Economic Impacts of the Proposed Northeast Supply Enhancement Pipeline Project in New Jersey, Pennsylvania and New York

Submitted to:

Megan Stafford
Williams Gas Pipeline

June 2017

Michael L. Lahr, Will Irving

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

Table of Contents

Executive Summary

This report estimates the economic impacts for New Jersey, New York and Pennsylvania of Williams Pipeline Partner's proposed Northeast Supply Enhancement Project, which would add 37.1 miles of pipeline to the existing Transco pipeline system in the three states, a new compressor station in Somerset County, New Jersey, and a new 21,902-horsepower motor to an existing compressor station in Chester County, Pennsylvania. Williams estimates expenditures of approximately $255.4 million in the three states for installation and upgrades of natural gas pipeline and related infrastructure. These regional expenditures are part of approximately $926.5 million in total estimated expenditures for the project.

- Based on the economic impact analysis detailed in this report, it is estimated that Williams' expenditures of $255.4 million in the three states ($52.1 million in Pennsylvania, $184.7 million in New Jersey and $18.6 million in New York) for these projects will generate:
  - 3,186 total job-years (one job-year is equivalent to one job lasting one year);
  - $327.2 million in GDP;
  - $234.1 million in compensation (income);
  - $12.5 million in state tax revenues; and $10.2 million in local tax revenues.
  - In addition, Williams estimates expenditures of approximately $630,000 for state and local environmental and building permits, and direct property tax payments on the pipeline and stations of approximately $11.1 million annually, with $9.8 million of that total in New York.

New Jersey

- The estimated statewide economic impacts of the approximately $184.7 million in in-state expenditures for all Northeast Supply Enhancement Project components in New Jersey include:
  - 2,411 total job-years;
  - $239.9 million in GDP;
  - $171.9 million in compensation;
  - $9.9 million in state tax revenues and $6.5 million in local tax revenues (statewide).
  - In addition to the $6.5 million in indirect local tax revenues generated by the construction process, Williams has estimated local environmental and building permit payments of $225,000 to the municipalities and counties where the work is performed, and approximately $50,000 in environmental permit payments to the state.

- Williams also estimates that approximately $1.3 million in property taxes and submerged land easement fees will be paid annually for the new pipeline to municipalities and the state.

Pennsylvania

- The estimated statewide economic impacts of the approximately $52.1 million in in-state expenditures for the two Northeast Supply Enhancement Project components in Pennsylvania include:
  - 499 total job-years;
  - $63.6 million in GDP;
  - $45.6 million in compensation;
  - $1.5 million in state tax revenues and $2.4 million in local tax revenues (statewide).
  - In addition to the state and local tax revenues generated by the construction process, Williams has estimated local environmental and building permit payments of $280,000 to the municipalities and counties where the work is performed, and approximately $65,183 in environmental permit payments to the state.

New York

- The estimated economic impacts of the approximately $18.6 million of in-state (New York) expenditures for construction of the Raritan Bay Loop include:
  - 276 total job-years statewide;
  - $23.7 million in GDP statewide;
  - $16.6 million in compensation statewide;
  - $1.1 million in state tax revenues and $1.2 million in local tax revenues (statewide).
  - In addition to the state and local tax revenues generated by the construction process, Williams has estimated $10,000 in environmental permit payments to the state.
  - Williams also estimates that approximately $9.8 million will be paid annually as a submerged land easement fee for the new pipeline based on use of New York waters.

Introduction

This report assesses the economic impact on New Jersey, New York and Pennsylvania of Williams Pipeline Partners' planned construction of several new natural gas pipeline loops and related compressor station additions and upgrades as part of its Northeast Supply Enhancement Project.[1] The full scope of the approximately $926.5 million project will include pipeline additions and compressor station installation or upgrades in New Jersey and Pennsylvania, as well as pipeline additions in Raritan Bay waters between New York and New Jersey. The project includes five main components – three in New Jersey/New York and two in Pennsylvania:

New Jersey/New York

- Madison Loop: Installation of 3.4 miles of 26-inch looped natural gas pipeline (laid adjacent to existing pipeline) in Middlesex County, New Jersey.
- Raritan Bay Loop: Installation of 23.5 miles of 26-inch looped natural gas pipeline in the Raritan Bay, extending from Middlesex County, New Jersey into New York waters.
- Compressor Station: Installation of a new 32,000-horsepower gas turbine compressor station in Somerset County, New Jersey.

Pennsylvania

- Quaryville Loop: Installation of 10.2 miles of 42-inch looped natural gas pipeline in Lancaster County.
- Compressor Station: Addition of a 21,902-horsepower electric motor at an existing compressor station in Chester County.

Approximately 27.6%, or $255.4 million of the $926.5 million in total project expenditures are expected to be made in New Jersey ($184.7 million), New York ($18.6 million) and Pennsylvania ($52.1 million), with approximately 60% of construction labor estimated to be drawn from within the region.

The report is organized as follows. First, a brief description is provided of the Bloustein School's research capacity, the economic input-output model used for this project, and the underlying assumptions of the analysis. The next section describes the distribution of construction expenditures across cost categories (labor, material, equipment, etc.) and the economic impacts generated by those expenditures for the project as a whole and for each of its individual components in each state. The impacts are measured at both the statewide and, where appropriate, county levels in terms of employment, gross domestic product (GDP), compensation (income) and tax revenues. An appendix at the end of the report provides a detailed description of the economic modeling techniques used in the analysis.

---

[1] Williams Pipeline Partners (NYSE: WPZ) is a master limited partnership in which Williams Companies, Inc. (NYSE: WMB) is the majority owner.

Institutional Background

The Edward J. Bloustein School of Planning and Public Policy serves as one of the nation's key centers for the theory and practice of planning and public policy scholarship and analysis. As part of Rutgers, The State University of New Jersey, the school capitalizes on the strength and resources of this major research university. The Bloustein School reaches to the larger world beyond the realm of academia to contribute to the regional, national, and international communities.

The Bloustein research team combines the skills and knowledge of senior professors and research staff from the school's public policy and planning departments with the economic modeling expertise and capacity of R/ECON™ Rutgers Economic Advisory Service, a division of the School providing economic forecasting and modeling services. The research team has extensive experience analyzing the economic impacts of policies, investments and economic events for both governmental and private-sector entities. Research clients have included ExxonMobil, Public Service Electric & Gas, BP, Lockheed Martin, Goldman Sachs, the Casino Association of New Jersey, the Office of the New Jersey Governor, New Jersey American Water, New Jersey Department of Transportation, New Jersey Commission on Science and Technology, New Jersey Department of Environmental Protection, and the New Jersey Economic Development Authority.

R/ECON™ Input-Output Model

The R/ECON™ Input-Output (I-O) Model developed at the Bloustein School is used to measure the economic and fiscal impacts of infrastructure investments, business operations, and other economic events. The highly detailed model comprises 389 industry sectors and measures the effect of changes in expenditures in one industry on economic activity in all other industries. Thus, the expenditures made *in New Jersey, New York and Pennsylvania* on labor, materials, professional services, and other inputs required for pipeline expansion and enhancements as part of the Northeast Supply Enhancement Project have both *direct* economic effects, as those expenditures become incomes and revenues for workers and businesses, and subsequent *indirect* effects, as those workers and businesses, in turn, spend those dollars on other things – consumer goods, business investment expenditures, which, in turn, become income for other workers and businesses. This income gets further spent, and so on.

The R/ECON™ Input-Output model estimates both the *direct* economic effects of the initial expenditures (in terms of jobs and income) and the *indirect* (or multiplier) effects of the subsequent economic activity that occurs following the initial expenditures. The model also estimates the gross domestic product by state and the tax revenues (federal, state, and local) generated by the combined direct and indirect new economic activity caused by the initial spending. A detailed description of input-output modeling and a comparison of the R/ECON™ model to other available input-output models are provided in Appendix A.

Assumptions Used in the Analysis

- Direct construction jobs are, by definition, assumed to be on-site in the counties or states where each of the project components is located. Williams estimates approximately 60% of project labor to be drawn from within the three-state region.

- Expenditures for the offshore portion of the Raritan Bay Loop are allocated at 85% to New Jersey and 15% to New York, with impacts calculated only at the state level.

- Employment data are calculated and reported in job-years. One job-year is defined as one job lasting one year. Intuitively, this measurement captures the fact that construction jobs generate economic impacts, including employment, that persist mainly for the length of time that money is spent on the specific project.

- Similar to the allocation of construction labor expenditures, the R/ECON™ Model initially locates material and equipment expenditures in the counties where the construction activity occurs. However, the model may subsequently re-distribute such expenditures to the remainder of the state depending on the capacity of local supply embodied in the model.

- Living expenses for construction inspectors and project team travel expenses are considered business expenditures of the company and are distributed across a range of applicable sectors (e.g., hotels, food, airfare, etc.) in the R/ECON™ Model.

- Indirect federal state and local tax revenue estimates are based on *effective* tax rates.

- State and local permitting cost and estimated property tax data were provided by Williams and are reported separately from the state and local tax revenues estimated by the R/ECON™ Model to be generated as a result of the construction expenditures.

