PRELIMINARY ECONOMIC IMPACT STUDY: UPDATE

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7 INPUT-OUTPUT ANALYSIS: CONSTRUCTION OF THE PURPLE LINE

From a regional, state and local perspective, the Purple Line construction program will have significant economic and financial impact in terms of short term job creation, income and output. Regional input-output (I-O) multipliers, which account for inter-industry relationships within specific regions, have proven to be a very potent and useful tool for evaluating economic stimulus of construction expenditures in a region.

7.1 SCOPE OF EVALUATION

In order to understand the economic impact of the Purple Line project construction on Montgomery and Prince George's Counties and Washington DC, an analysis was made of the temporary supply-side benefits that are derived by the analyzed region. This includes an assessment of both the temporary direct and indirect jobs created by construction of the project, as well as income and economic output.

An input-output methodology was used to identify the number of temporary jobs, both direct and indirect, that will be created in Montgomery and Prince George's Counties and Washington DC during each of 5 years of construction of the project. The input-output analysis measures the short-term economic stimuli that are created in this region as a result of the additional construction spending on the project. In our study we assume that Federal government will fund the capital cost of the project. As a result we will measure the influence of construction spending on output, job creation and correspondent income. Although an FHWA cost-benefit analysis treats the capital investment as a cost rather than as a benefit of the project, according to BEA methodology the construction cost creates job and income benefits to Montgomery and Prince George's Counties and Washington DC, because the money is spent in its states rather than elsewhere.

7.2 INPUT-OUTPUT METHODOLOGY

In the 1970's, the Bureau of Economic Analysis (BEA) developed a method for estimating regional I-O multipliers known as Regional Industrial Multiplier System (RIMS) In the 1980's, BEA completed an enhancement of RIMS, known as RIMS II, the Regional Input-Output Modeling System[30]. A second edition of the RIMS II handbook based on more recent data and an improved methodology was issued in 1992. A third edition was made available in 1997.

The main underpinning of the RIMS II methodology is an accounting framework known as an I-O matrix, which is discussed in detail in the Appendix A. The I-O matrix is an exhibit that shows the distribution of inputs purchased and outputs sold for each industry. There are two main data sources for the I-O matrix in RIMS II. First is the BEA's national I-O exhibit, which provides the input and output structure of nearly 500 detailed U.S. industries (in accordance with NAICS codes) and of 20 aggregated industries. Second, is represented by BEA's regional economic accounts, used to adjust the national I-O exhibit in order to reflect a region's industrial composition and trading patterns.

The fundamental idea behind the input-output model is that of the multiplier effect, whereby new money entering the economy has a ripple effect with spillover benefits for the entire community through direct and indirect impacts. To cite an example, when the government buys $10 billion worth of goods from a major industry, the purchase (notwithstanding the immediate effect of raising employment and profits in that

[30] For a detailed discussion on the data sources and methods underlying the use of RIMS II, the Reader is referred to the technical Appendix A.

industry) has repercussions leading to higher overall incomes, which in turn lead to even higher demand, thereby triggering a positive feedback loop. The total impact on the quantity of goods and services demanded is much larger than the initial impulse felt from higher government spending. The factor by which the initial impulse is multiplied will be determined by the individuals' marginal propensity to consume: the fraction of extra income that a household consumes rather than saves.

Exhibit 7.1, 7.2 and 7.3 illustrate how a single dollar of additional spending on auto production, for example, benefits the plastics, electricity, instruments and rubber industries, among others[31]. As shown in the Exhibit 7.1, a single dollar spent on auto production translates into 14 cents spent on plastics, 5 cents on electricity, 11 cents on instruments, 7 cents on rubber, 21 cents on local industries, 17 cents in earnings for local employees and 25 cents leakage. In the second ripple shown in Exhibit 7.2, the 14 cents earned by the plastics industry feeds 9 cents to the chemicals industry, 2 cents earnings for local employees and 3 cents of leakage. Similarly, in the third Exhibit 7.3, 21 cents spent on other local industries re-enters the economy in the form of 1 cent for utilities, 5 cents on autos, 4 cents for other local industries, and 4 cents income for local employees and 7 cents leakage.

It should be noted that depending upon the type of project and its location, the multiplier effects from the additional investment, jobs, income and workers' spending decisions would differ. This is because the characteristics of the local economy (i.e., the types of industry present) determines exactly how much extra impact an investment will generate in that region.

7.3 APPLICATION OF REGIONAL INPUT-OUTPUT MODELING SYSTEM

The main advantage of RIMS II is that multipliers can be estimated for any region composed of one or more counties, and for any industry or group of industries in the national I-O exhibit. In order to obtain multipliers especially for the Purple Line corridor a description of the region was provided to BEA. The RIMS II multipliers were calculated for the Montgomery and Prince George's Counties and Washington DC.

A systematic analysis of the regional economic benefits that will be accrued from the Purple Line transportation project calls for detailed information about inter-industry relationships not only at County level in general, but in the different parts of the Purple Line corridor region. Using Capital cost of 1.9 billion with construction cost of 1.7 billion (excluding vehicles cost from Capital cost), we calculate the economic impact of construction spending on output, income and job creations in different parts of the Purple Line corridor. Because the analysis is based on cash flows, we can identify only the employment generated during construction period.

[31] The given example illustrates the methodology of RIMS II multiplier calculations made by BEA and does not relate to Midwest region.

