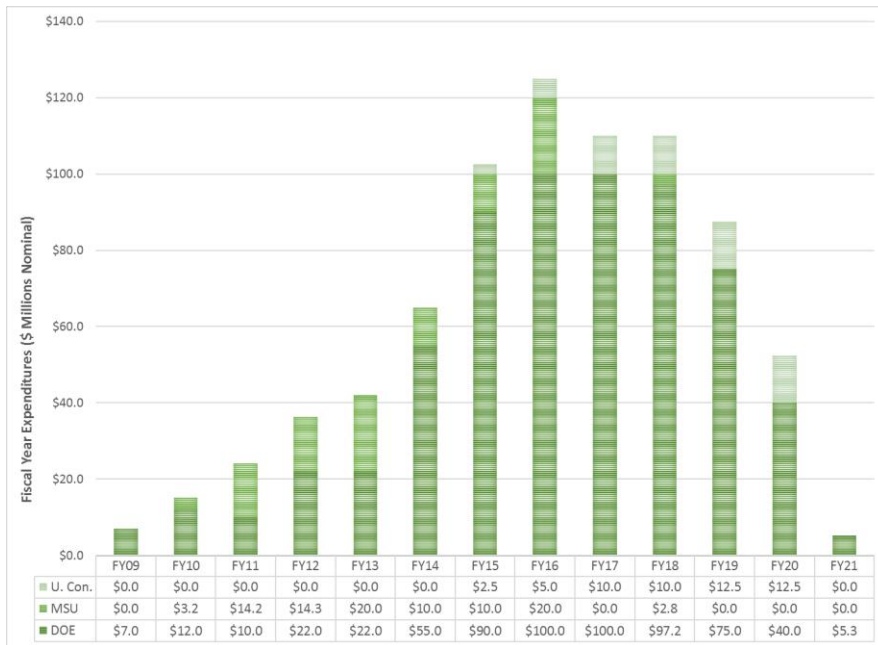
The report starts by describing the methods used in collecting data and modeling the economic impact estimates. This is followed by detailed findings that separate direct and total impacts by region. The report conclusion summarizes the findings and details model limitations.

## **Methods**

### ***Construction Phase Data***

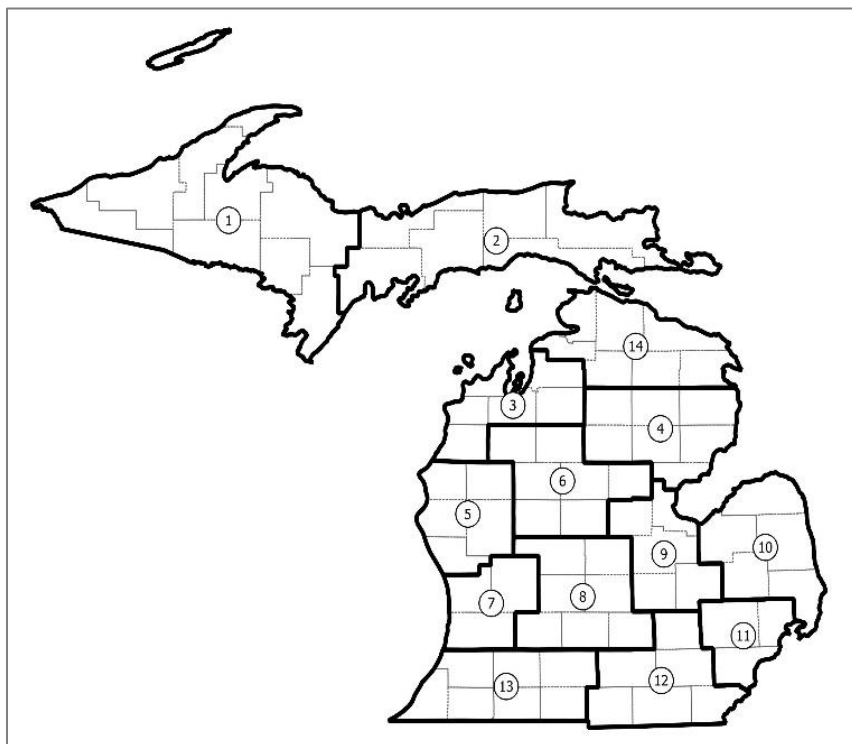
Planning and construction expenditure data and estimates were collected from FRIB management team, from the MSU Infrastructure Planning and Facilities (IPF), and from the MSU Office of Planning and Budget for payroll expenditures, material purchases and the acquisition of services, up to the end of fiscal year 2015. The MSU Enterprise Business Systems (EBS) database provides vendor location by zip code and a description of the purchase for coding into geographic regions and industry sectors. EBS also provides direct professional services and employment by residence for allocating salary distributions by geography. Using the EBS system for FRIB-related expenditures allows a full accounting of the geographic dispersion of direct expenditures and accounting for vendor sectors necessary to drive a multi-regional, economic impact simulation model.

Regional and industry delineations were only available for actual expenditures from fiscal year 2011 to 2015. The geographic and sector allocations of construction expenditure projections from fiscal year 2016 to 2021 were based on these historical distributions. As such, this report will document actual expenditures through fiscal year 2015 and projected expenditures beyond 2015. To time planned expenditures, planned aggregate expenditures by fiscal year were used based on the schedule shown in Figure 1. In this, sectoral and geographic expenditures were extrapolated based on actual and planned total construction expenditures. An additional installation budget was provided by FRIB administration. Projections of these expenditures were based on a simple allocation from 2015 to 2020 for utility connections was assumed as shown in Figure 1.



**Figure 1: Temporal Distribution of Construction-Related Expenditures**

The geographic distribution of impacts is based on the 14 regions defined by MSU Extension Services. These regions do not represent distinct regional groupings of economic activities or demographics, but rather reflect a regional detail used by MSU Extension in administering Extension programs and are used by the MI Spartan Impact reporting system (Michigan State University 2016). Figure 2 shows these impact regions.



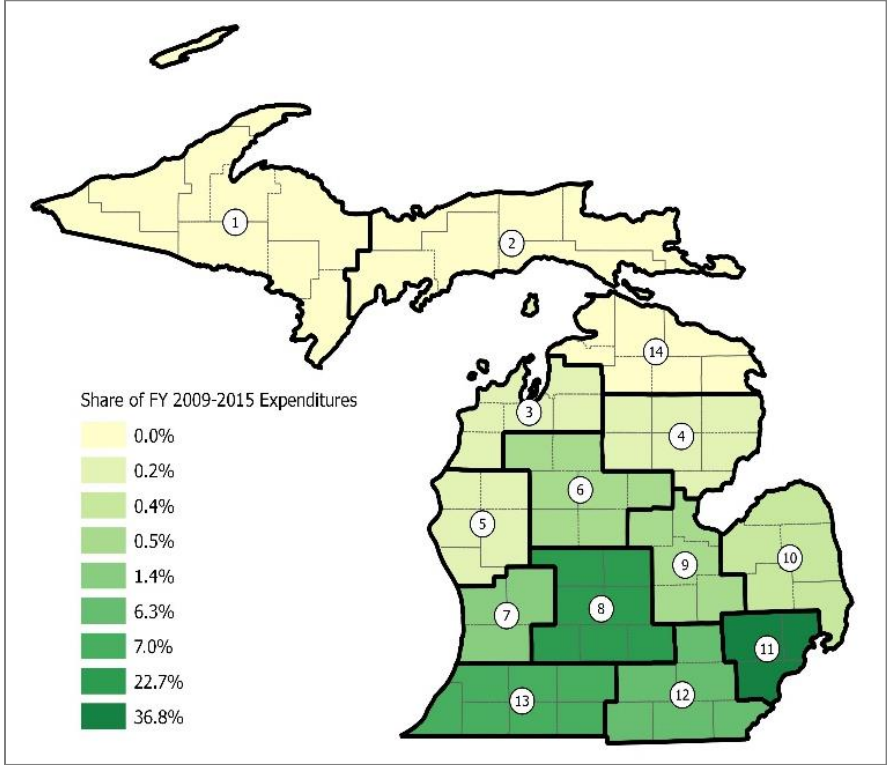
**Figure 2: Map MSU Extension Regions**

As expenditures and salaries are reported by zip codes, distributing to appropriate MSU Extension Regions required mapping those zip codes to distinct regions. This was accomplished with a simple GIS layering of Michigan Zip Codes into MSU Extension regions. Despite this inherent simplicity, a limited number of zip codes cross into multiple MSU Extension boundaries. Hence, exact centroids (or geometric center) of all zip codes were created and the MSU Extension region was assigned to the location of the centroid.

Using the temporal distribution of expenditures and the spatial distribution of expenditures from 2009 to 2015, a spatial and temporal allocation of actual expenditures through 2015 and planned transactions through fiscal year 2021 is created. This allocation of actual and planned expenditures is then distributed by year for modeling economic impacts.

Figure 3 shows the expenditure shares by region between 2009 and 2015, indicating that most direct expenditures accrued to regions in the Lower Peninsula. More specifically, Region 11 around the Detroit Metropolitan Area received approximately 36.8 percent of expenditures, while Region 8, encompassing FRIB construction site received about 22.7 percent of the expenditures. In addition, about 17.8 percent of expenditures took place outside of Michigan.

The direct expenditures in Figure 3 only paint a partial picture of the true allocation of economic impacts of the construction expenditures. This is because businesses transact with other businesses within and outside of Michigan. Some of these expenditures will cross regions, as determined by trade flows as described in the next section.



**Figure 3: Geographic Distribution of FY 2009-2015 Construction Expenditures**

### ***Operational Phase Data***

Operations impacts are those impacts stemming from FRIB ongoing operations. They are estimated based on FRIB management projected operation budgets and represent a business-as-usual scenario. The annual operating budget is largely expected to be stable over time. However, such is subject to change through future enhancements of the facilities, of which, such unforeseen future investments should be attributed to this initial investment in developing FRIB. As a corollary, consider all the intermittent investments in the MSU Cyclotron that raised it from being rated a K50 in 1965 to K1200 facility in 1989, with each successive increase in power associated with significant investment in upgrades to apply the latest technological advances. Regardless, at this point in time, such future endeavors are not foreseeable, and therefore not included in the economic impact estimates.

Pro-forma operational budgets were provided by FRIB administration team, as approved by the Department of Energy (DOE) and span the operational years of fiscal year 2021 to 2040. The annual operating budgets break expenditures down into distinct functions and are mostly comprised of wages, salaries and benefits. For 2021, the total operational budget is expected to be \$88.165 million, supporting 267 FTE positions that include scientists, technicians and engineers, and other support staff. This includes the retention of \$7 million that currently is allocated to the NSCL for the operation of the current Cyclotron and would be forfeited in the absence of FRIB. Barring unforeseeable changes in DOE allocations, these expenditures are expected to rise with inflation (set at 2.5 percent per year for modeling)<sup>1</sup>, while staffing counts are expected to remain constant. Because FRIB has a substantial energy draw, a significant component of the annual budget is the cost of generating or purchasing electricity.

The base budget is advanced each year to account for inflation and wage increases. While the DOE approved an annual rate of 3.2 percent, we applied a more conservative 2.5 percent annual increase, which is more aligned with the U.S. Congressional Budget Office estimate of 2.0 percent (U.S. Congressional Budget Office 2016).