Economic Impacts of the Northeast Supply Enhancement Project

Total expenditures for the Northeast Supply Enhancement Project are estimated at approximately $926.5 million. It is also estimated that Williams will pay approximately $11.1 million in new direct annual property taxes and submerged easement fees in New Jersey and New York once the projects are completed. Of the total project expenditures, approximately $255.4 million, or 27.6%, is expected to be spent in New Jersey, Pennsylvania and New York on labor, material, equipment and other project-related items. These expenditures generate economic impacts both directly, through hiring and business purchases, and indirectly, through the multiplier effects of those original expenditures. Because these are one-time capital expenditures, the impacts occur only once. That is, most of the impacts, including additions to income, economic output and employment that result from the expenditures occur at the same time or shortly after the expenditures are made, and do not recur annually. Following is a detailed description of those expenditures and their economic impacts both for the project as a whole, and for each project component.

Combined Economic Impacts: New Jersey, New York and Pennsylvania

The full scope of the Northeast Supply Enhancement Project comprises the 3.4-mile Madison Loop and a new compressor station in New Jersey; the 23.5-mile Raritan Bay Loop extending from Middlesex County, New Jersey into New Jersey and New York waters of the Raritan Bay; and the 10.2-mile Quaryville Loop and a compressor station upgrade in Pennsylvania. The total direct construction expenditures on labor, material, equipment and related items for all components are estimated at approximately $926.5 million, with approximately $255.4 million (27.6%) of that total expected to be spent in New Jersey, New York and Pennsylvania. The total in-state costs associated with all components of the project are reported in Table 1.

Table 1
In-State Construction and Related Expenditures
Northeast Supply Enhancement Project

	New Jersey	New York	Pennsylvania	Total
Payments to Construction Companies (less material and equipment)	$102,105,073	$10,819,319	$28,255,204	$141,179,596
Material and Equipment	$68,989,883	$7,312,804	$17,351,800	$93,654,487
Easements/Right of Way	$5,400,000	-	$2,300,000	$7,700,000
Other	$8,217,981	$489,019	$4,156,183	$12,863,183
Total	**$184,712,937**	**$18,621,142**	**$52,063,187**	**$255,397,266**

Payments to construction companies include all components of worker income, including fringes, insurance and payroll taxes, as well as overhead and profits. The "Other" category includes travel costs, consulting, permits and other miscellaneous expenditures.[2]

The R/ECON™ Model was used to evaluate the impacts of these expenditures. The impacts are reported in Table 2, followed by an explanation of each type of impact.

Table 2
Aggregate Economic Impacts of the Northeast Supply Enhancement Project in New Jersey, New York and Pennsylvania

	Direct	Indirect	Total
Employment (job-years)	1,298	1,889	**3,186**
Gross Domestic Product ($ million)	164.6	162.6	**327.2**
Compensation ($ million)	124.2	109.9	**234.1**
State Tax Revenues ($ million)	-	-	**12.5**
Local Tax Revenues ($ million)	-	-	**10.2**
Permits/Other Fees ($ thousand)	-	-	**630.1**

- **Employment**
  3,186 job-years (a job-year represents one worker employed for one year) are estimated to be generated by the nearly $255.4 million in planned expenditures in New Jersey, New York and Pennsylvania.

3,186 job-years

[2] Out-of-state expenditures excluded from the analysis include $123.8 million in compression equipment, pipe, valves, fittings and related pipeline construction material, as well as approximately $158 million in labor and civil construction equipment and material from outside the state.

As noted above, one job-year is equivalent to one job lasting one year. In the case of capital investments, the direct and indirect employment generated by the expenditures occurs as the expenditures are made, and lasts approximately as long as the expenditures continue. Employment would be generated across a wide range of sectors, as the initial direct expenditures supporting jobs and business revenues in the construction, engineering, management, manufacturing and wholesale sectors "ripple" through the broader economy, generating indirect employment in other industries such as retail, services, transportation, etc.[3] Table 4 provides the estimated sector distribution (job categories are from the U.S. Bureau of Labor Statistics) of the total employment generated by the $255.4 million of in-state expenditures. The large job totals in the construction (1,120 job-years), manufacturing (298 job-years), and services (1,019 job-years) sectors include the direct construction labor and associated services required for the project, as well as additional indirect employment. Significant indirect employment effects are also generated across a range of other sectors, including retail trade, transportation, financial activities and wholesaling.

Table 3
Distribution of Employment Impacts by Sector
Northeast Supply Enhancement Project

Sector	Employment (job-years)
Natural Resources & Mining	55
Construction	1,120
Manufacturing	298
Transportation & Public Utilities	64
Wholesale Trade	33
Retail Trade	332
Financial Activities	265
Services	1,019
Total	**3,186**

- **Gross Domestic Product**

  $327.2 million in GDP

  This is the total value of all newly produced final goods and services. It is also equivalent to the total payments made to owners of labor and capital including profits, dividends, rents and interest. It is measured and reported annually for each state by the U.S. Bureau of Economic Analysis. The model used in this analysis calculates the impact of the approximately $255.4 in estimated in-region expenditures in terms of the additional

[3] The broadly defined services sector includes professional and business services (e.g., engineering, architecture, accounting, legal services, etc.), education and health services, leisure and hospitality services, the information sector, and other service industries.

gross domestic product (GDP) generated in the states as a result of that spending.[4] It is estimated that the planned upgrades and modifications will *increase GDP in New Jersey, New York and Pennsylvania by $327.2 million*.

- **Compensation**
  Labor compensation represents the total wages, salaries and wage supplements (i.e., employer contributions to government and private pension funds) paid for all direct *and* indirect jobs generated in New Jersey as a result of the expenditures made *in New Jersey*. Williams' capital expenditures of $255.4 million in the state are estimated to generate $234.1 million in compensation.

$234.1 million in compensation

- **State Taxes and Fees**
  State taxes generated by the construction process include the personal income tax, sales tax, state business taxes, various excise taxes and other state levies and fees. State taxes are generated via the initial expenditures on the project and via the further rounds of economic activity that follow as the initial expenditures "ripple" through the broader economy. An estimated $12.5 million in additional state tax revenues are estimated to be generated in New Jersey, Pennsylvania and New York over the period of construction. In addition to these revenues, Williams estimates that state environmental permit fees paid to the three states will total approximately $125,183.

$12.5 million in state tax revenues

- **Local Taxes and Fees**
  The estimated local tax revenues for the three states represent property tax revenues that accrue, over time, as a result of improvements to existing or construction of new property afforded by the personal and business incomes generated directly and indirectly by the construction expenditures. These local tax revenues are estimated at $10.2 million. Unlike the other impacts, the increase in property tax revenues occurs over a considerably longer period (see

$10.2 million in local tax revenues

[4] Estimates of GDP generated at the county level are also provided for the individual project components.

Appendix B for additional detail). Williams also estimates local environmental and building permit fees at approximately $505,000 for the three states.

- **Projected Annual Property Taxes**

  In addition to the state and local tax revenues generated through its construction spending, Williams also estimates annual submerged land easement fees and direct property tax payments of approximately $1.3 million in New Jersey and $9.8 million in New York based on the value of the infrastructure put in place:

  - Middlesex County, NJ: $1,000,000
  - Somerset County, NJ: $ 25,000
  - New Jersey State Waters: $ 275,000
  - New York State Waters: $9,800,000

Economic Impacts in New Jersey

Total State Impacts

The portion of the Northeast Supply Enhancement Project in New Jersey comprises the 3.4-mile Madison Loop in Middlesex County, sections of the 23.4 mile Raritan Bay Loop in Middlesex County and state waters of the Raritan Bay, and a new 32,000-horsepower gas turbine compression station in Somerset County. Total in-state expenditures on labor, material, equipment and related items for all components are estimated at approximately $184.7 million. The in-state costs associated with all New Jersey components of the project are reported in Table 4.

Table 4
In-State Construction and Related Expenditures
Northeast Supply Enhancement Project, New Jersey

Payments to Construction Companies (less material and equipment)	$102,105,073
Material and Equipment	$68,989,883
Easements/Right of Way	$5,400,000
Other	$8,217,981
Total	**$184,712,937**

The R/ECON™ Input-Output Model was used to evaluate the total economic impacts of the expenditures for all projects in the state. The impacts are reported in Table 5, followed by a brief explanation of each type of impact.

Table 5 Aggregate State Economic Impacts Northeast Supply Enhancement Project, New Jersey			
	Direct	**Indirect**	**Total**
Employment (job-years)	984	1,427	**2,411**
Gross Domestic Product ($ million)	122.9	117.0	**239.9**
Compensation ($ million)	93.1	78.8	**171.9**
State Tax Revenues ($ million)	-	-	**9.9**
Local Tax Revenues ($ million)	-	-	**6.5**
Permits/Other Fees ($ thousand)	-	-	**275.0**

The estimated statewide economic impacts of the approximately $184.7 million in in-state expenditures for all Northeast Supply Enhancement Project components in New Jersey include:

- 2,411 total job-years;
- $239.9 million in GDP;
- $171.9 million in compensation;
- $9.9 million in state tax revenues and $6.5 million in local tax revenues (statewide).
- In addition to the $6.5 million in indirect local tax revenues generated by the construction process, Williams has estimated local environmental and building permit payments of $225,000 to the municipalities and counties where the work is performed, and approximately $50,000 in environmental permit payments to the state.
- Williams also estimates that approximately $1.3 million in submerged land easement fees and property taxes will be paid annually for the new pipeline to the state of New Jersey and municipalities in which the pipeline is located.

Table 3 provides the industry breakdown of both the total direct and indirect employment generated statewide by the project.