Exhibit 7.1: Multiplier Mechanism 1

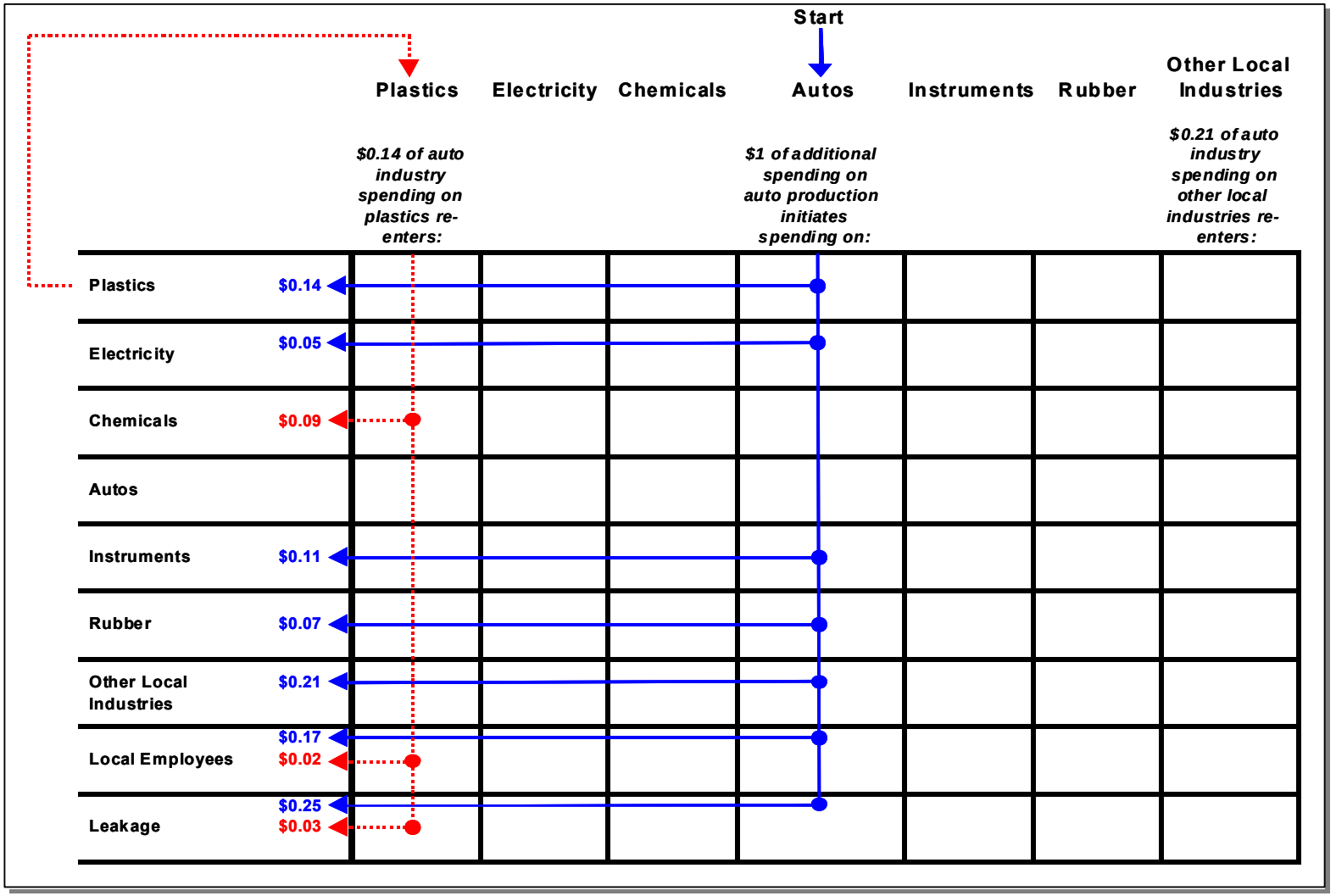


Exhibit 7.2: Multiplier Mechanism 2

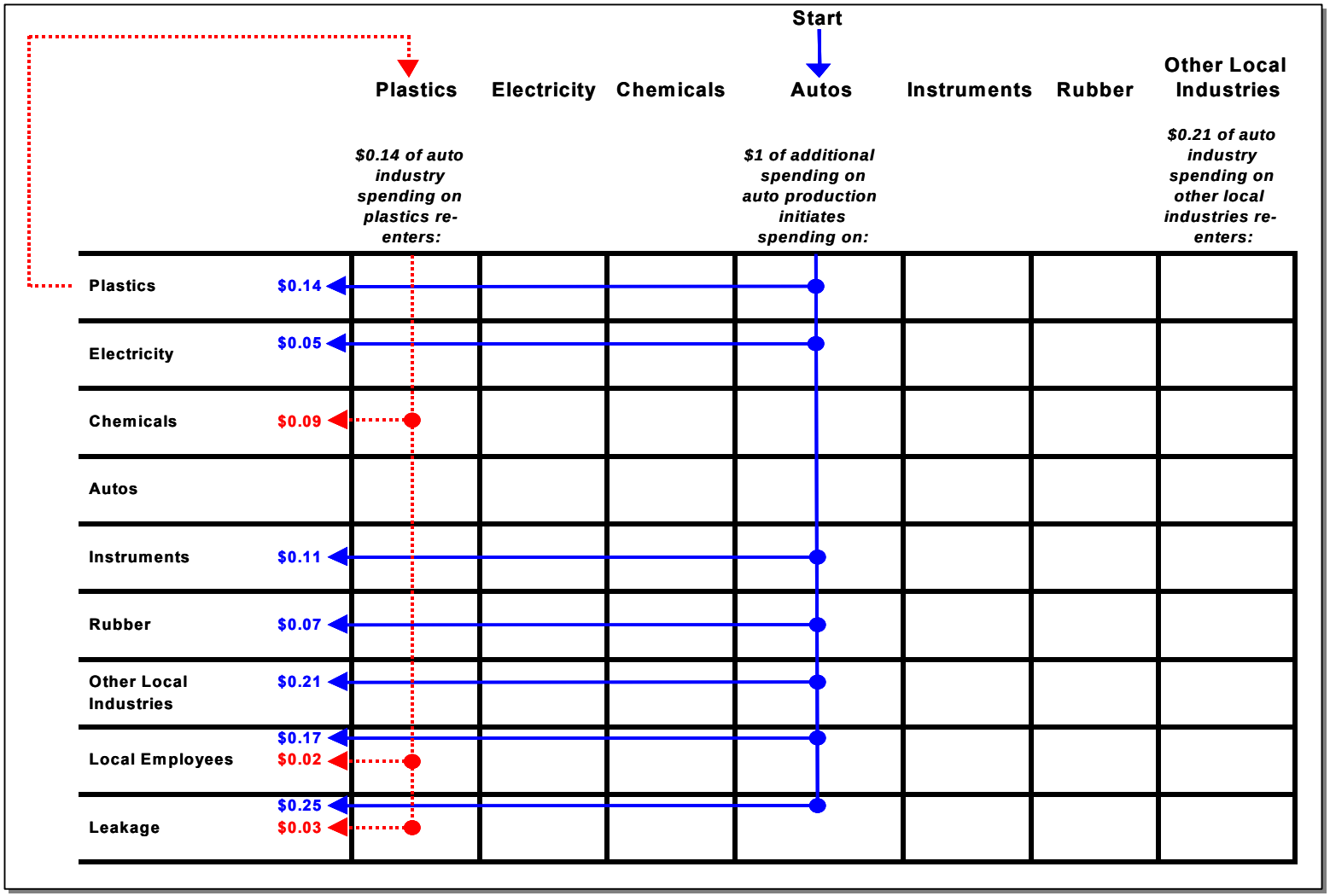
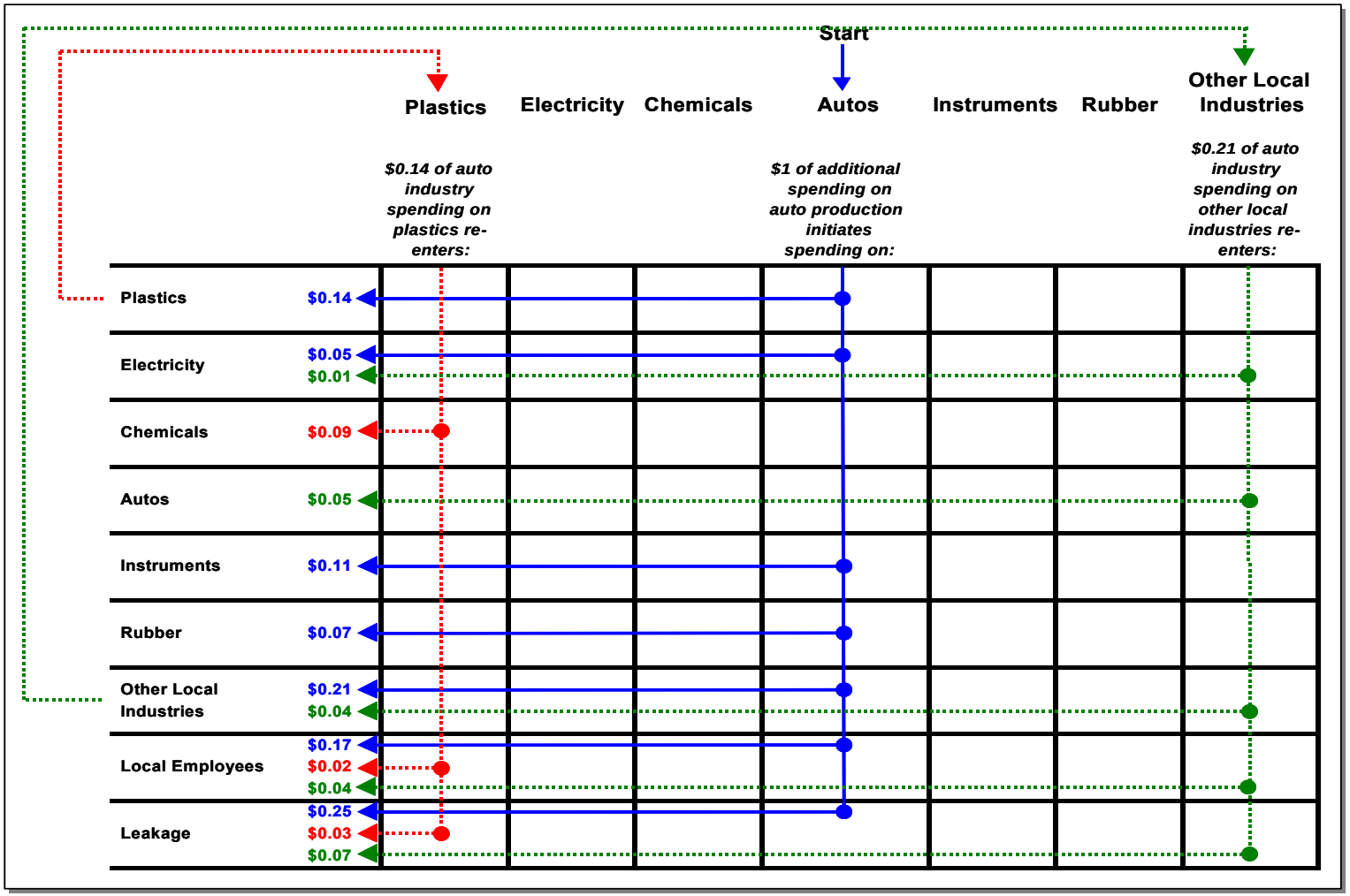


Exhibit 7.3: Multiplier Mechanism 3



7.4 RESULTS

Using RIMS II output and employment multipliers for annual capital infusion in the construction industry over 5-year construction period we estimate how different industries are expected to benefit from the Purple Line project in terms of output and jobs creation. The capital cost is taken as $1.9 billion with construction cost of $1.7 billion for a five-year period in 2014 dollars[32].

Following the methodology developed by BEA for RIMS II we calculate economic impacts on output, income and job creation for each stage (year) of construction period for Montgomery and Prince George's Counties and Washington DC. Exhibits 7.4 through 7.6 show the economic impact on job creations, output, and income by county during the construction period. As seen in Exhibit 7.4 through 7.6, 53% of temporary jobs, 37% of output and 53% of income are created in Montgomery County, 34% of temporary jobs, 35% of output and 33% of income are created in Prince George's County, and 14% of temporary jobs, 29% of output and 15% of income are created in Washington DC.

Exhibits 7.7 through 7.15 show the economic impact on temporary job creations, output, and income by Industry for Montgomery and Prince George's Counties and Washington DC. We can see from Exhibit 7.7 through 7.15, construction industry itself will benefit from project implementation more than other industries. It will obtain around 60% of temporary jobs and 65% of output created in the Montgomery and Prince George's Counties, and 77% of temporary jobs and 82% of output created in Washington DC.

Exhibit 7.4: Temporary Job Creation Person Years

	Year 1	Year 2	Year 3	Year 4	Year 5	Average # of Jobs	Total Person Years of Work
Montgomery County	2,134	2,134	2,134	2,134	2,134	2,134	10,670
Prince George's County	1,357	1,357	1,357	1,357	1,357	1,357	6,785
Washington DC	557	557	557	557	557	557	2,785
Total	**4,048**	**4,048**	**4,048**	**4,048**	**4,048**	**4,048**	**20,240**

Exhibit 7.5: Gross Regional Product (Millions 2014 $)

	Year 1	Year 2	Year 3	Year 4	Year 5	Total Output
Montgomery County	$511.80	$511.80	$511.80	$511.80	$511.80	$2,558.98
Prince George's County	$486.78	$486.78	$486.78	$486.78	$486.78	$2,433.89
Washington DC	$403.14	$403.14	$403.14	$403.14	$403.14	$2,015.70
Total	**$1,401.71**	**$1,401.71**	**$1,401.71**	**$1,401.71**	**$1,401.71**	**$7,008.57**

[32] According to Purple Line FEIS, the total project capital cost is 1.847 billion in 2012 dollars. By multiplying CPI factors from Bureau of Labor Statistics, it is converted to 2014 dollars.