As operational expenditures are largely expected to take place in the proximity of FRIB facilities, all direct infusions to the state economy are assumed to take place in the home Region 8. In this, while direct transactions are modeled to be limited in this region, secondary transactions that contribute to total economic impacts are free to flow across regional lines and outside of the state, depending on the sector trade flows described below.

### ***IMPLAN***

The impact simulation model used in this analysis is the IMpact for PLANning (IMPLAN) model for Michigan by county, using 2013 transactions. The IMPLAN model (IMPLAN Group LLC 2015) is a multi-regional input-output (MRIO) model for estimating economic impacts. Economists routinely turn to regional input-output models for simulating economic impacts of new infusions

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<sup>1</sup> Allocations for inflation adjustment have been set at 3.2 percent per year; however, we set the model parameter to a more conservative estimate of 2.5 percent based on Congressional Budget Office projections.

into local economies. These models trace the transactions that occur amongst producing sectors and across producing sectors and institutions like households and government. By tracing these transactions, a more complete image of how a change in one sector of the economy materializes into changes in other sectors through transactions in the course of producing goods and services is realized. As each sector interacts with institutions, the regions' institutions will also be impacted, changing the basket of goods and services they purchase. For example, an increase in labor income will result in higher household expenditures – some of which will go to local retailers and service providers. Because these models generate economy-wide impacts that exceed the direct change in economic activity, the resulting impacts are generally termed multiplier effects and are well documented in the economics literature (Coughlin and Mandelbaum 1991).

Input-output models account for these transactions using the National Benchmark Input-Output Accounts reported every five years by the U.S. Department of Commerce's Bureau of Economic Analysis (Bureau of Economic Analysis 2013). The last such estimate was for 2012. Because the National Benchmark Input-Output Accounts are national in scope, the transactions are regionalized to reflect the industries and institutions that reside in the defined economic region (Jackson 1998). For example, it accounts for the fact that no oranges are grown in Michigan in the production of orange juice, but they are grown nationally.

The standard approach to impact modeling with input-output models is to establish the direct infusion of new transaction by commodity. This new infusion is the transactions that would not have taken place in the absence of FRIB, and for this analysis, includes the construction phase and the operational phase expenditures. Using standard modeling terminology, this new infusion is referred to as the direct effects, as they are directly linked to the construction and operations of FRIB facilities. The model uses these direct effects to estimate secondary transactions arising in response to the direct effects. The first set of secondary transactions is the indirect effects, which are transactions between business sectors. Indirect effects arise because direct purchases of goods require the selling firm to restock the goods sold. They also arise as the proportionate share of the selling firm's costs of operations for such expenditures as electricity, rent, business services and others. Indirect effects ripple throughout the economy as the initial selling firm also purchases inputs from other firms. This continuum continues throughout the region, reduced only by the extent that inputs are purchased from suppliers outside the region. The second set of secondary transactions are called induced effects. Induced effects measure the value of new transactions by households, government and other institutions in response to higher labor income, taxes and profits. The total effects are simply the sum of the direct, indirect and induced effects.

This analysis deviates from conventional input-output economic impact estimates, in that the model used links multiple modeled geographies into a single model. This MRIO structure allows for the simultaneous accounting of trade flows across Michigan regions and the distribution of direct purchases across regions. Cross regional transactions are estimated using trade-transportation flow estimates across and within counties (Lindall, Olson et al. 2006, Minnesota



IMPLAN Group N.D.). Through this multi-regional structure, secondary transactions can be traced within and across regions and back, providing a much more complete assessment of the overall economic impacts associated with the construction and the operations of FRIB.

Standard measures of impacts include the number of jobs created, labor income associated with those jobs, the total value of transactions and new value-added activities, which is another term for contributions to gross state product. Impact estimates start with the estimated total value of purchases by category. The IMPLAN model provides 536 expenditure categories, and 11 household types by income group. The expenditure categories represent economic sectors in the modeling region, each with specific expenditure patterns in the production of goods and services. Hence, each expenditure category is associated with a unique economic impact profile. Institutions also have unique purchasing patterns that present a second set of unique impact profiles. These impact profiles are best approximations to actual industry expenditures on inputs, labor, rents and payments to owners. As such, estimated impacts may differ from actual impacts. The best case in point is employment impacts. Direct employment impacts are estimated as a fixed ratio of industry average employment per \$ million in industry sales and are calculated at the industry level. However, any one supplier may have a very different hiring practice or employment to sales ratio than the industry average. In the case of construction expenditures, it is not uncommon to find that direct jobs estimated do not match with actual jobs counted. Hence, we parameterize the employment direct effect estimates against actual estimated annual employment at the construction site for Region 8 impact estimates in 2016. As other factors may contribute to such mismatch in measurement, like the seasonality of employment, the measures are not expected to be on par, but rather in the neighborhood of actual observed direct impact estimates.

Standard multiplier interpretations do not hold in MRIO model estimates, as the strict link from regional direct effect to total effect is interrupted by the infusion of multi-regional contributions to total effects. That is, for single region models, a region's total effect is a multiple of and only of the region's direct effect. But for a multiple region model a region's total effect is a compendium of its direct effect and the secondary effects of other regions' purchases from the modeled region. Hence, multipliers do not follow well established bounds of predictable single-region multipliers.

Michigan's 83 counties were mapped into 14 distinct regions as shown in Figure 2. Then regional IMPLAN models were built for each of these 14 regions. Expenditure records from fiscal year 2009 to 2015 were then tabulated by year into 15 regions – the 14 MI Extension regions and non-Michigan regions. The difference between these expenditures to date and total expected construction expenditures were then projected by planned annual expenditures shown in Figure 1, using the 2009-2015 geographical allocations of actual expenditures. Using the 14-linked IMPLAN models, each of the 14 regional models were ran for consecutive odd-numbered years starting in 2009. Even numbered years' impact estimates were extrapolated from odd

numbered years for post-2015 estimates based on Figure 1 due to excessively long run times of the model.<sup>2</sup>

## **Findings**

### ***Estimated Construction Impacts***

The construction phase is broken out into three categories, Civil Construction and Technical Construction and utility connection installation. Civil Construction is for office space construction and land improvements while Technical Construction entails the primary research facilities and installation of technical fixtures and equipment. Utility connection installation entails all expenditures to connect FRIB to MSU and other power generation and distribution sources of electricity. The three construction categories were combined into single model runs because computing capacity was a constraint. A complete table of estimated impacts is presented in the Appendix 1 of this report. Because this is a lot of data to interpret, we present summaries of the findings here.

In total, about \$647 million of the \$730 million expected construction-related expenditures are expected to be realized in Michigan between fiscal year 2009 and 2021. This includes civil, technical and utility connections. About 17 percent of civil and technical construction expenditures are expected to accrue to vendors outside of Michigan, while most utility-connection-related expenditures will accrue within the state.

The average annual impacts for fiscal years 2014 through 2019 are reported in Table 1 below. These impact estimates correspond with the heavy construction phase of the project, where initial construction started in 2014. On the back end, construction is due to taper off, depending on how well the construction effort meets planned milestones.

Table 1 shows the estimated average annual direct expenditure impacts by region from Fiscal Year 2014 to 2019. Direct expenditures are those in-state expenditures generated from the actual construction of FRIB facilities. Table 1 does not include annual estimates in planning for construction nor construction-related expenditures past 2019 for finishing of grounds and other miscellaneous, post construction expenditures. As evident in Table 1, impacts are dispersed throughout the 14 Michigan regions. However, Regions 8 and 11, which include the Lansing-East Lansing and Detroit metropolitan areas respectively, are poised to receive the largest impacts in terms of jobs and output. Other in-state expenditures are expected to be widely distributed across other regions of the state, where total expected annual expenditures (sales) of \$46.2 million is expected to generate an average of 276 jobs between FY 2014 and 2019 with total labor income of \$15.8 million.

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<sup>2</sup> In all there were 13 years and 14 regions to model generating a total of 182 model runs. Each model run took from 20 to 30 minutes to complete. Completing all model runs would have required at least 60 hours of computing time to complete. By only estimating odd numbered years, total computer time was reduced to about 32 hours.

Region	Employ	Labor Income*	Output (Sales)*	Value Added (Gross Regional Product)*
<b>State</b>	<b>276</b>	<b>15,805,326</b>	<b>46,158,462</b>	<b>19,117,017</b>
01	0.0	172	455	201
02	1.0	24,752	71,371	34,724
03	0.6	27,718	86,228	33,629
04	0.7	17,449	78,731	23,034
05	1.5	42,150	125,177	53,455
06	1.8	80,629	273,719	94,889
07	6.3	283,122	789,815	366,062
08	83.6	3,861,593	12,804,483	4,828,624
09	24.8	1,184,861	3,202,074	1,441,253
10	1.5	51,860	172,609	69,635
11	110.9	7,796,445	21,131,946	9,275,699
12	19.4	1,031,588	3,226,470	1,233,047
13	23.8	1,386,862	4,137,948	1,641,672
14	0.4	16,125	57,436	21,092

**Table 1: Average Annual Direct Impacts from Construction (FY 2014-2019)**

\* Dollar values based on 2016 dollars

Direct expenditures will give rise to secondary transactions as shown in Table 2. Each region's secondary impacts arise from secondary transactions across the state. As shown in Table 2, the distribution of secondary effects largely follows that of the direct effects, though the Detroit region (Region 11) appears to have a larger draw on associated secondary transactions. In total, average annual secondary transactions between FY 2014 and 2019 are expected to reach \$37.4 million, supporting about 279 jobs with annual payroll of about \$12.3 million.

Region	Employ	Labor Income*	Output (Sales)*	Value Added (Gross Regional Product)*
<b>State</b>	<b>279</b>	<b>12,284,498</b>	<b>37,415,253</b>	<b>20,820,964</b>
01	0.2	8,233	39,217	14,548
02	0.5	13,836	61,826	28,290
03	1.0	40,570	132,289	62,860
04	0.8	23,959	102,768	43,063
05	1.2	44,738	194,488	88,874
06	3.5	129,353	454,545	205,439
07	11.6	539,718	1,720,050	883,210
08	62.8	2,158,908	7,212,003	4,013,749
09	20.7	773,439	2,588,665	1,368,529
10	1.9	74,223	336,887	148,285
11	134.7	6,825,602	18,986,756	11,020,017
12	18.7	814,523	2,858,260	1,481,036
13	20.3	799,537	2,581,974	1,399,531
14	1.0	37,859	145,526	63,533

**Table 2: Average Annual Secondary Impacts from Construction (FY 2014-2019)**

\* Dollar values based on 2016 dollars

Total impacts are the sum of direct and secondary impacts. Average annual construction-phase impacts are presented in Table 3 for expenditures from fiscal year 2014 to 2019. They represent the totality of direct and secondary expenditures that remain in Michigan and are reported by region. As indicated in

Tables 1 and 2, regions 8 and 11 share the largest estimated annual impacts, though other regions share in these impacts based on where direct expenditures are made and the flow of secondary transactions across regions. In total, the average annual direct construction expenditures of \$46.2 million (Table 1) is expected to generate about \$83.6 million in annual sales statewide. These annual expenditures are expected to give rise to an annual increase of employment totaling 555 jobs with annual wages of \$28.1 million.