Table 6 Distribution of Employment Impacts by Sector (statewide) All Project Components, New Jersey	
Sector	**Employment (job-years)**
Natural Resources & Mining	35
Construction	858
Manufacturing	200
Transportation & Public Utilities	47
Wholesale Trade	24
Retail Trade	254
Financial Activities	191
Services	802
Total	**2,411**

The large job totals in the construction (858 job-years), manufacturing (200 job-years), and services (802 job-years) sectors include the direct construction labor and associated services required for the project, as well as additional indirect employment. Significant indirect employment effects are also generated across a range of other sectors, including retail trade, transportation, financial activities and wholesaling.

Madison Loop: Middlesex County

The Madison Loop component of the project comprises installation of approximately 3.4 miles of 26-inch pipeline loop in two Middlesex County municipalities – Old Bridge and Sayreville. In-state expenditures on labor, material, equipment and other project-related costs are estimated at approximately $30.6 million (Table 7).

Table 7
In-State Construction and Related Expenditures
Madison Loop
Middlesex County, New Jersey

Payments to Construction Companies (less material and equipment)	$15,409,147
Material and Equipment	$10,403,930
Easements/Right of Way	$2,000,000
Other	$2,819,000
Total	**$30,632,077**

The R/ECON™ Input-Output Model was used to evaluate the impacts of these expenditures at the county and state levels. The impacts for Middlesex County and the state as a whole are reported in Table 8, followed by a brief explanation of each type of impact.

Table 8
Economic Impacts, Middlesex County and New Jersey
Madison Loop

	Middlesex County			New Jersey		
	Direct	Indirect	Total	Direct	Indirect	Total
Employment (job-years)	113	105	**218**	113	210	**323**
Gross Domestic Product ($ million)	20.6	7.4	**28.0**	20.6	18.6	**39.2**
Compensation ($ million)	14.4	6.1	**20.5**	14.4	12.1	**26.5**
State Tax Revenues ($ thousand)	-	-	**1,029.1**	-	-	**1,537.7**
Local Tax Revenues ($ thousand)	-	-	**707.4**	-	-	**1,014.3**
Permits/Other Fees ($ thousand)	-	-	**85.0**	-	-	**85.0**

The estimated economic impacts of the approximately $30.6 million in in-state expenditures for construction of the Madison Loop include:

- 218 total job-years in Middlesex County and 323 total job-years statewide;
- $28 million in GDP in Middlesex County and $39.2 million in GDP statewide;
- $20.5 million in compensation in Middlesex County and $26.5 million in compensation statewide;
- $1 million in state tax revenues generated from Middlesex County, $1.5 million in state tax revenues generated statewide, $707,400 in local tax revenues in Middlesex County, and $1 million in local tax revenues statewide.
- In addition to the state and local tax revenues generated by the construction process, Williams has estimated local building, road and environmental permit payments of $65,000 to Middlesex County and the municipalities of Old Bridge and Sayreville, and $20,000 in environmental permit payments to the state.
- Williams also estimates that approximately $475,000 in property taxes will be paid annually for the new pipeline to the municipalities in which it is located: Old Bridge ($250,000) and Sayreville ($225,000).

Table 9 provides the industry breakdown of the total direct and indirect employment generated statewide by construction of the Madison Loop.

Table 9
Distribution of Employment Impacts by Sector (statewide)
Madison Loop, Middlesex County, New Jersey

Sector	Employment (job-years)
Natural Resources & Mining	5
Construction	86
Manufacturing	30
Transportation & Public Utilities	7
Wholesale Trade	4
Retail Trade	36
Financial Activities	30
Services	125
Total	**323**

The large job totals in the construction (86 job-years), manufacturing (30 job-years), and services (125 job-years) sectors include the direct construction labor and associated services required for the project, as well as additional indirect employment. Significant indirect employment effects are also generated across a range of other sectors, including retail trade, transportation, financial activities and wholesaling.

Raritan Bay Loop: Middlesex County and State of New Jersey

The Raritan Bay Loop component of the project comprises installation of approximately 23.5 miles of 26-inch, primarily offshore pipeline extending from the New Jersey shore to an offshore transfer point. The loop begins in the municipality of Old Bridge, Middlesex County, New Jersey, and extends into the Raritan Bay into both New Jersey and New York waters. Approximately 19% of the in-state expenditures for the Raritan Bay Loop would be for the portion built onshore in Middlesex County. Based on discussions with Williams representatives, 85% of payroll and other costs of the offshore work were allocated to New Jersey and the remaining 15% to New York. This section considers those expenditures assumed to be made in New Jersey and Middlesex County. Total in-region expenditures for labor, material, equipment and all other construction-related costs for the Raritan Bay Loop are estimated at approximately $153.2 million. Approximately $134.5 million (87.8%) of those in-region expenditures are expected to be spent in New Jersey, including $29.1 million allocated to Middlesex County. These in-state expenditures are reported in Table 10.

Table 10
In-State Construction and Related Expenditures
Raritan Bay Loop
New Jersey

	New Jersey
Payments to Construction Companies (less material and equipment)	$77,041,886
Material and Equipment	$52,072,799
Easements/Right of Way	$2,000,000
Other	$3,425,981
Total	**$134,540,667**

The R/ECON™ Input-Output Model was used to evaluate the impacts of these expenditures at the county and state levels. The impacts for Middlesex County and the state as a whole are reported in Table 11.

Table 11
Economic Impacts, Middlesex County and New Jersey
Raritan Bay Loop

	Middlesex County			New Jersey		
	Direct	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
Employment (job-years)	106	100	**206**	764	1,065	**1,829**
Gross Domestic Product ($ million)	19.8	6.9	**26.7**	89.2	86.7	**175.9**
Compensation ($ million)	14.2	5.8	**20.0**	69.5	58.2	**127.7**
State Tax Revenues ($ thousand)	-	-	**980.2**	-	-	**7,309.7**
Local Tax Revenues ($ thousand)	-	-	**678.3**	-	-	**4,837.6**
Permits/Other Fees ($ thousand)	-	-	**15.0**	-	-	**15.0**

The estimated economic impacts of the approximately $134.5 million in in-state expenditures for construction of the Raritan Bay Loop include:

- 206 total job-years in Middlesex County and 1,829 total job-years statewide;
- $26.7 million in GDP in Middlesex County and $175.9 million in GDP statewide;
- $20 million in compensation in Middlesex County and $127.7 million in compensation statewide;
- $980,200 in state tax revenues generated in Middlesex County, $7.3 million in state tax revenues generated statewide, $678,300 in local tax revenues in Middlessex County and $4.8 million in local tax revenues generated statewide.
- In addition to the state and local tax revenues generated by the construction process, Williams has estimated local building, road and environmental permit payments of $5,000 to Middlesex County and Old Bridge, and $10,000 in environmental permit payments to the state.
- Williams also estimates that approximately $525,000 in property taxes will be paid annually for the new pipeline in Old Bridge, and $275,000 in submerged land easement fees will be paid annually to the state of New Jersey.

Table 12 provides the industry breakdown of the total direct and indirect employment generated statewide by construction of the Raritan Bay Loop.

Table 12
Distribution of Employment Impacts by Sector (statewide)
Raritan Bay Loop, New Jersey

Sector	Employment (job-years)
Natural Resources & Mining	27
Construction	686
Manufacturing	150
Transportation & Public Utilities	34
Wholesale Trade	18
Retail Trade	192
Financial Activities	142
Services	580
Total	**1,829**

The large job totals in the construction (686 job-years), manufacturing (150 job-years), and services (580 job-years) sectors include the direct construction labor and associated services required for the project, as well as additional indirect employment. Significant indirect employment effects are also generated across a range of other sectors, including retail trade, transportation, financial activities and wholesaling.

Compressor Station: Somerset County

The Northeast Supply Enhancement Project calls for installation of a new 32-000 horsepower gas turbine compressor station in Franklin Township, Somerset County, New Jersey. In-state expenditures on labor, material, equipment and other construction-related costs for this component of the project are estimated at approximately $19.5 million (Table 13).

Table 13
In-State Construction and Related Expenditures
Compressor Station
Somerset County, New Jersey

	New Jersey
Payments to Construction Companies (less material and equipment)	$9,654,040
Material and Equipment	$6,513,154
Easements/Right of Way	$1,400,000
Other	$1,973,000
Total	**$19,540,194**

The R/ECON™ Input-Output Model was used to evaluate the impacts of these expenditures at the county and state levels. The impacts are reported in Table 14.

Table 14
Economic Impacts, Somerset County and New Jersey
Compressor Station

	Somerset County			New Jersey		
	Direct	Indirect	Total	Direct	Indirect	Total
Employment (job-years)	107	59	**166**	107	152	**259**
Gross Domestic Product ($ million)	13.1	3.6	**16.7**	13.1	11.7	**24.8**
Compensation ($ million)	9.2	3.2	**12.4**	9.2	8.5	**17.7**
State Tax Revenues ($ thousand)	-	-	**602.6**	-	-	**1,047.0**
Local Tax Revenues ($ thousand)	-	-	**418.3**	-	-	**686.9**
Permits/Other Fees ($ thousand)	-	-	**175.0**	-	-	**175.0**

The estimated economic impacts of the $19.5 million in expenditures for installation of the compressor station include:

- 166 total job-years in Somerset County and 259 total job-years statewide;
- $16.7 million in GDP in Somerset County and $24.8 million in GDP statewide;
- $12.4 million in compensation in Somerset County and $17.7 million in compensation statewide;
- $602,600 in state tax revenues generated in Somerset County, $1 million in state tax revenues generated statewide, $418,300 in local tax revenues in Somerset County and $686,900 in local tax revenues generated statewide.
- In addition to the state and local tax revenues generated by the construction process, Williams has estimated local building, road and environmental permit payments of $155,000 to Somerset County and Franklin Township, and $20,000 in environmental permit payments to the state.
- Williams also estimates that approximately $25,000 in property taxes will be paid annually for the new station.