Exhibit 7.6: Personal Income (Millions 2014 $)

	Year 1	Year 2	Year 3	Year 4	Year 5	Average Income	Total Income
Montgomery County	$103.19	$103.19	$103.19	$103.19	$103.19	$103.19	$515.94
Prince George's County	$64.05	$64.05	$64.05	$64.05	$64.05	$64.05	$320.27
Washington DC	$28.90	$28.90	$28.90	$28.90	$28.90	$28.90	$144.48
Total	**$196.14**	**$196.14**	**$196.14**	**$196.14**	**$196.14**	**$196.14**	**$980.68**

Besides construction industry, noteworthy employment gains in Montgomery County will be mainly in retail trade (9% of new temporary jobs), professional, scientific and technical services (6%), administrative and management services (4%), whereas in Prince George's County besides construction industry, retail trade (10%), professional, scientific and technical services (4%), administrative and management services (4%). In Washington DC, besides construction, noteworthy employment gains will be mainly in professional, scientific and technical services (7%), administrative and management services (5%), and retail trade (2%). (See Exhibit 7.7 through 7.9)

Among the industries that are estimated to receive significant share of output besides construction industry, we can point out on professional, scientific and technical services (6% in Montgomery County, 5% in Prince George's County and 7% in Washington DC), real estate and rental and leasing (5% in Montgomery County, 4% in Prince George's County and 2% in Washington DC), retail trade (5% in Montgomery County, and 5% in Prince George's County), finance and insurance (4% in Montgomery County), and manufacturing (3% in Prince George's County). (See Exhibit 7.10 through 7.12)

As seen in Exhibit 7.13 through 7.15, among the industries that are estimated to receive significant income besides construction industry, we can point out on professional, scientific and technical services (9% in Montgomery County, 7% in Prince George's County and 11% in Washington DC), and retail trade (5% in Montgomery County, 6% in Prince George's County and 1% in Washington DC).

Exhibit 7.7: Economic Impact by Industry Grouping - Temporary Job Creation in Montgomery County

NAICS	Descriptions	Year 1	Year 2	Year 3	Year 4	Year 5	Average # of jobs	Total Person years of work
23	Construction	1288	1,288	1,288	1,288	1,288	1,288	**6,440**
44	Retail trade	192	192	192	192	192	192	**960**
54	Professional, scientific, and technical services	130	130	130	130	130	130	**650**
56	Administrative and waste management services	80	80	80	80	80	80	**400**
62	Health care and social assistance	77	77	77	77	77	77	**385**
53	Real estate and rental and leasing	74	74	74	74	74	74	**370**
52	Finance and insurance	57	57	57	57	57	57	**285**
72	Food services and drinking places	54	54	54	54	54	54	**270**

81, S0	Other services*	46	46	46	46	46	46	**230**
42	Wholesale trade	24	24	24	24	24	24	**120**
31	Manufacturing	23	23	23	23	23	23	**115**
51	Information	23	23	23	23	23	23	**115**
48	Transportation and warehousing*	15	15	15	15	15	15	**75**
55	Management of companies and enterprises	10	10	10	10	10	10	**50**
71	Arts, entertainment, and recreation	10	10	10	10	10	10	**50**
72	Accommodation	9	9	9	9	9	9	**45**
61	Educational services	8	8	8	8	8	8	**40**
H0	Households	8	8	8	8	8	8	**40**
21	Mining	4	4	4	4	4	4	**20**
11	Agriculture, forestry, fishing, and hunting	1	1	1	1	1	1	**5**
22	Utilities*	1	1	1	1	1	1	**5**
TOTAL		2,134	2,134	2,134	2,134	2,134	2,134	**10,670**

Exhibit 7.8: Economic Impact by Industry Grouping - Temporary Job Creation in Prince George's County

NAICS	Descriptions	Year 1	Year 2	Year 3	Year 4	Year 5	Average # of jobs	Total Person years of work
23	Construction	843	843	843	843	843	843	**4,215**
44	Retail trade	133	133	133	133	133	133	**665**
54	Professional, scientific, and technical services	58	58	58	58	58	58	**290**
56	Administrative and waste management services	52	52	52	52	52	52	**260**
53	Real estate and rental and leasing	38	38	38	38	38	38	**190**
72	Food services and drinking places	35	35	35	35	35	35	**175**
48	Transportation and warehousing*	32	32	32	32	32	32	**160**
62	Health care and social assistance	31	31	31	31	31	31	**155**
81, S0	Other services*	30	30	30	30	30	30	**150**
31	Manufacturing	26	26	26	26	26	26	**130**
42	Wholesale trade	19	19	19	19	19	19	**95**
52	Finance and insurance	18	18	18	18	18	18	**90**
51	Information	11	11	11	11	11	11	**55**
61	Educational services	8	8	8	8	8	8	**40**
71	Arts, entertainment, and recreation	6	6	6	6	6	6	**30**
H0	Households	6	6	6	6	6	6	**30**
72	Accommodation	4	4	4	4	4	4	**20**
21	Mining	3	3	3	3	3	3	**15**
11	Agriculture, forestry, fishing, and hunting	2	2	2	2	2	2	**10**
22	Utilities*	1	1	1	1	1	1	**5**
55	Management of companies and enterprises	1	1	1	1	1	1	**5**
TOTAL		1,357	1,357	1,357	1,357	1,357	1,357	**6,785**

Exhibit 7.9: Economic Impact by Industry Grouping - Temporary Job Creation in Washington DC

NAICS	Descriptions	Year 1	Year 2	Year 3	Year 4	Year 5	Average # of jobs	Total Person years of work
23	Construction	430	430	430	430	430	430	**2,150**
54	Professional, scientific, and technical services	37	37	37	37	37	37	**185**
56	Administrative and waste management services	26	26	26	26	26	26	**130**
44	Retail trade	13	13	13	13	13	13	**65**
72	Food services and drinking places	10	10	10	10	10	10	**50**
53	Real estate and rental and leasing	9	9	9	9	9	9	**45**
62	Health care and social assistance	6	6	6	6	6	6	**30**
51	Information	4	4	4	4	4	4	**20**
52	Finance and insurance	4	4	4	4	4	4	**20**
81, S0	Other services*	4	4	4	4	4	4	**20**
72	Accommodation	3	3	3	3	3	3	**15**
31	Manufacturing	2	2	2	2	2	2	**10**
42	Wholesale trade	2	2	2	2	2	2	**10**
48	Transportation and warehousing*	2	2	2	2	2	2	**10**
61	Educational services	2	2	2	2	2	2	**10**
71	Arts, entertainment, and recreation	2	2	2	2	2	2	**10**
H0	Households	1	1	1	1	1	1	**5**
11	Agriculture, forestry, fishing, and hunting	0	0	0	0	0	0	**0**
21	Mining	0	0	0	0	0	0	**0**
22	Utilities*	0	0	0	0	0	0	**0**
55	Management of companies and enterprises	0	0	0	0	0	0	**0**
TOTAL		557	557	557	557	557	557	**2,785**

Exhibit 7.10: Economic Impact by Industry Grouping - Gross Regional Product in Montgomery County (Millions 2014 $)

NAICS	Descriptions	Year 1	Year 2	Year 3	Year 4	Year 5	Total Output
23	Construction	$332.63	$332.63	$332.63	$332.63	$332.63	**$1,663.13**
54	Professional, scientific, and technical services	$31.48	$31.48	$31.48	$31.48	$31.48	**$157.40**
53	Real estate and rental and leasing	$26.11	$26.11	$26.11	$26.11	$26.11	**$130.56**
44	Retail trade	$23.92	$23.92	$23.92	$23.92	$23.92	**$119.62**
52	Finance and insurance	$20.48	$20.48	$20.48	$20.48	$20.48	**$102.39**
51	Information	$12.43	$12.43	$12.43	$12.43	$12.43	**$62.13**
62	Health care and social assistance	$11.10	$11.10	$11.10	$11.10	$11.10	**$55.50**
31	Manufacturing	$9.54	$9.54	$9.54	$9.54	$9.54	**$47.72**
42	Wholesale trade	$9.21	$9.21	$9.21	$9.21	$9.21	**$46.06**
56	Administrative and waste management services	$7.95	$7.95	$7.95	$7.95	$7.95	**$39.76**
81, S0	Other services*	$7.79	$7.79	$7.79	$7.79	$7.79	**$38.94**
55	Management of companies and enterprises	$4.41	$4.41	$4.41	$4.41	$4.41	**$22.04**
72	Food services and drinking places	$4.27	$4.27	$4.27	$4.27	$4.27	**$21.37**
48	Transportation and warehousing*	$2.85	$2.85	$2.85	$2.85	$2.85	**$14.25**
21	Mining	$2.65	$2.65	$2.65	$2.65	$2.65	**$13.25**
72	Accommodation	$1.66	$1.66	$1.66	$1.66	$1.66	**$8.28**
22	Utilities*	$1.19	$1.19	$1.19	$1.19	$1.19	**$5.96**
61	Educational services	$1.03	$1.03	$1.03	$1.03	$1.03	**$5.14**
71	Arts, entertainment, and recreation	$0.89	$0.89	$0.89	$0.89	$0.89	**$4.47**
11	Agriculture, forestry, fishing, and hunting	$0.20	$0.20	$0.20	$0.20	$0.20	**$0.99**
H0	Households	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
TOTAL		$511.80	$511.80	$511.80	$511.80	$511.80	**$2,558.98**