Region	Employ	Labor Income*	Output (Sales)*	Value Added (Gross Regional Product)*
<b>State</b>	<b>555</b>	<b>28,089,824</b>	<b>83,573,715</b>	<b>39,937,981</b>
01	0.2	8,405	39,672	14,749
02	1.4	38,588	133,197	63,014
03	1.6	68,288	218,517	96,489
04	1.5	41,407	181,499	66,097
05	2.7	86,888	319,664	142,330
06	5.3	209,982	728,265	300,328
07	18.0	822,841	2,509,865	1,249,271
08	146.4	6,020,501	20,016,486	8,842,373
09	45.5	1,958,301	5,790,739	2,809,781
10	3.5	126,083	509,496	217,920
11	245.6	14,622,048	40,118,702	20,295,716
12	38.1	1,846,110	6,084,730	2,714,083
13	44.1	2,186,398	6,719,922	3,041,203
14	1.4	53,985	202,962	84,626

**Table 3: Average Annual Total Impacts from Construction (FY 2014-2019)**

\* Dollar values based on 2016 dollars

### **Estimated Operations Impacts**

The DOE has committed to \$1.55 billion in operational funding for twenty years. Expenditures from such funds are expected to start in the fiscal year 2021 and carry on through 2040. However, operations of FRIB facilities are likely to continue well beyond this span. The fiscal years 2021 and 2040 annual projections were summarily placed into an MRIO IMPLAN model, where all direct expenditures were expected to occur in Region 8. However, secondary transactions across regions are tracked in the model, where the estimated state impact is calculated as the sum of impacts over all regions. The annual inflation adjustment of 2.5 percent per year was applied for the 2040 model run. Only economic impacts for fiscal year 2021 and 2040 were estimated using the IMPLAN model. The inter-year estimates were interpolated by year to generate a consecutive series of estimated annual impacts through 2040. The detailed, annual estimated impacts by region are provided in the Appendix 2.

Table 4 shows the annual average direct expenditure impacts from operations. Direct expenditures are mostly for the operations of the facilities and mostly accounts for personnel and energy inputs. While a minimum amount of direct expenditures may occur outside of Region 8, this assessment asserts all expenditures accrue locally. It is notable that the direct employment estimate exceeds the FTE projections made by FRIB administration team of 267 full-time equivalent jobs. Two factors contribute to this. First the anticipated FTEs reported by the

administration team understate the number of jobs since estimated jobs are a combination of partial and full-time equivalent jobs. Second, along with FRIB budget, is an allocation to the university for managing the university function and for electricity. This overhead is allocated to the overall university and energy sector and supports additional jobs outside of FRIB. Hence, the overall direct employment effect is expected to be larger than the number of jobs in FTEs FRIB employs.

Region	Employ	Labor Income*	Output (Sales)*	Value Added (Gross Regional Product)*
<b>State</b>	<b>389</b>	<b>29,361,043</b>	<b>77,347,855</b>	<b>34,593,778</b>
1	0.0	0	0	0
2	0.0	0	0	0
3	0.0	0	0	0
4	0.0	0	0	0
5	0.0	0	0	0
6	0.0	0	0	0
7	0.0	0	0	0
8	389.3	29,361,043	77,347,855	34,593,778
9	0.0	0	0	0
10	0.0	0	0	0
11	0.0	0	0	0
12	0.0	0	0	0
13	0.0	0	0	0
14	0.0	0	0	0

**Table 4: Average Annual Direct Impacts from Operations (FY 2021-2040)**

\* Dollar values based on 2016 dollars

Secondary impacts are expected to be disbursed throughout the state, depending on trade flows. Table 5 shows the expected secondary impacts, indicating that most secondary impacts are experienced in the home region, Region 8. However, trade flows across regions assert that other regions of the state will also benefit by supplying resources that go into FRIB operations and through household purchases. State-wide, the operations of FRIB is expected to generate an increase in employment of 613 jobs annually, with wages totaling \$26.2 million.

Total impacts are calculated as the sum of direct and secondary impacts, as shown in Table 6. There, the estimated average annual total impacts by region is reported. As opposed to construction impacts, the operational impacts are largely consistent from year to year, as discussed in the next section. Regardless, once fully operational, FRIB will likely support a total of 613 jobs in Michigan, dispersed throughout the state. Most jobs will be generated in proximity of FRIB, as captured in Region 8 impacts. These jobs are expected to generate about \$26.22 million in labor income with direct and secondary expenditures (sales) totaling \$82.2 million.

Region	Employ	Labor Income*	Output (Sales)*	Value Added (Gross Regional Product)*
<b>State</b>	<b>613</b>	<b>26,220,682</b>	<b>82,193,368</b>	<b>43,726,195</b>
1	0.1	3,956	18,739	6,436
2	0.2	7,358	37,986	15,230
3	1.0	46,578	166,276	84,913
4	0.2	7,646	33,469	12,531
5	1.1	51,203	270,454	126,849
6	9.0	411,293	1,305,755	616,601
7	31.4	1,631,951	4,671,236	2,505,253
8	494.9	19,324,952	63,355,195	33,614,199
9	7.8	364,676	1,166,592	602,964
10	0.6	24,342	116,875	49,411
11	34.7	2,381,548	5,524,533	3,147,760
12	15.8	905,985	3,009,197	1,514,909
13	15.6	1,036,569	2,422,062	1,386,224
14	0.5	22,625	94,999	42,915

**Table 5: Average Annual Secondary Impacts from Operations (FY 2021-2040)**

*\* Dollar values based on 2016 dollars*

While the operational impacts, as modeled, are to take place between the fiscal years 2021 and 2040, some of the faculty that will be working with FRIB have already been placed at MSU and others may be added before 2021. As these positions are and will be added because of FRIB, these early placements are pertinent to the economic impact estimates. However, we refrained from estimating the associated impacts of these early placements on the basis that funding for them up to 2021 largely came from internal funding sources. Impacts from such funds are negated by reductions in other expenditures that would have taken place in their absence. Regardless these positions are likely to generate immediate impacts to the state through federal grant funding they generate. Such impacts are difficult to project and hence, not considered in this report.

### ***Combined Expected Economic Impacts***

In this section, we summarize the total state findings over all years and attribute key expected values of the development and operations of FRIB. In total, about \$730 million will be invested in the construction of FRIB. Most will be from federal government funds, while about \$94.5 million came from Michigan public funds. Additionally, the DOE will contribute to the operational costs of FRIB. While much of the construction funds have been spent since 2009, most of these expenditures will be made in Michigan and to Michigan firms and contractors.

Region	Employ	Labor Income*	Output (Sales)*	Value Added (Gross Regional Product)*
<b>State</b>	<b>1,002</b>	<b>55,581,726</b>	<b>159,541,224</b>	<b>78,319,973</b>
1	0.1	3,956	18,739	6,436
2	0.2	7,358	37,986	15,230
3	1.0	46,578	166,276	84,913
4	0.2	7,646	33,469	12,531
5	1.1	51,203	270,454	126,849
6	9.0	411,293	1,305,755	616,601
7	31.4	1,631,951	4,671,236	2,505,253
8	884.2	48,685,995	140,703,050	68,207,977
9	7.8	364,676	1,166,592	602,964
10	0.6	24,342	116,875	49,411
11	34.7	2,381,548	5,524,533	3,147,760
12	15.8	905,985	3,009,197	1,514,909
13	15.6	1,036,569	2,422,062	1,386,224
14	0.5	22,625	94,999	42,915

**Table 6: Average Annual Total Impacts from Operations (FY 2021-2040)**

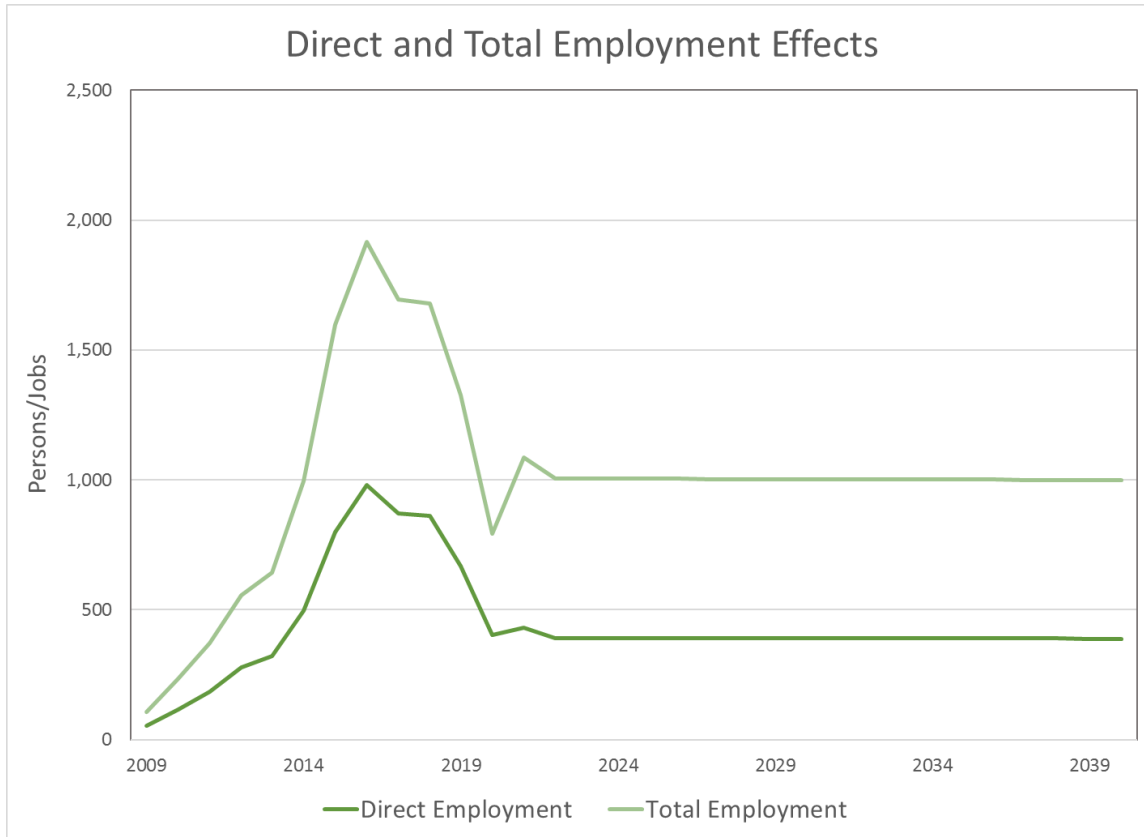
*\* Dollar values based on 2016 dollars*

The prior two sections report the estimated impacts and the distribution of those impacts during the construction phase and the operational phases respectively. Both phases will occur sequentially with minimal overlap. This section will review the sequential impact estimates over time, from fiscal year 2009 to 2040, encompassing the planning phase through the final estimated operational impacts. The complete year-to-year estimated impacts are in Appendix 1 and 2 for construction phase and operational phase impacts, respectively.