Table 15 provides the industry breakdown of the total direct and indirect employment generated statewide by the compressor station installation.

Table 15 Distribution of Employment Impacts by Sector (statewide) Compressor Station Somerset County, New Jersey	
Sector	**Employment (job-years)**
Natural Resources & Mining	3
Construction	86
Manufacturing	20
Transportation & Public Utilities	6
Wholesale Trade	2
Retail Trade	26
Financial Activities	19
Services	97
Total	**259**

The large job totals in the construction (86 job-years), manufacturing (20 job-years), and services (97 job-years) sectors include the direct construction labor and associated services required for the project, as well as additional indirect employment. Significant indirect employment effects are also generated across a range of other sectors, including retail trade, transportation, financial activities and wholesaling.

Economic Impacts in Pennsylvania

Total State Impacts

The portion of the Northeast Supply Enhancement Project in Pennsylvania comprises the 10.2-mile Quaryville Loop in Lancaster County and addition of a 21,902-horsepower electric motor at a compression station in Chester County. In-state expenditures on labor, material, equipment and related items for all components are estimated at approximately $52.1 million. The in-state costs associated with both Pennsylvania components of the project are reported in Table 16.

Table 16
In-State Construction and Related Expenditures
Northeast Supply Enhancement Project, Pennsylvania

Payments to Construction Companies (less material and equipment)	$28,255,204
Material and Equipment	$17,351,800
Easements/Right of Way	$2,300,000
Other	$4,156,183
Total	**$52,063,187**

The R/ECON™ Input-Output Model was used to evaluate the total economic impacts of the expenditures for all projects in the state. The impacts are reported in Table 17, followed by a brief explanation of each type of impact.

Table 17
Aggregate State Economic Impacts
Northeast Supply Enhancement Project, Pennsylvania

	Direct	Indirect	Total
Employment (job-years)	199	301	**499**
Gross Domestic Product ($ million)	30.4	33.2	**63.6**
Compensation ($ million)	22.8	22.8	**45.6**
State Tax Revenues ($ million)	-	-	**1.5**
Local Tax Revenues ($ million)	-	-	**2.4**
Permits/Other Fees ($ thousand)	-	-	**345.1**

The estimated statewide economic impacts of the approximately $52.1 million in in-state expenditures for the two Northeast Supply Enhancement Project components in Pennsylvania include:

- 499 total job-years;
- $63.6 million in GDP;
- $45.6 million in compensation;
- $1.5 million in state tax revenues and $2.4 million in local tax revenues (statewide).
- In addition to the state and local tax revenues generated by the construction process, Williams has estimated local environmental and building permit payments of $280,000 to the municipalities and counties where the work is performed, and approximately $65,183 in environmental permit payments to the state.

Table 18 provides the industry breakdown of both the total direct and indirect employment generated statewide by the project.

Table 18 Distribution of Employment Impacts by Sector (statewide) All Project Components, Pennsylvania	
Sector	**Employment (job-years)**
Natural Resources & Mining	11
Construction	166
Manufacturing	68
Transportation & Public Utilities	12
Wholesale Trade	7
Retail Trade	53
Financial Activities	48
Services	134
Total	**499**

The large job totals in the construction (166 job-years), manufacturing (68 job-years), and services (134 job-years) sectors include the direct construction labor and associated services required for the project, as well as additional indirect employment. Significant indirect employment effects are also generated across a range of other sectors, including retail trade, transportation, financial activities and wholesaling.

Quaryville Loop: Lancaster County

The Quaryville Loop component of the project comprises installation of approximately 10.2 miles of 42-inch pipeline loop in three Lancaster County municipalities – Drumore, East Drumore and Eden. In-state expenditures on labor, material, equipment and other project-related costs are estimated at approximately $34.7 million (Table 19).

Table 19 In-State Construction and Related Expenditures Quaryville Loop Lancaster County, Pennsylvania	
Payments to Construction Companies (less material and equipment)	$17,786,746
Material and Equipment	$11,665,857
Easements/Right of Way	$2,300,000
Other	$2,902,364
Total	**$34,654,967**

The R/ECON™ Input-Output Model was used to evaluate the impacts of these expenditures at the county and state levels. The impacts for Lancaster County and the state as a whole are reported in Table 20, followed by a brief explanation of each type of impact.

Table 20
Economic Impacts, Lancaster County and Pennsylvania
Quaryville Loop

	Lancaster County			Pennsylvania		
	Direct	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
Employment (job-years)	125	104	**229**	125	197	**322**
Gross Domestic Product ($ million)	20.6	7.1	**27.7**	20.6	20.1	**40.7**
Compensation ($ million)	14.7	6.6	**21.3**	14.7	14.4	**29.1**
State Tax Revenues ($ thousand)	-	-	**602.1**	-	-	**948.1**
Local Tax Revenues ($ thousand)	-	-	**960.3**	-	-	**1,558.1**
Permits/Other Fees ($ thousand)	-	-	**128.3**	-	-	**128.3**

The estimated economic impacts of the approximately $34.7 million in in-state expenditures for construction of the Quaryville Loop include:

- 229 total job-years in Lancaster County and 322 total job-years statewide;
- $27.7 million in GDP in Lancaster County and $40.7 million in GDP statewide;
- $21.3 million in compensation in Lancaster County and $29.1 million in compensation statewide;
- $602,100 in state tax revenues generated in Lancaster County, $948,100 in state tax revenues generated statewide, $960,300 in local tax revenues in Lancaster County and $1.5 million in local tax revenues generated statewide.
- In addition to the state and local tax revenues generated by the construction process, Williams has estimated local building, road and environmental permit payments of $115,000 to Lancaster County and the municipalities of Drumore, East Drumore and Eden, and $13,364 in environmental permit payments to the state.

Table 21 provides the industry breakdown of the total direct and indirect employment generated statewide by construction of the Quaryville Loop.

Table 21
Distribution of Employment Impacts by Sector (statewide)
Quaaryville Loop
Lancaster County, Pennsylvania

Sector	**Employment (job-years)**
Natural Resources & Mining	7
Construction	103
Manufacturing	45
Transportation & Public Utilities	8
Wholesale Trade	4
Retail Trade	33
Financial Activities	32
Services	90
Total	**322**

The large job totals in the construction (103 job-years), manufacturing (45 job-years), and services (90 job-years) sectors include the direct construction labor and associated services required for the project, as well as additional indirect employment. Significant indirect employment effects are also generated across a range of other sectors, including retail trade, transportation, financial activities and wholesaling.

Compressor Station: Chester County

The Northeast Supply Enhancement Project calls for the addition of a new 21,902 horsepower electric motor at an existing compressor station in East Whiteland, Chester County, Pennsylvania. In-state expenditures on labor, material, equipment and other construction-related costs for this component of the project are estimated at approximately $17.4 million (Table 22).

Table 22
In-State Construction and Related Expenditures
Compressor Station
Chester County, Pennsylvania

Payments to Construction Companies (less material and equipment)	$10,468,458
Material and Equipment	$5,685,943
Easements/Right of Way	-
Other	$1,253,819
Total	**$17,408,220**

The R/ECON™ Input-Output Model was used to evaluate the impacts of these expenditures at the county and state levels. The impacts are reported in Table 23.

Table 23
Economic Impacts, Chester County and Pennsylvania
Compressor Station (Motor Addition)

	Chester County			Pennsylvania		
	Direct	**Indirect**	**Total**	**Direct**	**Indirect**	**Total**
Employment (job-years)	74	43	**117**	74	104	**177**
Gross Domestic Product ($ million)	9.8	5.3	**15.1**	9.8	13.1	**22.9**
Compensation ($ million)	8.1	3.5	**11.6**	8.1	8.4	**16.5**
State Tax Revenues ($ thousand)	**-**	**-**	**310.3**	**-**	**-**	**534.7**
Local Tax Revenues ($ thousand)	**-**	**-**	**495.8**	**-**	**-**	**877.4**
Permits/Other Fees ($ thousand)	**-**	**-**	**216.8**	**-**	**-**	**216.8**

The estimated economic impacts of the $17.4 million in expenditures for installation of the new motor include:

- 117 total job-years in Chester County and 177 total job-years statewide;
- $15.1 million in GDP in Chester County and $22.9 million in GDP statewide;
- $11.6 million in compensation in Chester County and $16.5 million in compensation statewide;
- $310,300 in state tax revenues generated in Chester County, $534,700 in state tax revenues generated statewide, $495,800 in local tax revenues in Chester County and $877,400 in local tax revenues generated statewide.
- In addition to the state and local tax revenues generated by the construction process, Williams has estimated local building, road and environmental permit payments of $165,000 to Chester County and East Whiteland, and $51,819 in environmental permit payments to the state.

Table 24 provides the industry breakdown of the total direct and indirect employment generated statewide by the compressor station work.

Table 24
Distribution of Employment Impacts by Sector (statewide)
Compressor Station
Lancaster County, Pennsylvania

Sector	Employment (job-years)
Natural Resources & Mining	4
Construction	63
Manufacturing	23
Transportation & Public Utilities	4
Wholesale Trade	3
Retail Trade	20
Financial Activities	16
Services	44
Total	**177**

The large job totals in the construction (63 job-years), manufacturing (23 job-years), and services (44 job-years) sectors include the direct construction labor and associated services required for the project, as well as additional indirect employment. Significant indirect employment effects are also generated across a range of other sectors, including retail trade, transportation, financial activities and wholesaling.