Exhibit 7.11: Economic Impact by Industry Grouping - Gross Regional Product in Prince George's County (Millions 2014 $)

NAICS	Descriptions	Year 1	Year 2	Year 3	Year 4	Year 5	Total Output
23	Construction	$332.49	$332.49	$332.49	$332.49	$332.49	**$1,662.47**
54	Professional, scientific, and technical services	$25.88	$25.88	$25.88	$25.88	$25.88	**$129.40**
44	Retail trade	$23.39	$23.39	$23.39	$23.39	$23.39	**$116.97**
53	Real estate and rental and leasing	$19.82	$19.82	$19.82	$19.82	$19.82	**$99.08**
31	Manufacturing	$16.40	$16.40	$16.40	$16.40	$16.40	**$82.01**
42	Wholesale trade	$12.59	$12.59	$12.59	$12.59	$12.59	**$62.96**
52	Finance and insurance	$9.87	$9.87	$9.87	$9.87	$9.87	**$49.37**
51	Information	$8.85	$8.85	$8.85	$8.85	$8.85	**$44.24**
81, S0	Other services*	$6.99	$6.99	$6.99	$6.99	$6.99	**$34.96**
48	Transportation and warehousing*	$6.63	$6.63	$6.63	$6.63	$6.63	**$33.14**
56	Administrative and waste management services	$6.26	$6.26	$6.26	$6.26	$6.26	**$31.31**
62	Health care and social assistance	$6.16	$6.16	$6.16	$6.16	$6.16	**$30.82**
72	Food services and drinking places	$3.58	$3.58	$3.58	$3.58	$3.58	**$17.89**
55	Management of companies and enterprises	$2.02	$2.02	$2.02	$2.02	$2.02	**$10.11**
22	Utilities*	$1.66	$1.66	$1.66	$1.66	$1.66	**$8.28**
21	Mining	$1.56	$1.56	$1.56	$1.56	$1.56	**$7.79**
61	Educational services	$1.06	$1.06	$1.06	$1.06	$1.06	**$5.30**
72	Accommodation	$0.73	$0.73	$0.73	$0.73	$0.73	**$3.65**
71	Arts, entertainment, and recreation	$0.60	$0.60	$0.60	$0.60	$0.60	**$2.98**
11	Agriculture, forestry, fishing, and hunting	$0.23	$0.23	$0.23	$0.23	$0.23	**$1.16**
H0	Households	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
TOTAL		$486.78	$486.78	$486.78	$486.78	$486.78	**$2,433.89**

Exhibit 7.12: Economic Impact by Industry Grouping - Gross Regional Product in Washington DC (Millions 2014 $)

NAICS	Descriptions	Year 1	Year 2	Year 3	Year 4	Year 5	Total Output
23	Construction	$331.53	$331.53	$331.53	$331.53	$331.53	**$1,657.66**
54	Professional, scientific, and technical services	$26.44	$26.44	$26.44	$26.44	$26.44	**$132.22**
53	Real estate and rental and leasing	$9.84	$9.84	$9.84	$9.84	$9.84	**$49.21**
51	Information	$6.36	$6.36	$6.36	$6.36	$6.36	**$31.81**
52	Finance and insurance	$5.87	$5.87	$5.87	$5.87	$5.87	**$29.33**
56	Administrative and waste management services	$4.31	$4.31	$4.31	$4.31	$4.31	**$21.54**
44	Retail trade	$3.51	$3.51	$3.51	$3.51	$3.51	**$17.56**
81, S0	Other services*	$2.35	$2.35	$2.35	$2.35	$2.35	**$11.76**
62	Health care and social assistance	$2.29	$2.29	$2.29	$2.29	$2.29	**$11.43**
31	Manufacturing	$2.25	$2.25	$2.25	$2.25	$2.25	**$11.27**
42	Wholesale trade	$2.05	$2.05	$2.05	$2.05	$2.05	**$10.27**
72	Food services and drinking places	$1.49	$1.49	$1.49	$1.49	$1.49	**$7.46**
48	Transportation and warehousing*	$1.23	$1.23	$1.23	$1.23	$1.23	**$6.13**
72	Accommodation	$1.06	$1.06	$1.06	$1.06	$1.06	**$5.30**
22	Utilities*	$0.89	$0.89	$0.89	$0.89	$0.89	**$4.47**
55	Management of companies and enterprises	$0.73	$0.73	$0.73	$0.73	$0.73	**$3.65**
61	Educational services	$0.46	$0.46	$0.46	$0.46	$0.46	**$2.32**
71	Arts, entertainment, and recreation	$0.46	$0.46	$0.46	$0.46	$0.46	**$2.32**
11	Agriculture, forestry, fishing, and hunting	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
21	Mining	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
H0	Households	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
TOTAL		$403.14	$403.14	$403.14	$403.14	$403.14	**$2,015.70**

Exhibit 7.13: Economic Impact by Industry Grouping - Income in Montgomery County (Millions 2014 $)

NAICS	Descriptions	Year 1	Year 2	Year 3	Year 4	Year 5	Average Income	Total Income
23	Construction	$66.70	$66.70	$66.70	$66.70	$66.70	$66.70	**$333.52**
54	Professional, scientific, and technical services	$9.41	$9.41	$9.41	$9.41	$9.41	$9.41	**$47.05**
44	Retail trade	$5.40	$5.40	$5.40	$5.40	$5.40	$5.40	**$27.01**
52	Finance and insurance	$3.98	$3.98	$3.98	$3.98	$3.98	$3.98	**$19.88**
62	Health care and social assistance	$3.71	$3.71	$3.71	$3.71	$3.71	$3.71	**$18.56**
56	Administrative and waste management services	$2.05	$2.05	$2.05	$2.05	$2.05	$2.05	**$10.27**
53	Real estate and rental and leasing	$1.86	$1.86	$1.86	$1.86	$1.86	$1.86	**$9.28**
42	Wholesale trade	$1.76	$1.76	$1.76	$1.76	$1.76	$1.76	**$8.78**
81, S0	Other services*	$1.49	$1.49	$1.49	$1.49	$1.49	$1.49	**$7.46**
51	Information	$1.46	$1.46	$1.46	$1.46	$1.46	$1.46	**$7.29**
31	Manufacturing	$1.36	$1.36	$1.36	$1.36	$1.36	$1.36	**$6.79**
55	Management of companies and enterprises	$1.03	$1.03	$1.03	$1.03	$1.03	$1.03	**$5.14**
72	Food services and drinking places	$0.99	$0.99	$0.99	$0.99	$0.99	$0.99	**$4.97**
48	Transportation and warehousing*	$0.63	$0.63	$0.63	$0.63	$0.63	$0.63	**$3.15**
21	Mining	$0.36	$0.36	$0.36	$0.36	$0.36	$0.36	**$1.82**
72	Accommodation	$0.30	$0.30	$0.30	$0.30	$0.30	$0.30	**$1.49**
61	Educational services	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27	**$1.33**
71	Arts, entertainment, and recreation	$0.20	$0.20	$0.20	$0.20	$0.20	$0.20	**$0.99**
22	Utilities*	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	**$0.50**
H0	Households	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	**$0.50**
11	Agriculture, forestry, fishing, and hunting	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	**$0.17**
TOTAL		$103.19	$103.19	$103.19	$103.19	$103.19	$103.19	**$515.94**

Exhibit 7.14: Economic Impact by Industry Grouping - Income in Prince George's County (Millions 2014 $)

NAICS	Descriptions	Year 1	Year 2	Year 3	Year 4	Year 5	Average Income	Total Income
23	Construction	$43.64	$43.64	$43.64	$43.64	$43.64	$43.64	**$218.21**
54	Professional, scientific, and technical services	$4.18	$4.18	$4.18	$4.18	$4.18	$4.18	**$20.88**
44	Retail trade	$3.74	$3.74	$3.74	$3.74	$3.74	$3.74	**$18.72**
31	Manufacturing	$1.39	$1.39	$1.39	$1.39	$1.39	$1.39	**$6.96**
56	Administrative and waste management services	$1.39	$1.39	$1.39	$1.39	$1.39	$1.39	**$6.96**
42	Wholesale trade	$1.36	$1.36	$1.36	$1.36	$1.36	$1.36	**$6.79**
62	Health care and social assistance	$1.36	$1.36	$1.36	$1.36	$1.36	$1.36	**$6.79**
48	Transportation and warehousing*	$1.29	$1.29	$1.29	$1.29	$1.29	$1.29	**$6.46**
53	Real estate and rental and leasing	$1.16	$1.16	$1.16	$1.16	$1.16	$1.16	**$5.80**
52	Finance and insurance	$1.13	$1.13	$1.13	$1.13	$1.13	$1.13	**$5.63**
81, S0	Other services*	$0.96	$0.96	$0.96	$0.96	$0.96	$0.96	**$4.80**
51	Information	$0.73	$0.73	$0.73	$0.73	$0.73	$0.73	**$3.65**
72	Food services and drinking places	$0.66	$0.66	$0.66	$0.66	$0.66	$0.66	**$3.31**
61	Educational services	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27	**$1.33**
21	Mining	$0.23	$0.23	$0.23	$0.23	$0.23	$0.23	**$1.16**
71	Arts, entertainment, and recreation	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	**$0.66**
72	Accommodation	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	**$0.66**
22	Utilities*	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	**$0.50**
55	Management of companies and enterprises	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	**$0.50**
H0	Households	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07	**$0.33**
11	Agriculture, forestry, fishing, and hunting	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	**$0.17**
TOTAL		$64.05	$64.05	$64.05	$64.05	$64.05	$64.05	**$320.27**