The expected direct and total employment impacts are graphed in Figure 4. Up to fiscal year 2015, estimates are based on actual data. Beyond that they are projections based on expected construction and operational expenditures. In fiscal year 2021, there is a slight of overlap with construction expenditures winding down and operational expenditures starting. Beyond fiscal year 2021, employment impacts largely remain unchanged and distributed across the 14 regions.

As notable in Figure 4, both direct and total state employment impacts ramp up considerably during the construction phase, where actual construction starts in 2014 and is largely expected to be completed by 2019. Some installation and construction-related expenditures are expected to take place after 2019, but this is expected to have minor contributions to total state impacts. Beyond 2021 and during the operational phase, direct and total employment impacts are expected to remain stable.

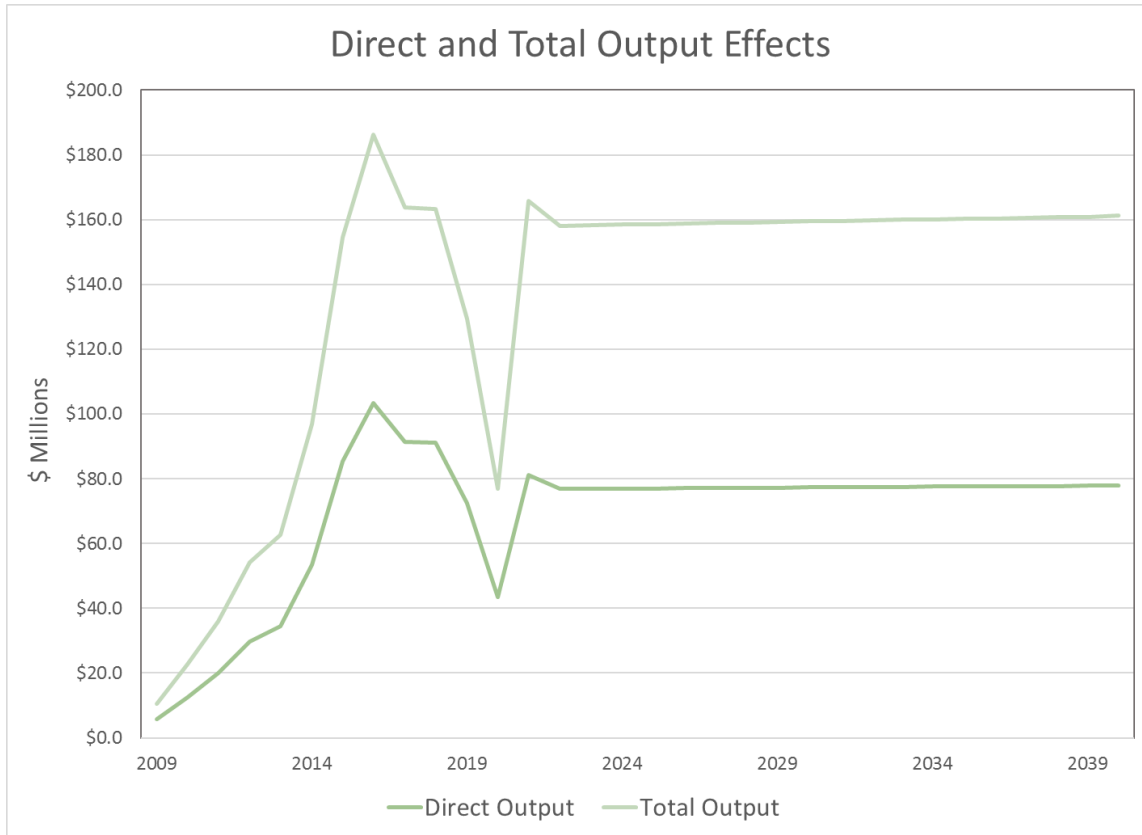
Economists are often interested in the ratio of total effects to direct effects. This is known as the multiplier of the project. Referencing Figure 4, the implied employment multiplier, as measured by the average over all years is 2.35. This is generally considered to be within the bounds of acceptable estimates but borders on being robust. This ratio implies that for every one direct job, an additional 1.35 jobs are created in the state.



**Figure 4: Time Series of State Direct and Total Employment Effects (FY 2009-2040)**

Output, as a measure of the value of transactions that arise from FRIB development and operations provides an alternate perspective of state-level impacts. Direct output expenditures largely mirror direct employment impacts but deviate slightly depending on what inputs and services are purchased. This is because different industries have different labor needs. Figure 5 shows the expected direct and total output effects from fiscal year 2009 to 2040. When compared with Figure 4, the operation impacts in terms of output are much larger than employment impacts. This mostly reflects that the operation of FRIB facilities is less labor intensive than the construction of the facility. It also suggests that output multipliers, as measured by the annual ratio of total output to direct output is smaller. The implicit annual output multiplier shown in Figure 5, as measured by the average annual output multiplier is a more conservative 1.96. Similar to the implied employment multiplier, the implied output multiplier suggests that for every one dollar of direct expenditure, an additional \$0.96 is generated in the state economy through secondary transactions.

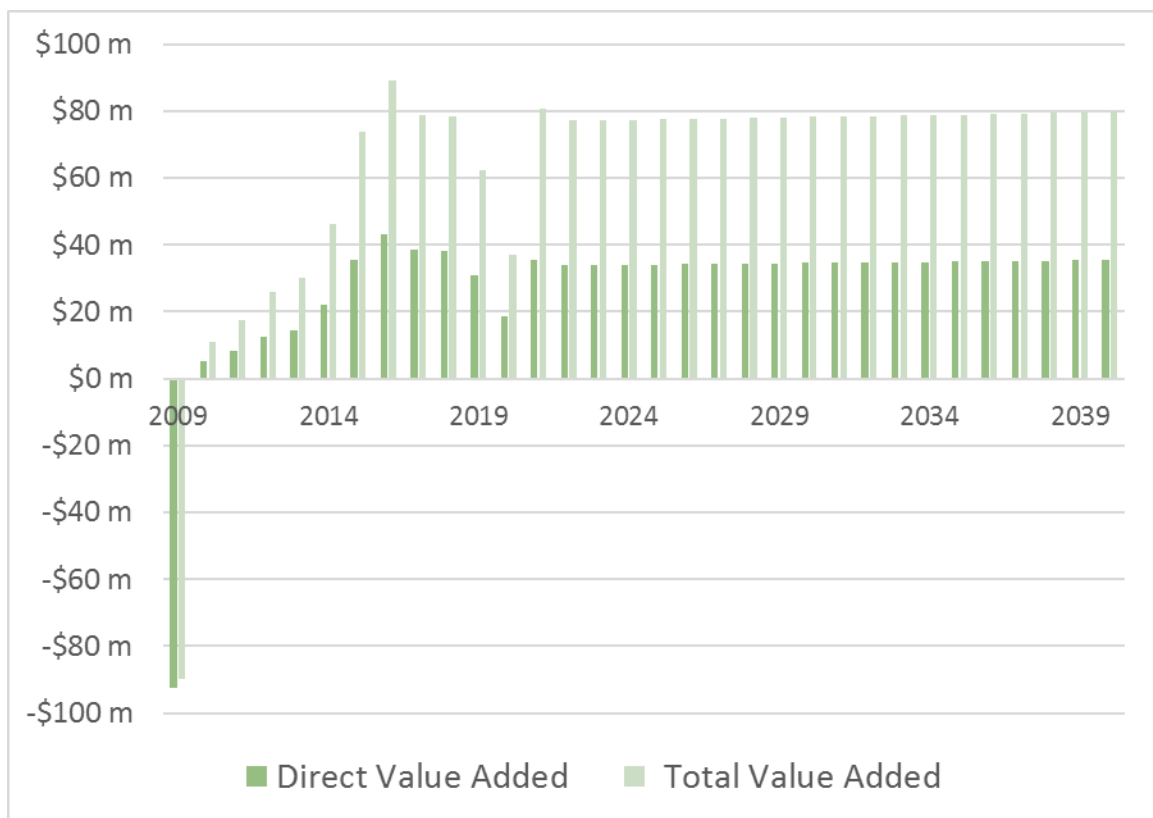




**Figure 5: Time Series of Direct and Total Output (Sales) Effects (FY 2009-2040)**

The final consideration in this analysis considers state investment in FRIB and the expected return of that investment. In this, we treat the state investment of \$94.5 million in initial construction and calculate the net present value of the resulting stream of income. To be clear, this is not a fiscal impact evaluation, where government expenditures are compared to tax revenues. Rather we compare public investment of \$94.5 million against public earnings as measured by gross state (regional) product. Gross state product is a measure of total earnings accruing to the state as the sum of labor income, returns to proprietors and business owners and indirect business tax. To facilitate this analysis, we assume the decision point is 2009, whether to go with public investment or not. A positive value indicates a positive return to public investment, while a negative return suggests that returns over time were not sufficient to cover the initial public investment.

Figure 6 shows the schedule of net gross state product, measured in 2016 dollars. The measures are net in that the first year (2009) subtracts initial public investment of \$94.55 million dollars from the estimated direct and total gross state product impacts. The remaining data points are estimated direct and total gross state product impacts by year.



**Figure 6: Returns to Gross State Product, Net of Initial Public Investment (Net Gross State Product valued in 2016 dollars)**

As evident in Figure 6, the state starts with a net negative return due to initial investment. However, positive returns are significant, leveraged by federal DOE investments in construction. Because of this federal investment, net returns turn positive in 2014 if considering total gross state product as income, and 2016 if limiting returns to direct gross state product.<sup>3</sup> In effect, a large component of the returns to state investment is in leveraging significant federal investment in the construction and operations of FRIB. This explains the relatively large returns from a small state investment in the facilities that precipitates a positive net return on public investment.

Net present values of public investment in FRIB are calculated based on direct and total gross state product flows to Michigan. Future streams are discounted using a five percent discount rate. Additionally, we assume state public investment takes place in 2009, the same year that initial DOE investment takes place.<sup>4</sup> We found that the net present value of this investment in 2016 dollars is equal to \$333 million if limiting consideration to direct flows in gross state product. However, if considering the larger total flows of gross state product that includes secondary transactions, the net present value rises to \$831.6 million.

<sup>3</sup> Future flows are discounted based on a five percent discount rate.

<sup>4</sup> The findings are not sensitive to this assumption.

To further estimate the economic payoff from state investment in FRIB, tax revenue impacts are estimated arising from the construction and operation of FRIB. Total state revenues reported in various issues of the Michigan Comprehensive Annual Financial Reports were collected against various metrics of state economic activities to generate a simple model relating changes in state revenues to changes in state economic production.<sup>5</sup> The resulting estimates provide an expected stream of state revenues over the project's 32 years, from 2009 to 2040. In total \$205.5 million in state revenues are expected. When discounted to 2009, this suggested a project return of \$100.3 million. Measured against the state's initial investment of \$94.5 this amounts to a positive return of \$5.8 million at the time of investment.

## **Conclusions**

This report details best approximations of the economic impact of the MSU FRIB and accounts for both construction-phase and operational phase impacts. A multi-regional input-output model is used in estimating economy-wide impacts for 14 regions that encompass all of Michigan. Impact estimates are also broken out by year of expenditures from the year of first approval for construction (2009) through to the expected life of FRIB through 2040.