Economic Impacts in New York

Total State Impacts: Raritan Bay Loop

The Raritan Bay Loop component of the project comprises installation of approximately 23.5 miles of 26-inch, primarily offshore pipeline extending from the New Jersey shore to an offshore transfer point. The loop begins in the municipality of Old Bridge, Middlesex County, New Jersey, and extends into the Raritan Bay into both New Jersey and New York waters. Approximately 19% of the in-state expenditures for the Raritan Bay Loop would be for the portion built onshore in Middlesex County. Based on discussions with Williams representatives, 85% of payroll and other costs of the offshore work were allocated to New Jersey and the remaining 15% to New York. This section considers those expenditures assumed to be made in New York. Of $153.2 million in regional expenditures on labor, material, equipment and other construction-related items, approximately $18.6 million (12.2%) is expected to be spent in New York. These in-state expenditures are reported in Table 25.

Table 25
In-State Construction and Related Expenditures
Northeast Supply Enhancement Project, New York

Payments to Construction Companies (less material and equipment)	$10,819,319
Material and Equipment	$7,312,804
Easements/Right of Way	-
Other	$489,019
Total	**$18,621,142**

The R/ECON™ Input-Output Model was used to evaluate the impacts of these expenditures for the state. These impacts are reported in Table 26.

Table 26 Economic Impacts Raritan Bay Loop New York			
	Direct	Indirect	Total
Employment (job-years)	115	161	**276**
Gross Domestic Product ($ million)	11.3	12.4	**23.7**
Compensation ($ million)	8.3	8.3	**16.6**
State Tax Revenues ($ million)	-	-	**1.1**
Local Tax Revenues ($ million)	-	-	**1.2**
Permits/Other Fees ($ thousand)	-	-	**10.0**

The estimated economic impacts of the approximately $18.6 million of in-state (New York) expenditures for construction of the Raritan Bay Loop include:

- 276 total job-years statewide;
- $23.7 million in GDP statewide;
- $16.6 million in compensation statewide;
- $1.1 million in state tax revenues and $1.2 million in local tax revenues (statewide).
- In addition to the state and local tax revenues generated by the construction process, Williams has estimated $10,000 in environmental permit payments to the state.
- Williams also estimates that approximately $9.8 million in submerged land easement fees will be paid annually for the new pipeline based on use of New York waters.

Table 27 provides the industry breakdown of the total direct and indirect employment generated statewide by construction of the Raritan Bay Loop.

Table 27
Distribution of Employment Impacts by Sector (statewide)
Raritan Bay Loop, New York

Sector	Employment (job-years)
Natural Resources & Mining	9
Construction	96
Manufacturing	30
Transportation & Public Utilities	5
Wholesale Trade	2
Retail Trade	25
Financial Activities	26
Services	83
Total	**276**

The large job totals in the construction (96 job-years), manufacturing (30 job-years), and services (83 job-years) sectors include the direct construction labor and associated services required for the project, as well as additional indirect employment. Significant indirect employment effects are also generated across a range of other sectors, including retail trade, transportation, financial activities and wholesaling.

Appendix A: Input-Output Analysis and the R/ECON™ Model

This appendix discusses the history and application of input-output analysis and details the input-output model, called the R/ECON™ I-O model, developed by Rutgers University. This model offers significant advantages in detailing the total economic effects of an activity (such as historic rehabilitation and heritage tourism), including multiplier effects.

Estimating Multipliers

The fundamental issue determining the size of the multiplier effect is the "openness" of regional economies. Regions that are more "open" are those that import their required inputs from other regions. Imports can be thought of as substitutes for local production. Thus, the more a region depends on imported goods and services instead of its own production, the more economic activity leaks away from the local economy. Businessmen noted this phenomenon and formed local chambers of commerce with the explicit goal of stopping such leakage by instituting a "buy local" policy among their membership. In addition, during the 1970s, as an import invasion was under way, businessmen and union leaders announced a "buy American" policy in the hope of regaining ground lost to international economic competition. Therefore, one of the main goals of regional economic multiplier research has been to discover better ways to estimate the leakage of purchases out of a region or, relatedly, to determine the region's level of self-sufficiency.

The earliest attempts to systematize the procedure for estimating multiplier effects used the economic base model, still in use in many econometric models today. This approach assumes that all economic activities in a region can be divided into two categories: "basic" activities that produce exclusively for export, and region-serving or "local" activities that produce strictly for internal regional consumption. Since this approach is simpler but similar to the approach used by regional input-output analysis, let us explain briefly how multiplier effects are estimated using the economic base approach.

If we let $\mathbf{x}$ be export employment, $\mathbf{l}$ be local employment, and $\mathbf{t}$ be total employment, then

$$\mathbf{t} = \mathbf{x} + \mathbf{l}$$

For simplification, we create the ratio $\mathbf{a}$ as

$$\mathbf{a} = \mathbf{l}/\mathbf{t}$$

so that

$$\mathbf{l} = \mathbf{at}$$

then substituting into the first equation, we obtain

$$\mathbf{t} = \mathbf{x} + \mathbf{at}$$

By bringing all of the terms with t to one side of the equation, we get

$$\mathbf{t} - \mathbf{at} = \mathbf{x} \text{ or } \mathbf{t}\,(1\text{-}\mathbf{a}) = \mathbf{x}$$

Solving for **t**, we get $\mathbf{t} = \mathbf{x}/(1-\mathbf{a})$

Thus, if we know the amount of export-oriented employment, **x,** and the ratio of local to total employment, **a**, we can readily calculate total employment by applying the economic base multiplier, 1/(1-**a**), which is embedded in the above formula. Thus, if 40 percent of all regional employment is used to produce exports, the regional multiplier would be 2.5. The assumption behind this multiplier is that all remaining regional employment is required to support the export employment. Thus, the 2.5 can be decomposed into two parts the direct effect of the exports, which is always 1.0, and the indirect and induced effects, which is the remainder—in this case 1.5. Hence, the multiplier can be read as telling us that for each export-oriented job another 1.5 jobs are needed to support it.

This notion of the multiplier has been extended so that **x** is understood to represent an economic change demanded by an organization or institution outside of an economy—so-called final demand. Such changes can be those effected by government, households, or even by an outside firm. Changes in the economy can therefore be calculated by a minor alteration in the multiplier formula:

$$\Delta\mathbf{t} = \Delta\mathbf{x}/(1-\mathbf{a})$$

The high level of industry aggregation and the rigidity of the economic assumptions that permit the application of the economic base multiplier have caused this approach to be subject to extensive criticism. Most of the discussion has focused on the estimation of the parameter **a**. Estimating this parameter requires that one be able to distinguish those parts of the economy that produce for local consumption from those that do not. Indeed, virtually all industries, even services, sell to customers both inside and outside the region. As a result, regional economists devised an approach by which to measure the *degree* to which each industry is involved in the nonbase activities of the region, better known as the industry's *regional purchase coefficient (r)*. Thus, they expanded the above formulations by calculating for each $\boldsymbol{i}$ industry

$$\mathbf{l}_i = \mathbf{r}_i\mathbf{d}_i$$

and

$$\mathbf{x}_i = \boldsymbol{t}_i - \mathbf{r}_i\mathbf{d}_i$$

given that $\mathbf{d}_i$ is the total regional demand for industry $\boldsymbol{i}$'s product. Given the above formulae and data on regional demands by industry, one can calculate an accurate traditional aggregate economic base parameter by the following:

$$\mathbf{a} = \mathbf{l}/\mathbf{t} = \Sigma\mathbf{l}_i/\Sigma\mathbf{t}_i$$

Although accurate, this approach only facilitates the calculation of an aggregate multiplier for the entire region. That is, we cannot determine from this approach what the effects are on the various sectors of an economy. This is despite the fact that one must painstakingly calculate the regional demand as well as the degree to which each industry is involved in nonbase activity in the region.

As a result, a different approach to multiplier estimation that takes advantage of detailed demand and trade data was developed. This approach is called input-output analysis.

Regional Input-Output Analysis: A Brief History

The basic framework for input-output analysis originated nearly 250 years ago when François Quesenay published *Tableau Economique* in 1758. Quesenay's "tableau" graphically and numerically portrayed the relationships between sales and purchases of the various industries of an economy. More than a century later, his description was adapted by Leon Walras, who advanced input-output modeling by providing a concise theoretical formulation of an economic system (including consumer purchases and the economic representation of "technology").

It was not until the twentieth century, however, that economists advanced and tested Walras's work. Wassily Leontief greatly simplified Walras's theoretical formulation by applying the Nobel prize–winning assumptions that both technology and trading patterns were fixed over time. These two assumptions meant that the pattern of flows among industries in an area could be considered stable. These assumptions permitted Walras's formulation to use data from a single time period, which generated a great reduction in data requirements.

Although Leontief won the Nobel Prize in 1973, he first used his approach in 1936 when he developed a model of the 1919 and 1929 U.S. economies to estimate the effects of the end of World War I on national employment. Recognition of his work in terms of its wider acceptance and use meant development of a standardized procedure for compiling the requisite data (today's national economic census of industries) and enhanced capability for calculations (i.e., the computer).

The federal government immediately recognized the importance of Leontief's development and has been publishing input-output tables of the U.S. economy since 1939. The most recently published tables are those for 2007. Other nations followed suit. Indeed, the United Nations maintains a bank of tables from most member nations with a uniform accounting scheme.