Exhibit 7.15: Economic Impact by Industry Grouping - Income in Washington DC (Millions 2014 $)

NAICS	Descriptions	Year 1	Year 2	Year 3	Year 4	Year 5	Average Income	Total Income
23	Construction	$22.27	$22.27	$22.27	$22.27	$22.27	$22.27	**$111.34**
54	Professional, scientific, and technical services	$3.28	$3.28	$3.28	$3.28	$3.28	$3.28	**$16.40**
56	Administrative and waste management services	$0.70	$0.70	$0.70	$0.70	$0.70	$0.70	**$3.48**
44	Retail trade	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	**$1.99**
52	Finance and insurance	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	**$1.99**
51	Information	$0.33	$0.33	$0.33	$0.33	$0.33	$0.33	**$1.66**
53	Real estate and rental and leasing	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27	**$1.33**
62	Health care and social assistance	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27	**$1.33**
72	Food services and drinking places	$0.20	$0.20	$0.20	$0.20	$0.20	$0.20	**$0.99**
31	Manufacturing	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	**$0.66**
42	Wholesale trade	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	**$0.66**
81, S0	Other services*	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	**$0.66**
72	Accommodation	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	**$0.50**
48	Transportation and warehousing*	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07	**$0.33**
61	Educational services	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07	**$0.33**
71	Arts, entertainment, and recreation	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07	**$0.33**
22	Utilities*	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	**$0.17**
55	Management of companies and enterprises	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	**$0.17**
H0	Households	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	**$0.17**
11	Agriculture, forestry, fishing, and hunting	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
21	Mining	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
TOTAL		$28.90	$28.90	$28.90	$28.90	$28.90	$28.90	**$144.48**

The Input-Output analysis shows that the Purple Line Project will have a general sizeable impact on the economies of Montgomery and Prince George's Counties and Washington DC. The results are summarized in Exhibit 7.4 through 7.15. Since contractors on the project will buy materials and services from other Purple Line corridor region businesses, the RIMS II analysis predicts a multiplier effect on the initial construction expenditure of $1.7 billion. All Purple Line corridor region industries are expected to benefit by approximately USD $7 billion and over 20,240 person-years of work during the construction period. Over a five-year construction period, this would be equivalent to adding approximately 4,048 temporary jobs annually in Montgomery and Prince George's Counties and Washington DC, occurring as a direct result of the construction expenditures alone.

It should be noted that depending upon the type of project and its location, the multiplier effects from the additional investment, jobs, income and workers' spending decisions would differ. This is because the characteristics of the local economy determines exactly how much extra impact an investment will generate.

8 CONCLUSION

The improvement of the Purple Line Preferred Alternative will provide an integrating force for the communities in Montgomery and Prince George's Counties and Washington DC. It will also support the opportunities to fundamentally change the character of business in the area while expanding the level of social, personal and tourist interaction. The project will create a new business environment and will ensure the stability of existing service, transportation and manufacturing industries, while fostering the growth of new small businesses in the area because of the improved access to smaller communities along the Purple Line corridor.

Economic Rent: The long-term supply side benefits are considerable because a very high level of east-west access is being provided between the communities along the Purple Line corridor and because the corridor has a very high level of economic vitality. The Economic Rent analysis shows supply side benefits for the economy of study region.

- 1.0 to 2.2 percent growth in the economy of Montgomery and Prince George's Counties and Washington DC.
- 23,033 long-term person years of work per year for Montgomery and Prince George's Counties and Washington DC.
- Increase in income to local households of $2.2 billion per year or over $40 billion over the life of the project (overall).
- The property value increase, assuming full advantage is taken by local communities of the Purple Line, is $12.8 billion (overall) or $11.0 billion for Montgomery and Prince George's Counties and Washington DC.
- Total expected tax benefits (Federal, State, Local and Sales Tax) from the Purple Line project implementation are in the range of at least $635 million per year (overall) or $541 million for Montgomery and Prince George's Counties and Washington DC.

The development of the Purple Line Preferred Alternative will also result in significant economic impact in Montgomery and Prince George's Counties and Washington DC during the construction of the project.

Input-Output Analysis: The regional use of federal construction dollars to build the system will generate a substantial economic impact in the region. During the construction period it will –

- Create 20,000 person years of work or the equivalent of 4,000 full-time jobs annually during the 5-year construction period (this includes construction plus other industry jobs) for Montgomery and Prince George's Counties and Washington DC.
- Increase in income in Montgomery and Prince George's Counties and Washington DC by $980 million during the 5-year construction period.
- Increase in regional output in these two counties and Washington DC by 7.0 billion during the 5-year construction period.

APPENDIX A: DATA SOURCES AND METHODS FOR RIMS II

Most regional economists agree that the most accurate method of estimating a regional input-output (I-O) model is to survey the businesses in a region in order to determine which goods and services are purchased by industries in the region and whether these goods and services are purchased from other industries in the region or from industries in other regions. However, because these surveys are costly, few regional I-O models in the United States are based on survey, or primary source, data.

As a result, the estimation of the regional input-output modeling system (RIMS II), like that of most regional I-O models, is based on data from the national I-O accounts and other secondary data. It is assumed that the national I-O data can be used to represent the composition of inputs purchased in the region. The national data are then adjusted by regional data, because the industries in a region cannot obtain all of their inputs from within the region.

The RIMS II model and its multipliers are prepared in three major steps.[33] First, an adjusted national industry-by-industry direct requirements table is prepared. Second, the adjusted national table is used to prepare a regional industry-by-industry direct requirements table.[34] Third, a regional industry-by-industry total requirements table is prepared, and the multipliers are derived from this table.

A.1 THE ADJUSTED NATIONAL DIRECT REQUIREMENTS TABLE

The adjusted national industry-by-industry direct requirements table is derived from the make and use tables in BEA's 1987 benchmark I-O accounts for the U.S. economy.[35] The use table is adjusted so that it includes only the use of domestically produced commodities. The data in a use table for imported commodities are subtracted from the data in the total commodity use table.

After this adjustment, a national industry-by-industry direct requirements table is prepared by means of standard I-O procedures.[36] An industry-share matrix, which shows each industry's share of the production of a commodity, is calculated by dividing each entry in each column of the make table by the respective column total. Next, a commodity-by-industry direct requirements matrix, which shows the dollar's worth of each commodity that is required to produce a dollar's worth of each industry's output, is calculated by dividing each entry in each column of the use table by the respective column total. A national industry-by-industry direct requirements table is then estimated by multiplying the industry-share matrix by the commodity-by-industry direct requirements matrix.

Unlike the national I-O accounts, RIMS II includes households as both suppliers of labor inputs to regional industries and as purchasers of regional output, because it is customary in regional impact analysis to

[33] This discussion is mainly for users who are familiar with I-O theory and linear algebra. For a more detailed discussion of I-O theory and the use of regional I-O models in impact analysis, see "Suggested Reading" at the end of this appendix.
[34] In RIMS II, a region consists of the county or counties that are specified by the user.
[35] The make table shows the dollar value, in producers' prices, of each commodity produced by each industry. The use table shows the dollar value, in producers' prices, of each commodity used by each industry and by each final user. See Benchmark Input-Output Accounts for the U.S. Economy, 1987, SURVEY OF CURRENT BUSINESS 74 (April 1994): 73–115;and U.S. Department of Commerce, Bureau of Economic Analysis, Benchmark Input-Output Accounts of the United States, 1987 (Washington, DC: U.S. Government Printing Office, 1994).
[36] See Ronald E. Miller and Peter D. Blair, Input-Output Analysis: Foundations and Extensions (Englewood Cliffs, NJ: Prentice-Hall, 1985), 149–199.

account for the effects of changes in household earnings and expenditures. Thus, both a household row and a household column are added to the national direct requirements table before the table is regionalized.[37]

A.2 THE HOUSEHOLD ROW

Each entry in the household row shows the earnings received by households per dollar of output of the column industry corresponding to the entry. In impact analysis with RIMS II, earnings is defined as the earnings that are received by households from the production of regional goods and services and that are available for spending on these goods and services. Thus, earnings is calculated as the sum of wages and salaries, proprietors' income, directors' fees, and employer contributions for health insurance less personal contributions for social insurance.[38] In equation form, the household row is -

$$HSHR_j = (W\&S_j + PRP_j + DF_j + ECHI_j - PCSI_j) \; / \; TIO_j \; ,$$

where the subscript *j* is industry *j* (column *j* in the direct requirements table), *HSHR* is the household row, *W&S* is wages and salaries, *PRP* is proprietors' income, *DF* is directors' fees, *ECHI* is employer contributions for health insurance, *PCSI* is personal contributions for social insurance, and *TIO* is total industry output.

The estimates of wages and salaries by I-O industry are from the national I-O accounts. The other earnings components are not available by I-O industry and must be estimated.