The Facility for Rare Isotope Beams will be an important contribution to science and contribute to industry through supplying isotopes for commercial applications and the potential for generating commercial applications from cutting-edge science. For Michigan and MSU, this represents a significant enhancement to an already established reputation as a leader in particle physics research partially build from the presence of the Cyclotron housed in the MSU National Superconducting Cyclotron Laboratory, for which the new facilities will replace and complement. The new facilities are expected to be fully operational by 2021.

The U.S. Department of Energy has committed significant resources for the establishment and operations of the Facilities for Rare Isotope Beams, including \$635.5 million in construction and \$1.5 billion in operational funding over twenty years. The state contributed another \$94.5 million toward construction. For Michigan residents, this is an investment in the future flows of benefits generated from the construction and operation of the facilities, where federal sources make up a significant component.

Annual economic impact estimates are broken out into two parts; those from the construction phase and those from the operational phase of FRIB. To assess the value of Michigan, public investment in FRIB, the report shows the expected net present value of initial state investment in this research facility. While estimated construction impacts varied by year, the analysis shows that expected jobs impacts during the primary construction phase from 2014 to 2019 totaled 1,535 jobs statewide. These jobs impacts are dispersed throughout the state, where larger impacts are expected in the metropolitan regions of Lansing-East Lansing and Detroit. These are expected to generate approximately \$76.8 million in annual labor incomes, measured in 2016

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<sup>5</sup> Actual inflation rates through 2016 applied and projected inflation through 2040 set at 2 percent per year. A discount rate of 5 percent was applied for measuring the present value of the tax revenue stream.

dollars. Operational impacts start in 2021, where, on average, the operations of the facility are expected to generate about 1,002 jobs per year with average annual labor income of \$55,6 million.

In the aggregate, FRIB is expected to generate 32,043 year-equivalent jobs<sup>6</sup> in Michigan with accumulated wages totaling \$1.7 billion. Average annual contributions to gross state product are expected to top \$66.4 million per year. When considering whether this was a profitable investment for Michigan residents, we show that the net present value of this investment is expected to generate an \$831.6 million positive return to Michigan through a positive stream in annual gross state product, and to generate \$205.5 million in public revenues.

This report omits some sources and constraints to realized economic impacts. In this, the report does not take into account many economic factors that may expand or crowd out such impacts. Such factors include commercial applications of isotopes or innovation spin-offs, nor FRIB's role in advancing Michigan's scientific and engineering communities. Such omissions are expected to positively impact Michigan's economy but are difficult to project. Additionally, the analysis does not account for crowding out effects of the construction and operations of FRIB. In this, it is conceivable that construction expenditures at FRIB crowds out other construction expenditures in the state by raising the cost of materials and labor. Additionally, scientific resources allocated to FRIB may crowd out other scientific endeavors in ways that are difficult to measure. The analysis also does not take into consideration additional grant and contract funding for undertaking research. Here, it is anticipated that the presence of the Facility for Rare Isotope Beams will benefit Michigan researchers in competing for additional research dollars. However, it is difficult to estimate how significant these flows of research dollars will be. Despite these issues, it is likely such omitted considerations are small in comparison to direct expenditures associated with the establishment and operations of FRIB.

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<sup>6</sup> Sum of annual jobs

Appendix 1: Construction Impacts (FY 2009-2021)

Year	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
<b>2009</b>	<b>State</b>	<b>53</b>	<b>108</b>	<b>3,075,514</b>	<b>5,448,102</b>	<b>5,754,000</b>	<b>10,438,376</b>	<b>2,402,249</b>	<b>5,009,858</b>
	01	0	0	33	1,645	58	5,050	25	1,890
	02	0	0	4,757	7,425	8,902	16,613	4,317	7,853
	03	0	0	5,255	13,035	10,654	27,054	4,134	11,931
	04	0	0	3,472	8,199	10,180	23,304	2,961	8,472
	05	0	1	8,152	16,752	15,612	39,804	6,687	17,775
	06	0	1	15,981	41,253	34,931	92,503	12,167	38,185
	07	1	3	54,794	158,721	98,226	312,726	45,738	156,028
	08	16	28	753,633	1,172,577	1,600,324	2,507,234	608,295	1,113,261
	09	5	9	232,154	383,729	408,470	737,133	182,719	356,684
	10	0	1	10,126	24,445	21,895	63,911	8,777	27,351
	11	21	48	1,521,058	2,838,101	2,635,542	5,011,504	1,168,245	2,547,161
	12	4	7	201,574	358,947	403,474	761,033	155,748	341,283
	13	5	8	264,451	417,414	505,564	825,831	202,378	375,989
	14	0	0	74	5,859	169	14,675	59	5,994
<b>2010</b>	<b>State</b>	<b>116</b>	<b>234</b>	<b>6,679,730</b>	<b>11,832,251</b>	<b>12,494,400</b>	<b>22,666,085</b>	<b>5,214,968</b>	<b>10,877,127</b>
	01	0	0	73	3,552	126	10,871	55	4,047
	02	0	1	10,432	16,242	19,516	36,306	9,461	17,162
	03	0	1	11,421	28,296	23,144	58,729	8,981	25,897
	04	0	1	7,509	17,741	22,006	50,415	6,405	18,329
	05	1	1	17,750	36,440	33,969	86,543	14,556	38,651
	06	1	2	34,559	89,253	75,518	200,157	26,311	82,625
	07	3	8	119,185	345,004	213,360	679,433	99,475	339,089
	08	35	62	1,637,039	2,546,655	3,476,335	5,445,383	1,320,308	2,416,635
	09	11	19	504,058	832,710	884,351	1,596,925	396,364	773,521
	10	1	1	22,034	53,157	47,592	138,923	19,095	59,459
	11	47	103	3,306,531	6,169,059	5,729,424	10,892,898	2,538,682	5,535,440
	12	8	16	437,633	779,484	876,419	1,653,106	338,005	740,973
	13	10	18	571,344	901,959	1,092,273	1,784,580	437,141	812,311
	14	0	0	160	12,699	367	31,813	128	12,988
<b>2011</b>	<b>State</b>	<b>185</b>	<b>372</b>	<b>10,637,218</b>	<b>18,841,569</b>	<b>19,892,400</b>	<b>36,086,624</b>	<b>8,300,599</b>	<b>17,315,229</b>
	01	0	0	118	5,621	201	17,156	89	6,351
	02	1	1	16,776	26,054	31,374	58,178	15,203	27,503
	03	0	1	18,201	45,036	36,863	93,475	14,305	41,215
	04	0	1	11,905	28,143	34,876	79,962	10,158	29,072
	05	1	2	28,338	58,121	54,195	137,963	23,235	61,624
	06	1	4	54,790	141,575	119,694	317,527	41,713	131,075
	07	4	12	190,086	549,851	339,802	1,082,329	158,633	540,329
	08	56	98	2,607,276	4,055,331	5,536,872	8,671,410	2,101,160	3,846,350
	09	17	31	802,439	1,324,901	1,403,746	2,536,466	630,410	1,229,917
	10	1	2	35,156	84,755	75,850	221,414	30,461	94,775
	11	75	165	5,270,282	9,832,046	9,132,434	17,360,104	4,044,963	8,820,234
	12	13	26	696,644	1,241,113	1,395,843	2,632,856	537,831	1,179,545
	13	16	29	904,953	1,428,841	1,730,063	2,827,215	692,233	1,286,605
	14	0	0	254	20,179	585	50,566	204	20,634

Appendix 1: Construction Impacts (FY 2009-2021)

Year	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
<b>2012</b>	<b>State</b>	<b>277</b>	<b>557</b>	<b>15,926,470</b>	<b>28,224,876</b>	<b>29,838,600</b>	<b>54,109,512</b>	<b>12,442,432</b>	<b>25,952,962</b>
	01	0	0	175	8,416	301	25,704	132	9,531
	02	1	1	25,166	39,059	47,061	87,201	22,846	41,260
	03	1	2	27,337	67,624	55,347	140,313	21,498	61,875
	04	1	2	17,772	42,002	52,016	119,298	15,171	43,384
	05	1	3	42,547	87,219	81,371	207,042	34,911	92,477
	06	2	5	81,787	211,662	178,776	474,728	62,281	195,972
	07	6	18	285,740	825,626	511,955	1,625,952	239,083	811,722
	08	84	147	3,901,950	6,071,194	8,301,243	12,996,446	3,147,852	5,761,661
	09	25	46	1,202,212	1,984,300	2,101,424	3,796,849	945,164	1,842,404
	10	2	3	52,659	127,013	113,585	331,858	45,699	142,083
	11	112	247	7,886,451	14,725,739	13,699,091	26,031,994	6,061,032	13,219,430
	12	20	38	1,042,798	1,858,845	2,093,107	3,947,312	805,804	1,767,520
	13	24	43	1,359,496	2,145,980	2,602,449	4,249,218	1,040,653	1,932,826
	14	0	1	380	30,196	873	75,596	304	30,816
<b>2013</b>	<b>State</b>	<b>321</b>	<b>644</b>	<b>18,392,284</b>	<b>32,612,154</b>	<b>34,524,000</b>	<b>62,581,672</b>	<b>14,386,098</b>	<b>30,004,491</b>
	01	0	0	202	9,718	346	29,705	152	11,033
	02	1	2	29,119	45,165	54,451	100,815	26,482	47,747
	03	1	2	31,672	78,326	64,101	162,464	24,922	71,652
	04	1	2	20,460	48,345	59,829	137,261	17,475	49,929
	05	2	3	49,277	100,960	94,241	239,669	40,463	107,045
	06	2	6	94,154	244,063	205,936	547,406	71,718	225,981
	07	7	21	331,339	956,282	595,033	1,884,202	277,978	940,647
	08	97	170	4,503,956	7,010,435	9,599,892	15,024,478	3,637,501	6,657,000
	09	29	53	1,389,263	2,292,243	2,426,393	4,383,680	1,093,038	2,128,758
	10	2	4	60,840	146,815	131,194	383,653	52,885	164,298
	11	129	285	9,102,176	17,011,395	15,850,713	30,109,921	7,005,111	15,282,175
	12	23	44	1,203,954	2,147,358	2,420,990	4,564,784	931,211	2,042,920
	13	27	50	1,575,437	2,486,197	3,019,877	4,926,470	1,206,811	2,239,812
	14	0	1	437	34,851	1,005	87,164	350	35,493
<b>2014</b>	<b>State</b>	<b>495</b>	<b>995</b>	<b>28,391,443</b>	<b>50,380,598</b>	<b>53,430,000</b>	<b>96,817,698</b>	<b>22,221,927</b>	<b>46,371,857</b>
	01	0	0	311	15,015	533	45,909	235	17,057
	02	2	3	44,824	69,569	83,794	155,314	40,762	73,543
	03	1	3	49,200	121,391	99,447	251,725	38,705	111,051
	04	1	3	31,512	74,491	92,138	211,493	26,928	76,943
	05	3	5	75,997	155,971	145,622	370,728	62,422	165,422
	06	3	9	145,199	376,892	318,158	845,844	110,640	349,065
	07	11	32	510,860	1,477,387	919,386	2,913,802	428,459	1,453,305
	08	150	263	6,949,799	10,823,103	14,851,783	23,234,877	5,618,817	10,284,842
	09	45	82	2,140,307	3,533,089	3,740,928	6,760,400	1,684,941	3,282,257
	10	3	6	93,716	226,663	202,090	592,676	81,493	253,720
	11	199	441	14,040,705	26,270,268	24,519,145	46,565,825	10,812,377	23,609,471
	12	35	68	1,857,391	3,316,361	3,744,512	7,060,534	1,437,304	3,156,460
	13	42	78	2,450,949	3,866,619	4,710,918	7,674,071	1,878,303	3,483,968
	14	0	1	673	53,778	1,548	134,500	540	54,752