Framework

Input-output modeling focuses on the interrelationships of sales and purchases among sectors of the economy. Input-output is best understood through its most basic form, the *interindustry transactions table* or matrix. In this table (see table C-1 for an example), the column industries are consuming sectors (or markets) and the row industries are producing sectors. The content of a matrix cell is the value of shipments that the row industry delivers to the column industry. Conversely, it is the value of shipments that the column industry receives from the row industry. Hence, the interindustry transactions table is a detailed accounting of the disposition of the value of shipments in an economy. Indeed, the detailed accounting of the interindustry transactions at the national level is performed not so much to facilitate calculation of national economic impacts as it is to back out an estimate of the nation's gross domestic product.

Table A-1
Interindustry Transactions Matrix (Values)

	Agriculture	Manufact-uring	Services	Other	Final Demand	Total Output
Agriculture	10	65	10	5	10	$100
Manufacturing	40	25	35	75	25	$200
Services	15	5	5	5	90	$120
Other	15	10	50	50	100	$225
Value Added	20	95	20	90		
Total Input	100	200	120	225		

For example, in table A-1, agriculture, as a producing industry sector, is depicted as selling $65 million of goods to manufacturing. Conversely, the table depicts that the manufacturing industry purchased $65 million of agricultural production. The sum across columns of the interindustry transaction matrix is called the *intermediate outputs vector*. The sum across rows is called the *intermediate inputs vector*.

A single *final demand* column is also included in table A-1. Final demand, which is outside the square interindustry matrix, includes imports, exports, government purchases, changes in inventory, private investment, and sometimes household purchases.

The *value added* row, which is also outside the square interindustry matrix, includes wages and salaries, profit-type income, interest, dividends, rents, royalties, capital consumption allowances, and taxes. It is called value added because it is the difference between the total value of the industry's production and the value of the goods and nonlabor services that it requires to produce. Thus, it is the *value* that an industry *adds* to the goods and services it uses as inputs in order to produce output.

The value added row measures each industry's contribution to wealth accumulation. In a national model, therefore, its sum is better known as the gross domestic product (GDP). At the state level, this is known as the gross state product—a series produced by the U.S. Bureau of Economic Analysis and published in the Regional Economic Information System. Below the state level, it is known simply as the regional equivalent of the GDP—the gross regional product.

Input-output economic impact modelers now tend to include the household industry within the square interindustry matrix. In this case, the "consuming industry" is the household itself. Its spending is extracted from the final demand column and is appended as a separate column in the interindustry matrix. To maintain a balance, the income of households must be appended as a row. The main income of households is labor income, which is extracted from the value-added row. Modelers tend not to include other sources of household income in the household industry's row. This is not because such income is not attributed to households but rather because much of this other income derives from sources outside of the economy that is being modeled.

The next step in producing input-output multipliers is to calculate the *direct requirements matrix*, which is also called the technology matrix. The calculations are based entirely on data from table A-1. As shown in table A-2, the values of the cells in the direct requirements matrix are derived by dividing each cell in a column of table A-1, the interindustry transactions matrix, by its column total. For example, the cell for manufacturing's purchases from agriculture is 65/200 = .33. Each cell in a column of the direct requirements matrix shows how many cents of each producing industry's goods and/or services are required to produce one dollar of the consuming industry's production and are called *technical coefficients*. The use of the terms "technology" and "technical" derive from the fact that a column of this matrix represents a recipe for a unit of an industry's production. It, therefore, shows the needs of each industry's production process or "technology."

Table A-2
Direct Requirements Matrix

	Agriculture	Manufact-uring	Services	Other
Agriculture	.10	.33	.08	.02
Manufacturing	.40	.13	.29	.33
Services	.15	.03	.04	.02
Other	.15	.05	.42	.22

Next in the process of producing input-output multipliers, the *Leontief Inverse* is calculated. To explain what the Leontief Inverse is, let us temporarily turn to equations. Now, from table A-1 we know that the sum across both the columns of the square interindustry transactions matrix (**Z**) and the final demand vector (**y**) is equal to vector of production by industry (**x**). That is,

$$\mathbf{x} = \mathbf{Zi} + \mathbf{y}$$

where **i** is a summation vector of ones. Now, we calculate the direct requirements matrix (**A**) by dividing the interindustry transactions matrix by the production vector or

$$\mathbf{A} = \mathbf{ZX}^{-1}$$

where $\mathbf{X}^{-1}$ is a square matrix with inverse of each element in the vector **x** on the diagonal and the rest of the elements equal to zero. Rearranging the above equation yields

$$\mathbf{Z} = \mathbf{AX}$$

where **X** is a square matrix with the elements of the vector **x** on the diagonal and zeros elsewhere. Thus,

$$\mathbf{x} = (\mathbf{AX})\mathbf{i} + \mathbf{y}$$

or, alternatively,

$$\mathbf{x} = \mathbf{Ax} + \mathbf{y}$$

solving this equation for **x** yields

$\mathbf{x} =$	$(\mathbf{I}\text{-}\mathbf{A})^{-1}$		$\mathbf{y}$
Total =	Total	*	Final
Output	Requirements		Demand

The Leontief Inverse is the matrix $(\mathbf{I}\text{-}\mathbf{A})^{-1}$. It portrays the relationships between final demand and production. This set of relationships is exactly what is needed to identify the economic impacts of an event external to an economy.

Because it does translate the direct economic effects of an event into the total economic effects on the modeled economy, the Leontief Inverse is also called the *total requirements matrix.* The total requirements matrix resulting from the direct requirements matrix in the example is shown in table A-3.

Table A-3 Total Requirements Matrix				
	Agriculture	**Manufact-uring**	**Services**	**Other**
Agriculture	1.5	.6	.4	.3
Manufacturing	1.0	1.6	.9	.7
Services	.3	.1	1.2	.1
Other	.5	.3	.8	1.4
Industry Multipliers	.33	2.6	3.3	2.5

In the direct or technical requirements matrix in table A-2, the technical coefficient for the manufacturing sector's purchase from the agricultural sector was .33, indicating the 33 cents of agricultural products must be directly purchased to produce a dollar's worth of manufacturing products. The same "cell" in table A-3 has a value of .6. This indicates that for every dollar's worth of product that manufacturing ships out of the economy (i.e., to the government or for export), agriculture will end up increasing its production by 60 cents. The sum of each column in the total requirements matrix is the *output multiplier* for that industry.

Multipliers

A *multiplier* is defined as the system of economic transactions that follow a disturbance in an economy. Any economic disturbance affects an economy in the same way as does a drop of water in a still pond. It creates a large primary "ripple" by causing a *direct* change in the purchasing patterns of affected firms and institutions. The suppliers of the affected firms and institutions must change their purchasing patterns to meet the demands placed upon them by the firms originally affected by the economic disturbance, thereby creating a smaller secondary "ripple." In turn, those who meet the needs of the suppliers must change their purchasing patterns to meet the demands placed upon them by the suppliers of the original firms, and so on; thus, a number of subsequent "ripples" are created in the economy.

The multiplier effect has three components—direct, indirect, and induced effects. Because of the pond analogy, it is also sometimes referred to as the *ripple effect*.

- A *direct effect* (the initial drop causing the ripple effects) is the change in purchases due to a change in economic activity.

- An *indirect effect* is the change in the purchases of suppliers to those economic activities directly experiencing change.

- An *induced effect* is the change in consumer spending that is generated by changes in labor income within the region as a result of the direct and indirect effects of the economic activity. Including households as a column and row in the interindustry matrix allows this effect to be captured.

Extending the Leontief Inverse to pertain not only to relationships between *total* production and final demand of the economy but also to *change*s in each permits its multipliers to be applied to many types of economic impacts. Indeed, in impact analysis the Leontief Inverse lends itself to the drop-in-a-pond analogy discussed earlier. This is because the Leontief Inverse multiplied by a change in final demand can be estimated by a power series. That is,

$$(\mathbf{I}\text{-}\mathbf{A})^{-1}\ \Delta\mathbf{y} = \Delta\mathbf{y} + \mathbf{A}\ \Delta\mathbf{y} + \mathbf{A}(\mathbf{A}\ \Delta\mathbf{y}) + \mathbf{A}(\mathbf{A}(\mathbf{A}\ \Delta\mathbf{y})) + \mathbf{A}(\mathbf{A}(\mathbf{A}(\mathbf{A}\ \Delta\mathbf{y}))) + \ldots$$

Assuming that **Δy**—the change in final demand—is the "drop in the pond," then succeeding terms are the ripples. Each "ripple" term is calculated as the previous "pond disturbance" multiplied by the direct requirements matrix. Thus, since each element in the direct requirements matrix is less than one, each ripple term is smaller than its predecessor. Indeed, it has been shown that after calculating about seven of these ripple terms that the power series approximation of impacts very closely estimates those produced by the Leontief Inverse directly.

In impacts analysis practice, **Δy** is a single column of expenditures with the same number of elements as there are rows or columns in the direct or technical requirements matrix. This set of elements is called an *impact vector*. This term is used because it is the *vector* of numbers that is used to estimate the *economic impacts* of the investment.