The estimates of non-farm proprietors' income by I-O industry are made by multiplying non-farm proprietors' income at the two-digit Standard Industrial Classification (SIC) level by each I-O industry's share of wages and salaries in the corresponding two-digit SIC industry. The data source for non-farm proprietors' income and for wages and salaries at the two-digit SIC level is BEA's Regional Economic Information System (REIS). The estimates of farm proprietors' income for 17 I-O agricultural industries are calculated by multiplying total farm proprietors' income by the shares of total farm cash receipts accounted for by each of the agricultural industries. The data source for farm proprietors' income and cash receipts is REIS.[39]

The estimates of directors' fees by I-O industry are calculated by multiplying directors' fees at the two-digit SIC level by each I-O industry's share of wages and salaries in the corresponding two-digit SIC industry. The data source for directors' fees is REIS.

The estimates of employer contributions for health insurance by I-O industry are prepared in two steps. First, employer contributions to private pension funds and private welfare funds at the two-digit SIC level are multiplied by the all-industry ratio of employer contributions for health insurance to employer contributions to private pension funds and private welfare funds to yield estimates of employer contributions for health insurance at the two-digit SIC level. These estimates are then multiplied by each I-O industry's share of wages and salaries in the corresponding two-digit SIC industry. The source for the all-industry data is the national income and product accounts, and the source for the two-digit SIC data is REIS.

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[37] I-O theory requires that the sum of the entries in each column of the direct requirements table be less than, or equal to, one. Because this condition is not met for all industries after the household row is added, nine industries must be combined with similar industries.

[38] Earnings include employer contributions for health insurance, because personal consumption expenditures data in the national I-O accounts include expenditures on health care. Earnings exclude personal contributions for social insurance, because these contributions are usually deducted from an employee's wages and salaries and therefore are unavailable for spending on regional goods and services.

[39] For agriculture, the estimates of proprietors' income by I-O industry are not based on wages and salaries, because the share of total employment accounted for by wage-and-salary workers in agriculture is substantially smaller than that in other industries.

The estimates of personal contributions for social insurance by I-O industry are calculated by multiplying personal contributions for social insurance for all industries by each I-O industry's share of wages and salaries for all industries. The data source for personal contributions for social insurance is REIS.

A.3 THE HOUSEHOLD COLUMN

Each entry in the household column shows the expenditures per dollar of household earnings on the product of the row industry corresponding to the entry. The estimation of the household column is based on personal consumption expenditures (PCE) data from the national I-O accounts. PCE data in the imported-commodity use table are subtracted from PCE data in the overall use table to yield a column that shows PCE for domestically produced commodities. After each column entry is expressed as a share of total PCE, the column is multiplied by the industry-share matrix (discussed earlier) to yield the PCE shares by I-O industry.[40] The PCE shares by industry are then multiplied by the ratio of personal income less taxes and savings to personal income in order to account for the dampening effect of taxes and savings on expenditures.

A.4 THE REGIONAL DIRECT REQUIREMENTS TABLE

The regional industry-by-industry direct requirements table is derived from the adjusted national industry-by-industry direct requirements table. Location quotients (LQ's) are used to "regionalize" the national data.[41] The LQ is used as a measure of the extent to which regional supply of an industry's output is sufficient to meet regional demand. If the LQ for a row industry in the regional direct requirements table is greater than, or equal to, one, it is assumed that the region's demand for the output of the row industry is met entirely from regional production. In this instance, all row entries for the industry in the regional direct requirements table are set equal to the corresponding entries in the adjusted national direct requirements table.

Conversely, if the LQ is less than one, it is assumed that regional supply of the industry's output is not sufficient to meet regional demand. In this instance, all row entries for the industry in the regional direct requirements table are set equal to the product of the corresponding entries in the adjusted national direct requirements table and the LQ for the industry.

The household row and the household column that were added to the national direct requirements table are also adjusted regionally. The household row entries are adjusted downward, on the basis of commuting data from the Census of Population, in order to account for the purchases made outside the region by commuters working in the region. The household column entries are adjusted downward, on the basis of tax data from the Internal Revenue Service, in order to account for the dampening effect of State and local taxes on household expenditures.

A.5 THE REGIONAL TOTAL REQUIREMENTS TABLE AND THE MULTIPLIERS

A regional industry-by-industry total requirements table is prepared by calculating the Leontief inverse from the regional direct requirements table.[42] The regional total requirements table shows the regional final-demand output multipliers. In I-O terminology, the multipliers account for the sum of the direct,

[40] The last entry of the column is purchases of domestic services by households, which equals earnings received by domestic service workers.
[41] For most industries in RIMS II, LQ's are based on 1992 wages and salaries by industry at the four-digit SIC level. The LQ for wages and salaries is the ratio of the industry's share of regional wages and salaries to that industry's share of national wages and salaries. For some industries, the LQ's are adjusted, because wages and salaries in these industries, in comparison with proprietors' income, accounts for a relatively small share of total earnings.
[42] The Leontief inverse is defined as (I-A)-1, where I is an identity matrix, A is the regional industry-by-industry direct requirements matrix, and -1 indicates a matrix inversion.

indirect, and induced effects of a change in final demand. The final-demand, direct-effect, and output-driven multipliers can be derived from the total requirements table.[43]

A.6 FINAL-DEMAND EARNINGS AND EMPLOYMENT MULTIPLIERS

Final-demand earnings multipliers are derived by multiplying each final-demand output multiplier in the total requirements table by the household row entry in the direct requirements table that corresponds to the row industry for the output multiplier. This calculation is expressed as

$$c_{i,j} = b_{i,j} * a_{471,i} ,$$

where $c_{i,j}$ is the entry in row i and column j of the final-demand earnings multiplier table, $b_{i,j}$ is the final-demand output multiplier in the total requirements table, and $a_{471,i}$ is the household row entry in the direct requirements table.[44] Final-demand employment multipliers are derived by multiplying each entry in the final-demand earnings multiplier table by the employment-to-earnings ratio for each row industry.[45] This calculation is expressed as

$$e_{i,j} = c_{i,j} * G_i ,$$

where $e_{i,j}$ is the entry in row i and column j of the final-demand employment multiplier table, $ci_{,j}$ is the final-demand earnings multiplier, and G_i is the employment-to-earnings ratio for row industry i.

A.7 DIRECT-EFFECT EARNINGS AND EMPLOYMENT MULTIPLIERS

Direct-effect earnings multipliers are derived by dividing each household row entry in the total requirements table by the corresponding household row entry in the direct requirements table. This calculation is expressed as

$$D_j = b_{471,j} / a_{471,j} ,$$

where D_j is the direct-effect earnings multiplier for industry j, $b_{471,j}$ is the household row entry for industry j in the total requirements table, and $a_{471,j}$ is the household row entry for industry j in the direct requirements table. Direct-effect employment multipliers are derived by dividing the final-demand employment multiplier for each industry by the product of the corresponding household row entry in the direct requirements table and the employment-to-earnings ratio for each column industry. This calculation is expressed as

$$H_j = F_j / (a_{471,j} * G_j) ,$$

[43] For the discussion of the use of these multipliers in regional impact analysis, see the section "RIMS II Multipliers for Output, Earnings, and Employment."
[44] The sum of all the entries in column j of the final-demand earnings multiplier table is equal to the household-row entry in column j of the total requirements table. The last row of the final-demand earnings multiplier table represents earnings received by households that have domestic service jobs.
[45] Employment is measured on a job-count basis for both wage-and-salary workers and proprietors. Estimates of employment by I-O industry are made by allocating REIS employment data by two-digit SIC industry in proportion to Bureau of Labor Statistics wage-and-salary employment data by I-O industry.

where H_j is the direct-effect employment multiplier for industry j, F_j is the final-demand employment multiplier for industry j, $a_{471,j}$ is the household row entry for industry j in the direct requirements table, and G_j is the employment-to-earnings ratio for industry j.[46]

A.8 OUTPUT-DRIVEN MULTIPLIERS

Output-driven multipliers can be calculated from the total requirements table. The table entry for which the row entry i equals the column entry j is called the "diagonal" entry for column j. The output-driven multiplier for industry j is defined as the ratio of each entry in column j to the diagonal entry for that column. This ratio is expressed as

$$o_{i,j} = b_{i,j} / b_{j,j} ,$$

where $o_{i,j}$ is the output-driven multiplier i for industry j, $b_{i,j}$ is the final-demand output multiplier i for industry j in the total requirements table, and $b_{j,j}$ is the diagonal entry for industry j in the total requirements table.

A.9 REFERENCES

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Richardson, Harry W. *Input-Output and Regional Economics*. New York, NY: Halsted Press, 1972.

[46] The final-demand employment multiplier for industry j is the sum of all the entries except the household-row entry in column j of the final-demand employment multiplier table.

APPENDIX B: STATED PREFERENCE SURVEY

B.1 INTRODUCTION

The Stated Preference Analysis was based on results from a broad range of collected stated preference survey forms. Stated Preference Survey method uses a quota sampling approach as a fast and effective way of gathering consumer information on the importance of different travel decisions. This includes such issues as how travelers value travel time (for auto and transit modes) and how they value frequency of service and access time (for transit modes). A quota survey, as opposed to a random survey or a focus group study, is particularly effective in ensuring that all the important travel attributes are measured for the whole population at minimum cost. The quota survey, which has been widely adopted for public opinion surveys, is based on the development of representative "quotas" of the traveling public. The TEMS analysis requires that, two sets of data be collected: (1) the data that define the "travel behavior" quota and (2) the data that define the "personal profile" quota for the individuals surveyed. This allows the data to be stratified by such factors as trip length, income, and group size.