Appendix 1: Construction Impacts (FY 2009-2021)

Year	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
<b>2015</b>	<b>State</b>	<b>800</b>	<b>1,597</b>	<b>45,244,380</b>	<b>80,194,413</b>	<b>85,449,706</b>	<b>154,572,334</b>	<b>35,509,692</b>	<b>73,944,789</b>
	01	0	1	475	23,739	816	72,644	359	26,953
	02	3	4	68,583	107,047	128,176	239,518	62,366	113,330
	03	2	4	75,979	189,125	153,373	392,560	59,755	173,372
	04	2	4	48,244	115,214	141,043	327,252	41,247	118,995
	05	4	7	116,508	244,325	223,682	585,552	95,725	261,026
	06	5	15	222,582	596,833	488,616	1,340,567	169,670	554,075
	07	17	52	782,949	2,365,986	1,412,113	4,679,960	656,456	2,336,175
	08	270	466	12,338,281	19,081,184	26,090,538	40,650,149	10,015,545	18,135,256
	09	68	126	3,277,654	5,445,219	5,733,218	10,439,008	2,581,867	5,065,574
	10	4	10	143,494	350,737	309,434	919,410	124,827	393,026
	11	306	679	21,529,668	40,449,452	37,703,565	71,802,417	16,589,608	36,367,704
	12	53	106	2,848,408	5,132,606	5,757,282	10,963,737	2,205,251	4,896,517
	13	65	121	3,790,525	6,008,167	7,305,479	11,946,665	2,906,188	5,415,931
	14	0	2	1,030	84,778	2,369	212,896	827	86,855
<b>2016</b>	<b>State</b>	<b>980</b>	<b>1,917</b>	<b>54,299,461</b>	<b>96,295,039</b>	<b>103,289,734</b>	<b>186,303,415</b>	<b>43,173,937</b>	<b>89,336,604</b>
	01	0	1	567	28,288	974	86,777	429	32,184
	02	3	5	81,847	128,070	152,924	286,701	74,424	135,777
	03	2	5	91,504	227,470	184,478	472,088	71,947	208,523
	04	2	5	57,607	137,422	168,399	390,343	49,278	141,972
	05	5	9	139,312	292,840	267,985	702,724	114,492	313,141
	06	6	18	266,130	710,997	585,291	1,598,464	202,942	660,783
	07	21	62	935,942	2,841,012	1,691,746	5,629,730	784,511	2,808,290
	08	345	561	14,908,910	23,033,874	32,047,610	49,568,437	12,639,618	22,413,597
	09	82	151	3,914,896	6,505,878	6,852,997	12,474,994	3,085,681	6,054,257
	10	5	11	171,365	420,790	369,543	1,103,138	149,131	471,505
	11	366	814	25,749,367	48,473,448	45,221,326	86,149,145	19,853,222	43,592,508
	12	64	127	3,407,038	6,150,179	6,904,195	13,153,166	2,639,009	5,868,110
	13	79	146	4,573,746	7,242,609	8,839,437	14,430,764	3,508,265	6,530,743
	14	0	3	1,230	102,164	2,829	256,944	988	105,213
<b>2017</b>	<b>State</b>	<b>870</b>	<b>1,695</b>	<b>47,544,258</b>	<b>84,152,798</b>	<b>91,277,038</b>	<b>163,804,092</b>	<b>38,490,698</b>	<b>78,780,159</b>
	01	0	1	470	24,270	808	74,739	356	27,644
	02	3	4	67,814	107,159	126,670	240,697	61,660	114,051
	03	2	4	76,538	192,887	154,102	400,913	60,163	177,285
	04	2	4	47,758	115,246	139,595	327,564	40,876	119,065
	05	4	8	115,663	250,219	222,945	606,570	95,084	270,242
	06	5	15	220,939	611,619	486,837	1,376,769	168,547	570,669
	07	17	54	776,843	2,501,120	1,407,377	4,977,300	650,962	2,486,682
	08	342	557	14,802,445	22,678,105	31,898,987	48,818,055	13,096,135	22,556,729
	09	68	126	3,246,605	5,439,811	5,687,608	10,450,631	2,560,545	5,070,699
	10	4	10	142,089	354,684	306,415	932,063	123,704	397,802
	11	305	681	21,383,265	40,511,822	37,664,599	72,078,569	16,497,408	36,440,055
	12	53	106	2,829,645	5,173,885	5,749,569	11,103,759	2,192,870	4,949,099
	13	66	123	3,833,165	6,103,206	7,429,180	12,191,666	2,941,569	5,507,382
	14	0	2	1,019	88,767	2,345	224,797	819	92,755

Appendix 1: Construction Impacts (FY 2009-2021)

Year	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
<b>2018</b>	<b>State</b>	<b>861</b>	<b>1,678</b>	<b>47,328,655</b>	<b>83,839,858</b>	<b>91,059,928</b>	<b>163,388,298</b>	<b>38,315,786</b>	<b>78,493,223</b>
	01	0	1	468	24,202	804	74,533	354	27,580
	02	3	4	67,428	106,594	125,916	239,452	61,306	113,432
	03	2	4	76,805	192,991	154,445	401,007	60,357	177,369
	04	2	4	47,514	114,668	138,869	325,908	40,690	118,485
	05	4	8	115,235	249,493	222,568	605,357	94,760	269,441
	06	5	15	220,112	609,410	485,932	1,372,596	167,981	568,685
	07	17	54	773,785	2,491,261	1,405,008	4,961,636	648,231	2,476,508
	08	334	542	14,668,408	22,487,947	31,671,156	48,472,483	12,970,686	22,364,234
	09	68	126	3,230,988	5,414,868	5,664,498	10,407,954	2,549,779	5,049,014
	10	4	10	141,383	353,593	304,899	929,728	123,138	396,674
	11	304	679	21,309,707	40,411,491	37,644,136	72,008,943	16,450,920	36,365,174
	12	53	106	2,820,179	5,160,103	5,745,420	11,090,320	2,186,593	4,937,717
	13	66	123	3,855,630	6,134,889	7,493,944	12,274,695	2,960,175	5,536,663
	14	0	2	1,014	88,348	2,333	223,686	815	92,246
<b>2019</b>	<b>State</b>	<b>668</b>	<b>1,327</b>	<b>37,337,124</b>	<b>66,011,857</b>	<b>72,460,013</b>	<b>129,388,650</b>	<b>30,750,158</b>	<b>62,341,523</b>
	01	0	0	349	18,710	599	57,845	264	21,345
	02	2	3	50,267	80,307	93,844	181,046	45,701	85,813
	03	1	3	57,813	147,386	116,103	306,725	45,420	135,822
	04	1	3	35,444	86,595	103,580	246,292	30,370	89,481
	05	3	6	86,091	192,081	166,629	470,803	70,815	209,526
	06	4	12	164,433	472,386	363,737	1,065,266	125,540	442,553
	07	13	43	577,932	1,975,520	1,051,892	3,950,166	484,024	1,974,733
	08	273	469	12,906,121	19,655,429	27,909,999	42,367,306	11,780,256	19,878,828
	09	50	95	2,410,952	4,076,277	4,230,189	7,850,551	1,903,863	3,807,568
	10	3	7	105,482	268,438	227,480	707,566	91,908	301,433
	11	228	511	15,924,399	30,404,506	28,217,000	54,237,166	12,301,609	27,365,574
	12	40	80	2,107,685	3,909,293	4,305,801	8,431,914	1,635,005	3,750,640
	13	50	93	2,909,400	4,655,757	5,671,421	9,339,678	2,234,773	4,204,952
	14	0	2	756	69,173	1,740	176,327	609	73,256
<b>2020</b>	<b>State</b>	<b>402</b>	<b>792</b>	<b>22,034,142</b>	<b>38,762,842</b>	<b>43,431,452</b>	<b>76,842,013</b>	<b>18,722,210</b>	<b>37,220,094</b>
	01	0	0	182	11,021	312	34,268	138	12,575
	02	1	2	26,187	44,446	48,875	102,774	23,807	48,605
	03	1	2	30,396	83,881	60,967	176,022	23,874	78,394
	04	1	2	18,475	48,243	53,987	138,068	15,840	50,563
	05	2	3	44,941	107,360	87,161	268,601	36,977	119,583
	06	2	7	85,833	268,363	190,235	606,269	65,557	253,446
	07	7	25	301,623	1,165,969	550,258	2,347,356	252,552	1,177,965
	08	189	321	9,015,261	13,596,132	19,507,256	29,274,694	8,590,029	14,077,446
	09	26	50	1,257,114	2,169,380	2,207,350	4,193,301	993,320	2,033,458
	10	2	4	54,991	145,306	118,596	384,810	47,934	163,447
	11	119	271	8,315,152	16,113,365	14,777,498	28,749,582	6,427,529	14,499,217
	12	21	43	1,100,650	2,101,176	2,254,520	4,557,858	854,228	2,026,181
	13	26	50	1,533,986	2,487,548	2,998,902	5,008,697	1,178,841	2,250,036
	14	6	12	249,350	420,651	575,536	999,714	211,583	429,179



Appendix 1: Construction Impacts (FY 2009-2021)

Year	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
<b>2021</b>	<b>State</b>	<b>40</b>	<b>80</b>	<b>2,257,901</b>	<b>4,023,184</b>	<b>4,356,600</b>	<b>7,856,570</b>	<b>1,779,994</b>	<b>3,724,407</b>
	01	0	0	23	1,313	40	4,011	18	1,492
	02	0	0	3,384	5,729	6,315	13,315	3,077	6,249
	03	0	0	3,967	10,624	7,947	22,234	3,115	9,910
	04	0	0	2,389	6,177	6,981	17,715	2,050	6,580
	05	0	0	5,821	12,278	11,315	29,585	4,791	13,093
	06	0	1	11,118	29,725	24,691	67,032	8,495	27,632
	07	1	3	39,060	115,493	71,436	229,709	32,697	113,797
	08	12	20	534,405	835,855	1,164,152	1,816,977	435,439	798,610
	09	3	6	162,632	270,347	285,796	519,457	128,591	251,873
	10	0	0	7,113	17,603	15,340	46,272	6,203	19,744
	11	15	34	1,077,393	2,038,187	1,920,818	3,649,980	833,383	1,836,690
	12	3	5	142,624	256,917	292,983	553,163	110,750	245,339
	13	3	6	200,829	316,166	393,813	635,063	154,410	285,212
	14	2	3	67,141	106,770	154,971	252,057	56,974	108,187