There are two types of changes in investments, and consequently economic impacts, generally associated with projects—*one-time impacts* and *recurring impacts*. One-time impacts are impacts that are attributable to an expenditure that occurs once over a limited period of time. For example, the impacts resulting from the construction of a project are one-time impacts. Recurring impacts are impacts that continue permanently as a result of new or expanded ongoing expenditures. The ongoing operation of a new train station, for example, generates recurring impacts to the economy. Examples of changes in economic activity are investments in the preservation of old homes, tourist expenditures, or the expenditures required to run a historical site. Such activities are considered changes in final demand and can be either positive or negative. When the activity is not made in an industry, it is generally not well represented by the input-output model. Nonetheless, the activity can be represented by a special set of elements that are similar to a column of the transactions matrix. This set of elements is called an economic disturbance or impact vector. The latter term is used because it is the vector of numbers that is used to estimate the impacts. In this study, the impact vector is estimated by multiplying one or more economic *translators* by a dollar figure that represents an investment in one or more projects. The term translator is derived from the fact that such a vector *translates* a dollar amount of an activity into its constituent purchases by industry.

One example of an industry multiplier is shown in table A-4. In this example, the activity is the preservation of a historic home. The *direct impact* component consists of purchases made specifically for the construction project from the producing industries. The *indirect impact* component consists of expenditures made by producing industries to support the purchases made for this project. Finally, the *induced impact* component focuses on the expenditures made by workers involved in the activity on-site and in the supplying industries.

Table A-4
Components of the Multiplier for the
Historic Rehabilitation of a Single-Family Residence

<table>
<tr><th>Direct Impact</th><th>Indirect Impact</th><th>Induced Impact</th></tr>
<tr><td>Excavation/Construction Labor</td><td>Production Labor</td><td rowspan="6">Expenditures by wage earners on-site and in the supplying industries for food, clothing, durable goods, entertainment</td></tr>
<tr><td>Concrete</td><td>Steel Fabrication</td></tr>
<tr><td>Wood</td><td>Concrete Mixing</td></tr>
<tr><td>Bricks</td><td>Factory and Office Expenses</td></tr>
<tr><td>Equipment</td><td>Equipment Components</td></tr>
<tr><td>Finance and Insurance</td><td></td></tr>
</table>

Regional Input-Output Analysis

Because of data limitations, regional input-output analysis has some considerations beyond those for the nation. The main considerations concern the depiction of regional technology and the adjustment of the technology to account for interregional trade by industry.

In the regional setting, local technology matrices are not readily available. An accurate region-specific technology matrix requires a survey of a representative sample of organizations for each industry to be depicted in the model. Such surveys are extremely expensive.[5] Because of the expense, regional analysts have tended to use national technology as a surrogate for regional technology. This substitution does not affect the accuracy of the model as long as local industry technology does not vary widely from the nation's average.[6]

Even when local technology varies widely from the nation's average for one or more industries, model accuracy may not be affected much. This is because interregional trade may mitigate the error that would be induced by the technology. That is, in estimating economic impacts via a regional input-output model, national technology must be regionalized by a vector of regional purchase coefficients,[7] **r**, in the following manner:

$$(\mathbf{I}\text{-}\mathbf{rA})^{-1}\,\mathbf{r}\cdot\Delta\mathbf{y}$$

or

$$\mathbf{r}\cdot\Delta\mathbf{y} + \mathbf{rA}\,(\mathbf{r}\cdot\Delta\mathbf{y}) + \mathbf{rA}(\mathbf{rA}\,(\mathbf{r}\cdot\Delta\mathbf{y})) + \mathbf{rA}(\mathbf{rA}(\mathbf{rA}\,(\mathbf{r}\cdot\Delta\mathbf{y}))) + \ldots$$

where the vector-matrix product **rA** is an estimate of the region's direct requirements matrix. Thus, if national technology coefficients—which vary widely from their local equivalents—are multiplied by small RPCs, the error transferred to the direct requirements matrices will be relatively small. Indeed, since most manufacturing industries have small RPCs and since technology differences tend to arise due to substitution in the use of manufactured goods, technology differences have generally been found to be minor source error in economic impact measurement. Instead, RPCs and their measurement error due to industry aggregation have been the focus of research on regional input-output model accuracy.

---

[5]The most recent statewide survey-based model was developed for the State of Kansas in 1986 and cost on the order of $60,000 (in 1990 dollars). The development of this model, however, leaned heavily on work done in 1965 for the same state. In addition the model was aggregated to the 35-sector level, making it inappropriate for many possible applications since the industries in the model do not represent the very detailed sectors that are generally analyzed.

[6]Only recently have researchers studied the validity of this assumption. They have found that large urban areas may have technology in some manufacturing industries that differs in a statistically significant way from the national average. As will be discussed in a subsequent paragraph, such differences may be unimportant after accounting for trade patterns.

[7]A regional purchase coefficient (RPC) for an industry is the proportion of the region's demand for a good or service that is fulfilled by local production. Thus, each industry's RPC varies between zero (0) and one (1), with one implying that all local demand is fulfilled by local suppliers. As a general rule, agriculture, mining, and manufacturing industries tend to have low RPCs, and both service and construction industries tend to have high RPCs.

A Comparison of Three Major Regional Economic Impact Models

In the United States there are three major vendors of regional input-output models. They are U.S. Bureau of Economic Analysis's (BEA) RIMS II multipliers, Minnesota IMPLAN Group Inc.'s (MIG) IMPLAN Pro model, and CUPR's own RECON™ I–O model. CUPR has had the privilege of using them all. (R/ECON™ I–O builds from the PC I–O model produced by the Regional Science Research Corporation (RSRC).)

Although the three systems have important similarities, there are also significant differences that should be considered before deciding which system to use in a particular study. This document compares the features of the three systems. Further discussion can be found in Brucker, Hastings, and Latham's article in the Summer 1987 issue of *The Review of Regional Studies* entitled "Regional Input-Output Analysis: A Comparison of Five Ready-Made Model Systems." Since that date, CUPR and MIG have added a significant number of new features to PC I–O (now, R/ECON™ I–O) and IMPLAN, respectively.

Model Accuracy

RIMS II, IMPLAN, and RECON™ I–O all employ input-output (I–O) models for estimating impacts. All three regionalize the U.S. national I–O technology coefficients table at the highest levels of disaggregation. Since aggregation of sectors has been shown to be an important source of error in the calculation of impact multipliers, the retention of maximum industrial detail in these regional systems is a positive feature that they share. The systems diverge in their regionalization approaches, however. The difference is in the manner that they estimate regional purchase coefficients (RPCs), which are used to regionalize the technology matrix. An RPC is the proportion of the region's demand for a good or service that is fulfilled by the region's own producers rather than by imports from producers in other areas. Thus, it expresses the proportion of the purchases of the good or service that do not leak out of the region, but rather feed back to its economy, with corresponding multiplier effects. Thus, the accuracy of the RPC is crucial to the accuracy of a regional I–O model, since the regional multiplier effects of a sector vary directly with its RPC.

The techniques for estimating the RPCs used by CUPR and MIG in their models are theoretically more appealing than the location quotient (LQ) approach used in RIMS II. This is because the former two allow for crosshauling of a good or service among regions and the latter does not. Since crosshauling of the same general class of goods or services among regions is quite common, the CUPR-MIG approach should provide better estimates of regional imports and exports. Statistical results reported in Stevens, Treyz, and Lahr (1989) confirm that LQ methods tend to overestimate RPCs. By extension, inaccurate RPCs may lead to inaccurately estimated impact estimates.

Further, the estimating equation used by CUPR to produce RPCs should be more accurate than that used by MIG. The difference between the two approaches is that MIG estimates RPCs at a more aggregated level (two-digit SICs, or about 86 industries) and applies them at a disaggregate level (over 500 industries). CUPR both estimates and applies the RPCs at the most detailed industry level. The application of aggregate RPCs can induce as much as 50 percent error in impact estimates (Lahr and Stevens, 2002).

Although both RECON™ I–O and IMPLAN use an RPC-estimating technique that is theoretically sound and update it using the most recent economic data, some practitioners question their accuracy. The reasons for doing so are three-fold. First, the observations currently used to estimate their implemented RPCs are based on 20-years old trade relationships—the Commodity Transportation Survey (CTS) from the 1977 Census of Transportation. Second, the CTS observations are at the state level. Therefore, RPC's estimated for substate areas are extrapolated. Hence, there is the potential that RPCs for counties and metropolitan areas are not as accurate as might be expected. Third, the observed CTS RPCs are only for shipments of goods. The interstate provision of services is unmeasured by the CTS. IMPLAN replies on relationships from the 1977 U.S. Multiregional Input-Output Model that are not clearly documented. RECON™ I–O relies on the same econometric relationships that it does for manufacturing industries but employs expert judgment to construct weight/value ratios (a critical variable in the RPC-estimating equation) for the nonmanufacturing industries.

The fact that BEA creates the RIMS II multipliers gives it the advantage of being constructed from the full set of the most recent regional earnings data available. BEA is the main federal government purveyor of employment and earnings data by detailed industry. It therefore has access to the fully disclosed and disaggregated versions of these data. The other two model systems rely on older data from *County Business Patterns* and Bureau of Labor Statistic's ES202 forms, which have been "improved" by filling-in for any industries that have disclosure problems (this occurs when three or fewer firms exist in an industry or a region).

Model Flexibility

For the typical user, the most apparent differences among the three modeling systems are the level of flexibility they enable and the type of results that they yield. R/ECON™ I–O allows the user to make changes in individual cells of the 383-by-383 technology matrix as well as in the 11 383-sector vectors of region-specific data that are used to produce the regionalized model. The 11 sectors are: output, demand, employment per unit output, labor income per unit output, total value added per unit of output, taxes per unit of output (state and local), nontax value added per unit output, administrative and auxiliary output per unit output, household consumption per unit of labor income, and the RPCs. The PC I–O model tends to be simple to use. Its User's Guide is straightforward and concise, providing instruction about the proper implementation of the model as well as the interpretation of the model's results.