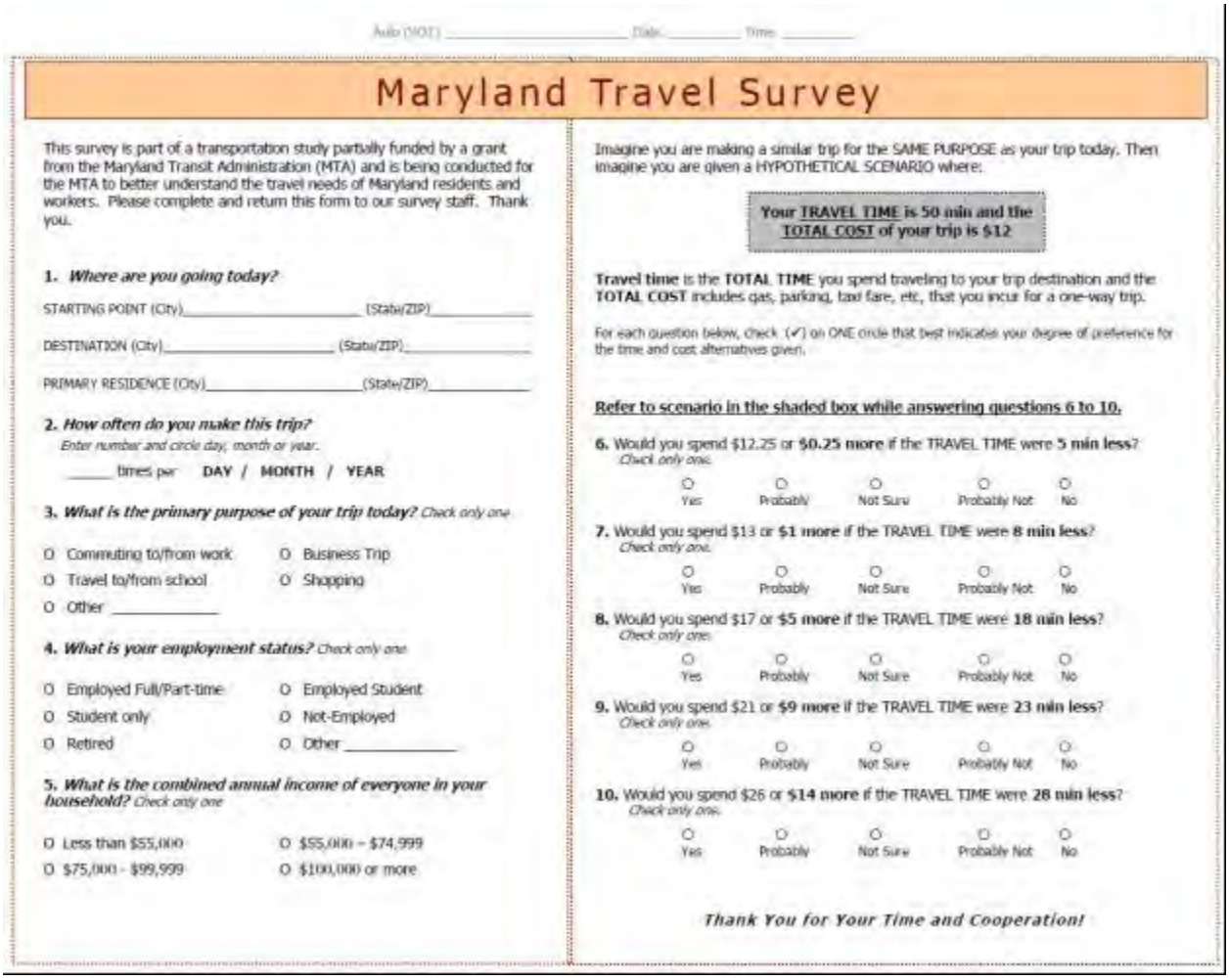
B.2 SURVEY FORMS

Specifically for the Purple Line Economic Impact Study, TEMS has developed three types of Stated Preference Survey forms - the Auto Mode Stated Preference Survey with VOT questions (see Exhibit B.1), - the Transit Mode Stated Preference Survey with VOT and VOF questions (see Exhibit B.2) and the Transit Mode Stated Preference Survey with VOA questions (see Exhibit B.3). One part of the survey contains profile questions while the other part contains questions that aim on defining the travel behavior of the surveyed individuals. The profile data collected from the surveys is used in conjunction with origin-destination and census data to ensure that the stated preference survey can be effectively expanded to properly represent the total population. The collected travel behavior data provides the critical part of the data needed to estimate the generalized cost of travel.

In terms of the size of the survey for each of the quota groups identified - usually up to 10 primary groups - it has been shown that a sample as small as 20 individuals[47] is statistically significant to define the behavioral choices of each group. These primary groups are based on correspondence between 2-3 mode groups - auto and transit (that includes bus and rail) to 3-4 purpose groups (commuter, business, and other (that includes shopping and social). To improve statistical reliability, TEMS typically seeks 40 to 100 respondents per quota. This means that between 500 and 1,200 surveys are needed for a stated preference survey analysis. There were 6 total quota groups identified for the Purple Line study on the base of selected 2 mode groups (auto and transit) and 3 purpose groups (commuter, business and other.) The minimum of 1,000-1,200 surveys was set as a goal.

[47] Spiegel, M.R., Theory and Problems of Probability and Statistics, NY McGraw Hill, pp. 112-113, 1992

Exhibit B.1: Survey Form for Auto Users with VOT questions



Auto (VOT) _____ Date _____ Time _____

Maryland Travel Survey

This survey is part of a transportation study partially funded by a grant from the Maryland Transit Administration (MTA) and is being conducted for the MTA to better understand the travel needs of Maryland residents and workers. Please complete and return this form to our survey staff. Thank you.

1. *Where are you going today?*

STARTING POINT (City)_____ (State/ZIP)_____

DESTINATION (City)_____ (State/ZIP)_____

PRIMARY RESIDENCE (City)_____ (State/ZIP)_____

2. *How often do you make this trip?*
Enter number and circle day, month or year.

_____ times per **DAY / MONTH / YEAR**

3. *What is the primary purpose of your trip today?* *Check only one*

- O Commuting to/from work
- O Business Trip
- O Travel to/from school
- O Shopping
- O Other _____

4. *What is your employment status?* *Check only one*

- O Employed Full/Part-time
- O Employed Student
- O Student only
- O Not-Employed
- O Retired
- O Other _____

5. *What is the combined annual income of everyone in your household?* *Check only one*

- O Less than $55,000
- O $55,000 - $74,999
- O $75,000 - $99,999
- O $100,000 or more

Imagine you are making a similar trip for the SAME PURPOSE as your trip today. Then imagine you are given a HYPOTHETICAL SCENARIO where:

Your TRAVEL TIME is 50 min and the TOTAL COST of your trip is $12

Travel time is the **TOTAL TIME** you spend traveling to your trip destination and the **TOTAL COST** includes gas, parking, taxi fare, etc, that you incur for a one-way trip.

For each question below, check (✓) on ONE circle that best indicates your degree of preference for the time and cost alternatives given.

Refer to scenario in the shaded box while answering questions 6 to 10.

6. Would you spend $12.25 or **$0.25 more** if the TRAVEL TIME were **5 min less**?
Check only one.

O Yes O Probably O Not Sure O Probably Not O No

7. Would you spend $13 or **$1 more** if the TRAVEL TIME were **8 min less**?
Check only one.

O Yes O Probably O Not Sure O Probably Not O No

8. Would you spend $17 or **$5 more** if the TRAVEL TIME were **18 min less**?
Check only one.

O Yes O Probably O Not Sure O Probably Not O No

9. Would you spend $21 or **$9 more** if the TRAVEL TIME were **23 min less**?
Check only one.

O Yes O Probably O Not Sure O Probably Not O No

10. Would you spend $26 or **$14 more** if the TRAVEL TIME were **28 min less**?
Check only one.

O Yes O Probably O Not Sure O Probably Not O No

Thank You for Your Time and Cooperation!

Exhibit B.2: Survey Form for Transit Users with VOT and VOF Questions

Transit (VOT/VOF): _____ Date: _____ Time: _____

Maryland Travel Survey

This survey is part of a transportation study partially funded by a grant from the Maryland Transit Administration (MTA) and is being conducted for the MTA to better understand the travel needs of Maryland residents and workers. Please complete and return this form to our survey staff. Thank you.

1. *Where are you going today?*

STARTING POINT (City)_____ (State/ZIP)_____

DESTINATION (City)_____ (State/ZIP)_____

RESIDENCE (City)_____ (State/ZIP)_____

2. *How often do you make this trip?*

Enter number and circle day, month or year.

_____ times per DAY / MONTH / YEAR

3. *What is the primary purpose of your trip today?* *Check only one*

O Commuting to/from work O Business Trip
O Travel to/from school O Shopping
O Other _____

4. *What is your employment status?* *Check only one*

O Employed Full/Part-time O Employed Student
O Student only O Not Employed
O Retired O Other _____

5. *What is the combined annual income of everyone in your household?* *Check only one*

O Less than $55,000 O $55,000 – $74,999
O $75,000 - $99,999 O $100,000 or more

Imagine you are making a similar trip for the SAME PURPOSE as your trip today. Then imagine you are given a HYPOTHETICAL SCENARIO where:

Your TRAVEL TIME is 60 min and the COST of your trip is $4

Travel time is the **TOTAL TIME** you spend on the bus/train and the **COST** of your trip is one-way bus/rail fare.