Appendix 2: Operational Impacts (FY 2021-2040)

	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
2021	State	390	1,005	28,586,560	54,501,146	76,790,683	158,001,459	33,780,390	76,963,066
	1	0	0	0	3,921	0	18,575	0	6,380
	2	0	0	0	7,285	0	37,611	0	15,077
	3	0	1	0	46,119	0	164,650	0	84,087
	4	0	0	0	7,575	0	33,150	0	12,412
	5	0	1	0	50,667	0	267,408	0	125,376
	6	0	9	0	407,756	0	1,294,431	0	611,254
	7	0	32	0	1,617,357	0	4,628,498	0	2,482,236
	8	390	886	28,586,560	47,667,037	76,790,683	139,336,644	33,780,390	66,943,695
	9	0	8	0	361,084	0	1,154,800	0	596,803
	10	0	1	0	24,089	0	115,635	0	48,884
	11	0	35	0	2,360,567	0	5,474,959	0	3,119,638
	12	0	16	0	897,779	0	2,980,676	0	1,500,761
	13	0	16	0	1,027,490	0	2,400,262	0	1,373,918
	14	0	1	0	22,419	0	94,159	0	42,544
2022	State	390	1,005	28,667,658	54,614,296	76,849,025	158,162,691	33,865,562	77,105,151
	1	0	0	0	3,925	0	18,592	0	6,386
	2	0	0	0	7,293	0	37,650	0	15,093
	3	0	1	0	46,167	0	164,820	0	84,174
	4	0	0	0	7,582	0	33,184	0	12,424
	5	0	1	0	50,723	0	267,727	0	125,531
	6	0	9	0	408,126	0	1,295,617	0	611,814
	7	0	32	0	1,618,885	0	4,632,973	0	2,484,646
	8	390	886	28,667,658	47,773,734	76,849,025	139,479,724	33,865,562	67,076,081
	9	0	8	0	361,460	0	1,156,035	0	597,448
	10	0	1	0	24,115	0	115,765	0	48,939
	11	0	35	0	2,362,764	0	5,480,150	0	3,122,583
	12	0	16	0	898,638	0	2,983,662	0	1,502,242
	13	0	16	0	1,028,441	0	2,402,545	0	1,375,206
	14	0	1	0	22,441	0	94,247	0	42,583
2023	State	390	1,005	28,748,755	54,727,445	76,907,368	158,323,923	33,950,733	77,247,235
	1	0	0	0	3,929	0	18,609	0	6,392
	2	0	0	0	7,300	0	37,689	0	15,109
	3	0	1	0	46,215	0	164,991	0	84,260
	4	0	0	0	7,590	0	33,217	0	12,437
	5	0	1	0	50,780	0	268,046	0	125,685
	6	0	9	0	408,497	0	1,296,803	0	612,374
	7	0	32	0	1,620,413	0	4,637,448	0	2,487,056
	8	390	886	28,748,755	47,880,431	76,907,368	139,622,803	33,950,733	67,208,466
	9	0	8	0	361,836	0	1,157,269	0	598,094
	10	0	1	0	24,142	0	115,895	0	48,995
	11	0	35	0	2,364,961	0	5,485,341	0	3,125,528
	12	0	16	0	899,498	0	2,986,649	0	1,503,724
	13	0	16	0	1,029,391	0	2,404,828	0	1,376,495
	14	0	1	0	22,462	0	94,335	0	42,622
2024	State	390	1,004	28,829,853	54,840,595	76,965,711	158,485,155	34,035,905	77,389,320
	1	0	0	0	3,932	0	18,626	0	6,398
	2	0	0	0	7,308	0	37,729	0	15,125
	3	0	1	0	46,263	0	165,161	0	84,347
	4	0	0	0	7,597	0	33,250	0	12,449
	5	0	1	0	50,836	0	268,365	0	125,839
	6	0	9	0	408,867	0	1,297,988	0	612,934
	7	0	32	0	1,621,941	0	4,641,923	0	2,489,466
	8	390	886	28,829,853	47,987,129	76,965,711	139,765,882	34,035,905	67,340,852
	9	0	8	0	362,213	0	1,158,504	0	598,739
	10	0	1	0	24,169	0	116,024	0	49,050
	11	0	35	0	2,367,158	0	5,490,532	0	3,128,472
	12	0	16	0	900,357	0	2,989,635	0	1,505,205
	13	0	16	0	1,030,342	0	2,407,111	0	1,377,783
	14	0	1	0	22,484	0	94,423	0	42,661

Appendix 2: Operational Impacts (FY 2021-2040)

	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
2025	State	390	1,004	28,910,951	54,953,745	77,024,053	158,646,387	34,121,076	77,531,404
	1	0	0	0	3,936	0	18,644	0	6,404
	2	0	0	0	7,316	0	37,768	0	15,141
	3	0	1	0	46,311	0	165,331	0	84,433
	4	0	0	0	7,605	0	33,284	0	12,462
	5	0	1	0	50,892	0	268,684	0	125,993
	6	0	9	0	409,237	0	1,299,174	0	613,494
	7	0	32	0	1,623,470	0	4,646,399	0	2,491,876
	8	390	885	28,910,951	48,093,826	77,024,053	139,908,961	34,121,076	67,473,237
	9	0	8	0	362,589	0	1,159,739	0	599,384
	10	0	1	0	24,195	0	116,154	0	49,105
	11	0	35	0	2,369,355	0	5,495,723	0	3,131,417
	12	0	16	0	901,216	0	2,992,622	0	1,506,687
	13	0	16	0	1,031,292	0	2,409,393	0	1,379,072
	14	0	1	0	22,505	0	94,511	0	42,700
2026	State	390	1,004	28,992,049	55,066,894	77,082,396	158,807,618	34,206,248	77,673,489
	1	0	0	0	3,939	0	18,661	0	6,410
	2	0	0	0	7,323	0	37,807	0	15,157
	3	0	1	0	46,360	0	165,501	0	84,519
	4	0	0	0	7,612	0	33,317	0	12,474
	5	0	1	0	50,948	0	269,003	0	126,148
	6	0	9	0	409,608	0	1,300,360	0	614,054
	7	0	32	0	1,624,998	0	4,650,874	0	2,494,286
	8	390	885	28,992,049	48,200,523	77,082,396	140,052,040	34,206,248	67,605,623
	9	0	8	0	362,965	0	1,160,974	0	600,029
	10	0	1	0	24,222	0	116,284	0	49,160
	11	0	35	0	2,371,552	0	5,500,914	0	3,134,362
	12	0	16	0	902,075	0	2,995,608	0	1,508,168
	13	0	16	0	1,032,243	0	2,411,676	0	1,380,361
	14	0	1	0	22,527	0	94,599	0	42,738
2027	State	389	1,003	29,073,146	55,180,044	77,140,739	158,968,850	34,291,419	77,815,573
	1	0	0	0	3,943	0	18,678	0	6,415
	2	0	0	0	7,331	0	37,847	0	15,173
	3	0	1	0	46,408	0	165,671	0	84,606
	4	0	0	0	7,620	0	33,350	0	12,487
	5	0	1	0	51,004	0	269,322	0	126,302
	6	0	9	0	409,978	0	1,301,546	0	614,613
	7	0	32	0	1,626,526	0	4,655,349	0	2,496,697
	8	389	885	29,073,146	48,307,220	77,140,739	140,195,119	34,291,419	67,738,009
	9	0	8	0	363,341	0	1,162,209	0	600,674
	10	0	1	0	24,248	0	116,414	0	49,215
	11	0	35	0	2,373,749	0	5,506,105	0	3,137,306
	12	0	16	0	902,934	0	2,998,595	0	1,509,650
	13	0	16	0	1,033,194	0	2,413,959	0	1,381,649
	14	0	1	0	22,548	0	94,687	0	42,777
2028	State	389	1,003	29,154,244	55,293,194	77,199,082	159,130,082	34,376,591	77,957,658
	1	0	0	0	3,947	0	18,695	0	6,421
	2	0	0	0	7,338	0	37,886	0	15,189
	3	0	1	0	46,456	0	165,842	0	84,692
	4	0	0	0	7,627	0	33,384	0	12,499
	5	0	1	0	51,060	0	269,641	0	126,456
	6	0	9	0	410,349	0	1,302,732	0	615,173
	7	0	31	0	1,628,054	0	4,659,824	0	2,499,107
	8	389	885	29,154,244	48,413,918	77,199,082	140,338,198	34,376,591	67,870,394
	9	0	8	0	363,717	0	1,163,443	0	601,319
	10	0	1	0	24,275	0	116,544	0	49,270
	11	0	35	0	2,375,946	0	5,511,296	0	3,140,251
	12	0	16	0	903,794	0	3,001,581	0	1,511,131
	13	0	16	0	1,034,144	0	2,416,241	0	1,382,938
	14	0	1	0	22,570	0	94,775	0	42,816

Appendix 2: Operational Impacts (FY 2021-2040)