The software for IMPLAN Pro is Windows-based, and its User's Guide is more formalized. Of the three modeling systems, it is the most user-friendly. The Windows orientation has enabled MIG to provide many more options in IMPLAN without increasing the complexity of use. Like R/ECON™ I–O, IMPLAN's regional data on RPCs, output, labor compensation, industry average margins, and employment can be revised. It does not have complete information on tax revenues other than those from indirect business taxes (excise and sales taxes), and those cannot be altered. Also like R/ECON™, IMPLAN allows users to modify the cells of the 538-by-538 technology matrix. It also permits the user to change and apply price deflators so that dollar figures can be updated from the default year, which may be as many as four years prior to the current year. The plethora of options, which are advantageous to the advanced user, can be extremely confusing to the novice. Although default values are provided for most of the options, the accompanying documentation does not clearly point out which items should get the most attention. Further, the calculations needed to make any requisite changes can be more complex than those needed for the R/ECON™ I–O model. Much of the documentation for the model dwells on technical issues regarding the guts of the model. For example, while one can aggregate the 538-sector impacts to the one- and two-digit SIC level, the current documentation does not discuss that possibility. Instead, the user is advised by the Users Guide to produce an aggregate model to achieve this end. Such a model, as was discussed earlier, is likely to be error ridden.

For a region, RIMS II typically delivers a set of 38-by-471 tables of multipliers for output, earnings, and employment; supplementary multipliers for taxes are available at additional cost. Although the model's documentation is generally excellent, use of RIMS II alone will not provide proper estimates of a region's economic impacts from a change in regional demand. This is because no RPC estimates are supplied with the model. For example, in order to estimate the impacts of rehabilitation, one not only needs to be able to convert the engineering cost estimates into demands for labor as well as for materials and services by industry, but must also be able to estimate the percentage of the labor income, materials, and services which will be provided by the region's households and industries (the RPCs for the demanded goods and services). In most cases, such percentages are difficult to ascertain; however, they are provided in the R/ECON™ I–O and IMPLAN models with simple triggering of an option. Further, it is impossible to change any of the model's parameters if superior data are known. This model ought not to be used for evaluating any project or event where superior data are available or where the evaluation is for a change in regional demand (a construction project or an event) as opposed to a change in regional supply (the operation of a new establishment).

Model Results

Detailed total economic impacts for about 400 industries can be calculated for jobs, labor income, and output from R/ECON™ I–O and IMPLAN only. These two modeling systems can also provide total impacts as well as impacts at the one- and two-digit industry levels. RIMS II provides total impacts and impacts on only 38 industries for these same three measures. Only the manual for R/ECON™ I–O warns about the problems of interpreting and comparing multipliers and any measures of output, also known as the value of shipments.

As an alternative to the conventional measures and their multipliers, R/ECON™ I–O and IMPLAN provide results on a measure known as "value added." It is the region's contribution to the nation's gross domestic product (GDP) and consists of labor income, nonmonetary labor compensation, proprietors' income, profit-type income, dividends, interest, rents, capital consumption allowances, and taxes paid. It is, thus, the region's production of wealth and is the single best economic measure of the total economic impacts of an economic disturbance.

In addition to impacts in terms of jobs, employee compensation, output, and value added, IMPLAN provides information on impacts in terms of personal income, proprietor income, other property-type income, and indirect business taxes. R/ECON™ I–O breaks out impacts into taxes collected by the local, state, and federal governments. It also provides the jobs impacts in terms of either about 90 or 400 occupations at the users request. It goes a step further by also providing a return-on-investment-type multiplier measure, which compares the total impacts on all of the main measures to the total original expenditure that caused the impacts. Although these latter can be readily calculated by the user using results of the other two modeling systems, they are rarely used in impact analysis despite their obvious value.

In terms of the format of the results, both R/ECON™ I–O and IMPLAN are flexible. On request, they print the results directly or into a file (Excel® 4.0, Lotus 123®, Word® 6.0, tab delimited, or ASCII text). It can also permit previewing of the results on the computer's monitor. Both now offer the option of printing out the job impacts in either or both levels of occupational detail.

RSRC Equation

The equation currently used by RSRC in estimating RPCs is reported in Treyz and Stevens (1985). In this paper, the authors show that they estimated the RPC from the 1977 CTS data by estimating the demands for an industry's production of goods or services that are fulfilled by local suppliers (*LS*) as

$$LS = D^{e(-1/x)}$$

and where for a given industry

$x = k\ Z_1^{a1} Z_2^{a2}\ P_j\ Z_j^{aj}$ and D is its total local demand.

Since for a given industry RPC = LS/D then

$$\ln\{-1/[\ln(\ln LS/\ln D)]\} = \ln k + a_1 \ln Z_1 + a_2 \ln Z_2 + S_j\, a_j \ln Z_j$$

which was the equation that was estimated for each industry.

This odd nonlinear form not only yielded high correlations between the estimated and actual values of the RPCs, it also assured that the RPC value ranges strictly between 0 and 1. The results of the empirical implementation of this equation are shown in Treyz and Stevens (1985, table 1). The table shows that total local industry demand (Z_1), the supply/demand ratio (Z_2), the weight/value ratio of the good (Z_3), the region's size in square miles (Z_4), and the region's average establishment size in terms of employees for the industry compared to the nation's (Z_5) are the variables that influence the value of the RPC across all regions and industries. The latter of these maintain the least leverage on RPC values.

Because the CTS data are at the state level only, it is important for the purposes of this study that the local industry demand, the supply/demand ratio, and the region's size in square miles are included in the equation. They allow the equation to extrapolate the estimation of RPCs for areas smaller than states. It should also be noted here that the CTS data only cover manufactured goods. Thus, although calculated effectively making them equal to unity via the above equation, RPC estimates for services drop on the weight/value ratios. A very high weight/value ratio like this forces the industry to meet this demand through local production. Hence, it is no surprise that a region's RPC for this sector is often very high (0.89). Similarly, hotels and motels tend to be used by visitors from outside the area. Thus, a weight/value ratio on the order of that for industry production would be expected. Hence, an RPC for this sector is often about 0.25.

The accuracy of CUPR's estimating approach is exemplified best by this last example. Ordinary location quotient approaches would show hotel and motel services serving local residents. Similarly, IMPLAN RPCs are built from data that combine this industry with eating and drinking establishments (among others). The results of such aggregation process is an RPC that represents neither industry (a value of about 0.50) but which is applied to both. In the end, not only is the CUPR's RPC-estimating approach the most sound, but it is also widely acknowledged by researchers in the field as being state of the art.

Advantages and Limitations of Input-Output Analysis

Input-output modeling is one of the most accepted means for estimating economic impacts. This is because it provides a concise and accurate means for articulating the interrelationships among industries. The models can be quite detailed. For example, the current U.S. model currently has more than 500 industries representing many six-digit North American Industrial Classification System (NAICS) codes. The R/ECON™ model used in this study has 383 sectors. Further, the industry detail of input-output models provides not only a consistent and systematic approach but also more accurately assesses multiplier effects of changes in economic activity. Research has shown that results from more aggregated economic models can have as much as 50 percent error inherent in them. Such large errors are generally attributed to poor estimation of regional trade flows resulting from the aggregation process.

Input-output models also can be set up to capture the flows among economic regions. For example, the model used in this study can calculate impacts for a county, as well as a metropolitan area or a state economy.

The limitations of input-output modeling should also be recognized. The approach makes several key assumptions. First, the input-output model approach assumes that there are no economies of scale to production in an industry; that is, the proportion of inputs used in an industry's production process does not change regardless of the level of production. This assumption will not work if the technology matrix depicts an economy of a recessional economy (e.g., 1982) and the analyst is attempting to model activity in a peak economic year (e.g., 1989). In a recession year, the labor-to-output ratio tends to be excessive because firms are generally reluctant to lay off workers when they believe an economic turnaround is about to occur.

A less-restrictive assumption of the input-output approach is that technology is not permitted to change over time. It is less restrictive because the technology matrix in the United States is updated frequently and, in general, production technology does not radically change over short periods.

Finally, the technical coefficients used in most regional models are based on the assumption that production processes are spatially invariant and are well represented by the nation's average technology. In a region as large and diverse as New Jersey, this assumption is likely to hold true.

Appendix B: Note on Local Tax Revenues

The local tax revenues estimated in this analysis represent property tax revenues that accrue, over time, as a result of improvements to existing or construction of new property. This activity is afforded by the personal and business incomes generated directly and indirectly by the construction expenditures.

Local tax revenues result from the expenditures generated from the income for workers and revenues for business.[8] The personal incomes and in business revenues are, in part, used to pay property taxes and to improve properties (both residential and commercial). Thus, households and businesses that benefit from the construction expenditures acquire and/or improve residential and commercial properties or alternatively are able to pay rents that include associated property taxes.

Historical fiscal and economic data are used to measure the relationship between business revenues and the amount of commercial property tax revenues collected, and between household incomes and the amount of residential property tax revenues collected.[9] Given both household income and business revenues associated with Williams' construction expenditures, the R/ECON™ Input-Output Model invokes the known statistical relation of local property tax revenues to both household income and business revenues in order to estimate the addition to local tax revenues attributable to the expenditures.

---

[8] For businesses, the revenue increase is measured in terms of value-added, and it is the change in value added in the business sector that is the basis for the estimated change in property tax revenues.

[9] In New Jersey, for example, approximately 76% of total local property tax revenues are attributable to residential property; with approximately 21% derived primarily from commercial and industrial property.