	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
2029	State	389	1,003	29,235,342	55,406,344	77,257,424	159,291,314	34,461,762	78,099,742
	1	0	0	0	3,950	0	18,712	0	6,427
	2	0	0	0	7,346	0	37,925	0	15,205
	3	0	1	0	46,504	0	166,012	0	84,779
	4	0	0	0	7,635	0	33,417	0	12,512
	5	0	1	0	51,116	0	269,960	0	126,610
	6	0	9	0	410,719	0	1,303,917	0	615,733
	7	0	31	0	1,629,582	0	4,664,300	0	2,501,517
	8	389	885	29,235,342	48,520,615	77,257,424	140,481,277	34,461,762	68,002,780
	9	0	8	0	364,093	0	1,164,678	0	601,964
	10	0	1	0	24,301	0	116,673	0	49,325
	11	0	35	0	2,378,143	0	5,516,487	0	3,143,196
	12	0	16	0	904,653	0	3,004,568	0	1,512,613
	13	0	16	0	1,035,095	0	2,418,524	0	1,384,226
	14	0	1	0	22,591	0	94,863	0	42,855
2030	State	389	1,002	29,316,440	55,519,493	77,315,767	159,452,546	34,546,934	78,241,827
	1	0	0	0	3,954	0	18,729	0	6,433
	2	0	0	0	7,354	0	37,965	0	15,221
	3	0	1	0	46,552	0	166,182	0	84,865
	4	0	0	0	7,642	0	33,450	0	12,524
	5	0	1	0	51,172	0	270,279	0	126,764
	6	0	9	0	411,090	0	1,305,103	0	616,293
	7	0	31	0	1,631,110	0	4,668,775	0	2,503,927
	8	389	884	29,316,440	48,627,312	77,315,767	140,624,357	34,546,934	68,135,165
	9	0	8	0	364,469	0	1,165,913	0	602,609
	10	0	1	0	24,328	0	116,803	0	49,381
	11	0	35	0	2,380,340	0	5,521,678	0	3,146,140
	12	0	16	0	905,512	0	3,007,555	0	1,514,094
	13	0	16	0	1,036,046	0	2,420,807	0	1,385,515
	14	0	1	0	22,613	0	94,951	0	42,894
2031	State	389	1,002	29,397,537	55,632,643	77,374,110	159,613,778	34,632,106	78,383,911
	1	0	0	0	3,957	0	18,746	0	6,439
	2	0	0	0	7,361	0	38,004	0	15,237
	3	0	1	0	46,600	0	166,352	0	84,952
	4	0	0	0	7,650	0	33,484	0	12,537
	5	0	1	0	51,228	0	270,598	0	126,919
	6	0	9	0	411,460	0	1,306,289	0	616,853
	7	0	31	0	1,632,638	0	4,673,250	0	2,506,337
	8	389	884	29,397,537	48,734,009	77,374,110	140,767,436	34,632,106	68,267,551
	9	0	8	0	364,845	0	1,167,148	0	603,255
	10	0	1	0	24,354	0	116,933	0	49,436
	11	0	35	0	2,382,537	0	5,526,869	0	3,149,085
	12	0	16	0	906,371	0	3,010,541	0	1,515,576
	13	0	16	0	1,036,996	0	2,423,089	0	1,386,803
	14	0	1	0	22,634	0	95,039	0	42,933
2032	State	389	1,002	29,478,635	55,745,793	77,432,452	159,775,010	34,717,277	78,525,996
	1	0	0	0	3,961	0	18,763	0	6,445
	2	0	0	0	7,369	0	38,043	0	15,253
	3	0	1	0	46,648	0	166,522	0	85,038
	4	0	0	0	7,657	0	33,517	0	12,549
	5	0	1	0	51,284	0	270,917	0	127,073
	6	0	9	0	411,830	0	1,307,475	0	617,413
	7	0	31	0	1,634,167	0	4,677,725	0	2,508,748
	8	389	884	29,478,635	48,840,706	77,432,452	140,910,515	34,717,277	68,399,936
	9	0	8	0	365,221	0	1,168,383	0	603,900
	10	0	1	0	24,381	0	117,063	0	49,491
	11	0	35	0	2,384,734	0	5,532,060	0	3,152,030
	12	0	16	0	907,231	0	3,013,528	0	1,517,057
	13	0	16	0	1,037,947	0	2,425,372	0	1,388,092
	14	0	1	0	22,656	0	95,127	0	42,972

Appendix 2: Operational Impacts (FY 2021-2040)

	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
2033	State	389	1,002	29,559,733	55,858,942	77,490,795	159,936,242	34,802,449	78,668,080
	1	0	0	0	3,965	0	18,781	0	6,451
	2	0	0	0	7,376	0	38,083	0	15,269
	3	0	1	0	46,696	0	166,693	0	85,124
	4	0	0	0	7,665	0	33,551	0	12,562
	5	0	1	0	51,340	0	271,236	0	127,227
	6	0	9	0	412,201	0	1,308,660	0	617,973
	7	0	31	0	1,635,695	0	4,682,201	0	2,511,158
	8	389	884	29,559,733	48,947,404	77,490,795	141,053,594	34,802,449	68,532,322
	9	0	8	0	365,597	0	1,169,617	0	604,545
	10	0	1	0	24,408	0	117,193	0	49,546
	11	0	35	0	2,386,931	0	5,537,251	0	3,154,975
	12	0	16	0	908,090	0	3,016,514	0	1,518,538
	13	0	16	0	1,038,898	0	2,427,655	0	1,389,381
	14	0	1	0	22,678	0	95,215	0	43,011
2034	State	389	1,001	29,640,831	55,972,092	77,549,138	160,097,474	34,887,620	78,810,165
	1	0	0	0	3,968	0	18,798	0	6,457
	2	0	0	0	7,384	0	38,122	0	15,285
	3	0	1	0	46,744	0	166,863	0	85,211
	4	0	0	0	7,672	0	33,584	0	12,574
	5	0	1	0	51,397	0	271,555	0	127,381
	6	0	9	0	412,571	0	1,309,846	0	618,532
	7	0	31	0	1,637,223	0	4,686,676	0	2,513,568
	8	389	883	29,640,831	49,054,101	77,549,138	141,196,673	34,887,620	68,664,707
	9	0	8	0	365,974	0	1,170,852	0	605,190
	10	0	1	0	24,434	0	117,322	0	49,601
	11	0	35	0	2,389,128	0	5,542,442	0	3,157,919
	12	0	16	0	908,949	0	3,019,501	0	1,520,020
	13	0	16	0	1,039,848	0	2,429,937	0	1,390,669
	14	0	1	0	22,699	0	95,302	0	43,050
2035	State	389	1,001	29,721,928	56,085,242	77,607,480	160,258,706	34,972,792	78,952,249
	1	0	0	0	3,972	0	18,815	0	6,463
	2	0	0	0	7,391	0	38,161	0	15,301
	3	0	1	0	46,793	0	167,033	0	85,297
	4	0	0	0	7,680	0	33,617	0	12,587
	5	0	1	0	51,453	0	271,874	0	127,536
	6	0	9	0	412,942	0	1,311,032	0	619,092
	7	0	31	0	1,638,751	0	4,691,151	0	2,515,978
	8	389	883	29,721,928	49,160,798	77,607,480	141,339,752	34,972,792	68,797,093
	9	0	8	0	366,350	0	1,172,087	0	605,835
	10	0	1	0	24,461	0	117,452	0	49,656
	11	0	35	0	2,391,325	0	5,547,633	0	3,160,864
	12	0	16	0	909,808	0	3,022,487	0	1,521,501
	13	0	16	0	1,040,799	0	2,432,220	0	1,391,958
	14	0	1	0	22,721	0	95,390	0	43,088
2036	State	389	1,001	29,803,026	56,198,391	77,665,823	160,419,938	35,057,963	79,094,334
	1	0	0	0	3,976	0	18,832	0	6,469
	2	0	0	0	7,399	0	38,201	0	15,317
	3	0	1	0	46,841	0	167,203	0	85,384
	4	0	0	0	7,687	0	33,651	0	12,600
	5	0	1	0	51,509	0	272,193	0	127,690
	6	0	9	0	413,312	0	1,312,218	0	619,652
	7	0	31	0	1,640,279	0	4,695,626	0	2,518,388
	8	389	883	29,803,026	49,267,495	77,665,823	141,482,831	35,057,963	68,929,479
	9	0	8	0	366,726	0	1,173,322	0	606,480
	10	0	1	0	24,487	0	117,582	0	49,711
	11	0	35	0	2,393,522	0	5,552,824	0	3,163,809
	12	0	16	0	910,668	0	3,025,474	0	1,522,983
	13	0	16	0	1,041,749	0	2,434,503	0	1,393,246
	14	0	1	0	22,742	0	95,478	0	43,127

Appendix 2: Operational Impacts (FY 2021-2040)

	Region	Direct Employ	Total Employ	Direct Labor Income	Total Labor Income	Direct Output	Total Output	Direct Value Added	Total Value Added
2037	State	389	1,000	29,884,124	56,311,541	77,724,166	160,581,170	35,143,135	79,236,418
	1	0	0	0	3,979	0	18,849	0	6,474
	2	0	0	0	7,407	0	38,240	0	15,333
	3	0	1	0	46,889	0	167,373	0	85,470
	4	0	0	0	7,695	0	33,684	0	12,612
	5	0	1	0	51,565	0	272,512	0	127,844
	6	0	9	0	413,683	0	1,313,403	0	620,212
	7	0	31	0	1,641,807	0	4,700,102	0	2,520,798
	8	389	883	29,884,124	49,374,193	77,724,166	141,625,911	35,143,135	69,061,864
	9	0	8	0	367,102	0	1,174,557	0	607,125
	10	0	1	0	24,514	0	117,712	0	49,767
	11	0	35	0	2,395,719	0	5,558,016	0	3,166,753
	12	0	16	0	911,527	0	3,028,460	0	1,524,464
	13	0	16	0	1,042,700	0	2,436,786	0	1,394,535
	14	0	1	0	22,764	0	95,566	0	43,166
2038	State	389	1,000	29,965,222	56,424,691	77,782,508	160,742,402	35,228,306	79,378,503
	1	0	0	0	3,983	0	18,866	0	6,480
	2	0	0	0	7,414	0	38,279	0	15,349
	3	0	1	0	46,937	0	167,544	0	85,556
	4	0	0	0	7,702	0	33,717	0	12,625
	5	0	1	0	51,621	0	272,831	0	127,998
	6	0	9	0	414,053	0	1,314,589	0	620,772
	7	0	31	0	1,643,336	0	4,704,577	0	2,523,209
	8	389	882	29,965,222	49,480,890	77,782,508	141,768,990	35,228,306	69,194,250
	9	0	8	0	367,478	0	1,175,791	0	607,770
	10	0	1	0	24,540	0	117,842	0	49,822
	11	0	34	0	2,397,916	0	5,563,207	0	3,169,698
	12	0	16	0	912,386	0	3,031,447	0	1,525,946
	13	0	15	0	1,043,651	0	2,439,068	0	1,395,823
	14	0	1	0	22,785	0	95,654	0	43,205
2039	State	389	1,000	30,046,319	56,537,841	77,840,851	160,903,634	35,313,478	79,520,587
	1	0	0	0	3,986	0	18,883	0	6,486
	2	0	0	0	7,422	0	38,319	0	15,365
	3	0	1	0	46,985	0	167,714	0	85,643
	4	0	0	0	7,709	0	33,751	0	12,637
	5	0	1	0	51,677	0	273,150	0	128,153
	6	0	9	0	414,423	0	1,315,775	0	621,332
	7	0	31	0	1,644,864	0	4,709,052	0	2,525,619
	8	389	882	30,046,319	49,587,587	77,840,851	141,912,069	35,313,478	69,326,635
	9	0	8	0	367,854	0	1,177,026	0	608,416
	10	0	1	0	24,567	0	117,971	0	49,877
	11	0	34	0	2,400,113	0	5,568,398	0	3,172,643
	12	0	16	0	913,245	0	3,034,433	0	1,527,427
	13	0	15	0	1,044,601	0	2,441,351	0	1,397,112
	14	0	1	0	22,807	0	95,742	0	43,244
2040	State	389	999	30,208,515	56,764,140	77,957,536	161,226,097	35,483,821	79,804,756
	1	0	0	0	3,994	0	18,918	0	6,498
	2	0	0	0	7,437	0	38,397	0	15,397
	3	0	1	0	47,081	0	168,054	0	85,816
	4	0	0	0	7,724	0	33,817	0	12,662
	5	0	1	0	51,789	0	273,788	0	128,461
	6	0	9	0	415,164	0	1,318,146	0	622,451
	7	0	31	0	1,647,920	0	4,718,003	0	2,530,439
	8	389	882	30,208,515	49,800,981	77,957,536	142,198,227	35,483,821	69,591,406
	9	0	8	0	368,606	0	1,179,496	0	609,706
	10	0	1	0	24,620	0	118,231	0	49,987
	11	0	34	0	2,404,507	0	5,578,780	0	3,178,532
	12	0	16	0	914,964	0	3,040,406	0	1,530,390
	13	0	15	0	1,046,503	0	2,445,916	0	1,399,689
	14	0	1	0	22,850	0	95,918	0	43,322

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