For each question below, check (✓) on ONE circle that best indicates your degree of preference for the time and cost alternatives given.
Refer to scenario in the shaded box while answering questions 6 to 10.

6. Would you spend $4.25 or **$0.25 more** if the TRAVEL TIME were **8 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

7. Would you spend $5 or **$1 more** if the TRAVEL TIME were **10 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

8. Would you spend $9 or **$5 more** if the TRAVEL TIME were **22 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

9. Would you spend $13 or **$9 more** if the TRAVEL TIME were **28 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

10. Would you spend $18 or **$14 more** if the TRAVEL TIME were **34 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

Imagine you are making a similar trip for the SAME PURPOSE as your trip today. Then imagine you are given a HYPOTHETICAL SCENARIO where:

Your WAIT TIME is 35 min and the COST of your trip is $4

Wait Time is the **time between departures** or how long you have to wait for the next bus/train and the **COST** of your trip is one-way bus/rail fare.

For each question below, check (✓) on ONE circle that best indicates your degree of preference for the time and cost alternatives given.
Refer to scenario in the shaded box while answering questions 11 to 15.

11. Would you spend $4.25 or **$0.25 more** if the WAIT TIME were **8 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

12. Would you spend $5 or **$1 more** if the WAIT TIME were **11 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

13. Would you spend $7 or **$3 more** if the WAIT TIME were **21 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

14. Would you spend $9 or **$5 more** if the WAIT TIME were **26 min less**? *Check only one*

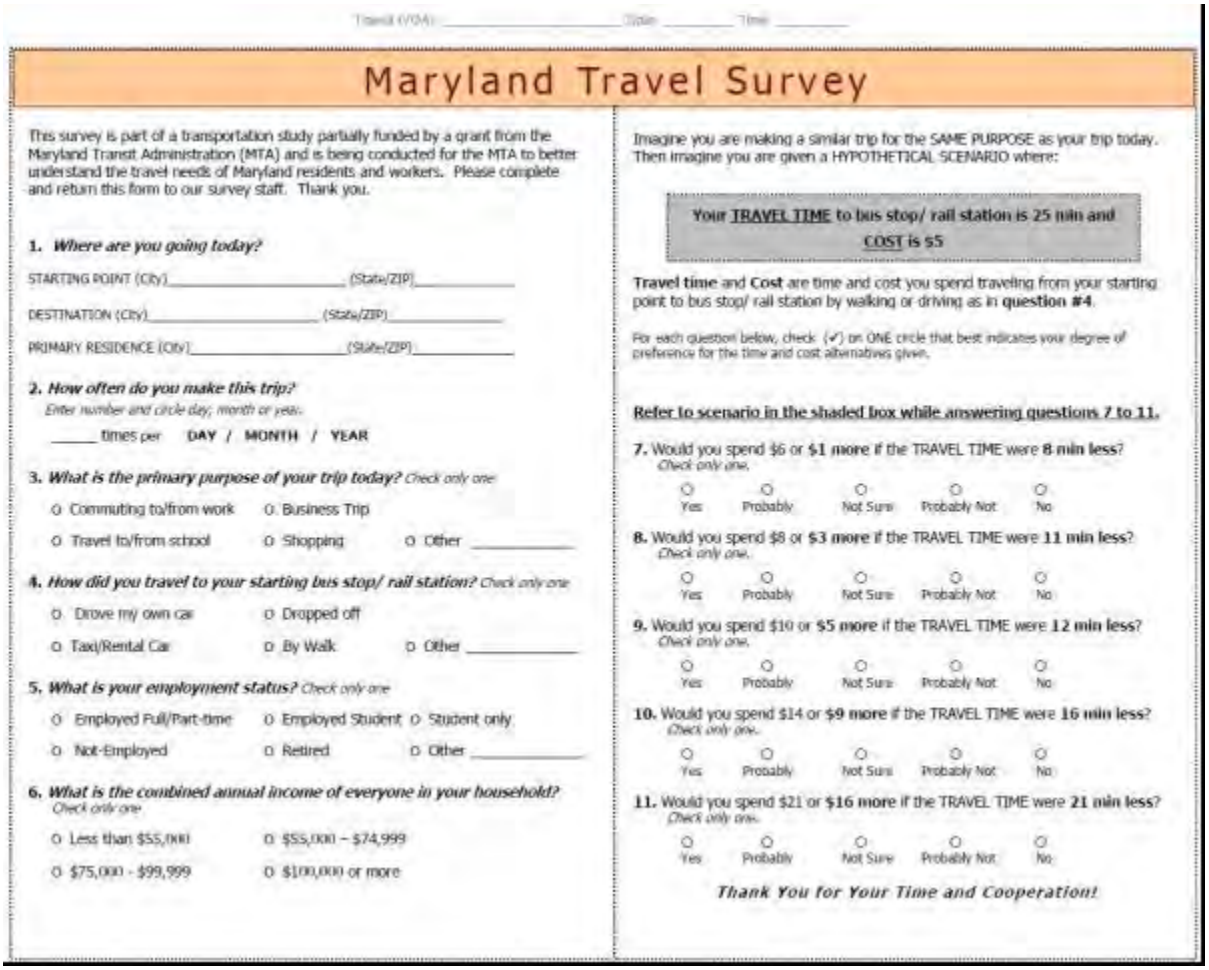
O Yes O Probably O Not Sure O Probably Not O No

15. Would you spend $12 or **$8 more** if the WAIT TIME were **32 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

Thank You for Your Time and Cooperation!

Exhibit B.3: Survey Form for Transit Users with VOA Questions



Travel (VOA) _____ Date _____ Time _____

Maryland Travel Survey

This survey is part of a transportation study partially funded by a grant from the Maryland Transit Administration (MTA) and is being conducted for the MTA to better understand the travel needs of Maryland residents and workers. Please complete and return this form to our survey staff. Thank you.

1. *Where are you going today?*

STARTING POINT (City)_____ (State/ZIP)_____

DESTINATION (City)_____ (State/ZIP)_____

PRIMARY RESIDENCE (City)_____ (State/ZIP)_____

2. *How often do you make this trip?*
Enter number and circle day, month or year.

_____ times per **DAY / MONTH / YEAR**

3. *What is the primary purpose of your trip today?* *Check only one*

O Commuting to/from work O Business Trip
O Travel to/from school O Shopping O Other _____

4. *How did you travel to your starting bus stop/ rail station?* *Check only one*

O Drove my own car O Dropped off
O Taxi/Rental Car O By Walk O Other _____

5. *What is your employment status?* *Check only one*

O Employed Full/Part-time O Employed Student O Student only
O Not-Employed O Retired O Other _____

6. *What is the combined annual income of everyone in your household?*
Check only one

O Less than $55,000 O $55,000 – $74,999
O $75,000 - $99,999 O $100,000 or more

Imagine you are making a similar trip for the SAME PURPOSE as your trip today. Then imagine you are given a HYPOTHETICAL SCENARIO where:

Your TRAVEL TIME to bus stop/ rail station is 25 min and COST is $5

Travel time and **Cost** are time and cost you spend traveling from your starting point to bus stop/ rail station by walking or driving as in **question #4**.

For each question below, check (✓) on ONE circle that best indicates your degree of preference for the time and cost alternatives given.

Refer to scenario in the shaded box while answering questions 7 to 11.

7. Would you spend $6 or **$1 more** if the TRAVEL TIME were **8 min less**?
Check only one.
O Yes O Probably O Not Sure O Probably Not O No

8. Would you spend $8 or **$3 more** if the TRAVEL TIME were **11 min less**?
Check only one.
O Yes O Probably O Not Sure O Probably Not O No

9. Would you spend $10 or **$5 more** if the TRAVEL TIME were **12 min less**?
Check only one.
O Yes O Probably O Not Sure O Probably Not O No

10. Would you spend $14 or **$9 more** if the TRAVEL TIME were **16 min less**?
Check only one.
O Yes O Probably O Not Sure O Probably Not O No

11. Would you spend $21 or **$16 more** if the TRAVEL TIME were **21 min less**?
Check only one.
O Yes O Probably O Not Sure O Probably Not O No

Thank You for Your Time and Cooperation!

B.3 SURVEY LOCATIONS

A very important part of the survey process is to identify the desirable survey locations. Exhibit B.4 shows the Purple Line Stated Preference Survey locations map with the Purple Line rail corridor. Prince George's and Montgomery Counties were the main locations chosen for the surveys, as the proposed Purple Line stations are located in these counties. The surveys were conducted both electronically and also in the field. The main aim of the surveys was to target all six quota groups i.e., Business, Commuters, and for other purpose such as shopping and other social events for both auto and transit users. The survey locations are listed below:

Metro & Rail Stations: Greenbelt, and New Carrollton, and ***Bus stop*** at Prince George's Community College;

Social Events: Art Fest at Riverdale, Engineers Field Day event at University of Maryland at College park, Fenton Street Market near Silver spring Metro station, and Langley Park shopping Plaza; and

Work Places and Educational Institutions: National Institutes of Health at Bethesda, and Rockville, Guardian Life Insurance at Bethesda, American Institute of Physics at College Park, and Montgomery Community College at Rockville.

TEMS collected 3,374 surveys, and exceeded their target range. As shown in Exhibit B.5 each quota group has a statically significant representation.

Exhibit B.4: Survey Locations Map

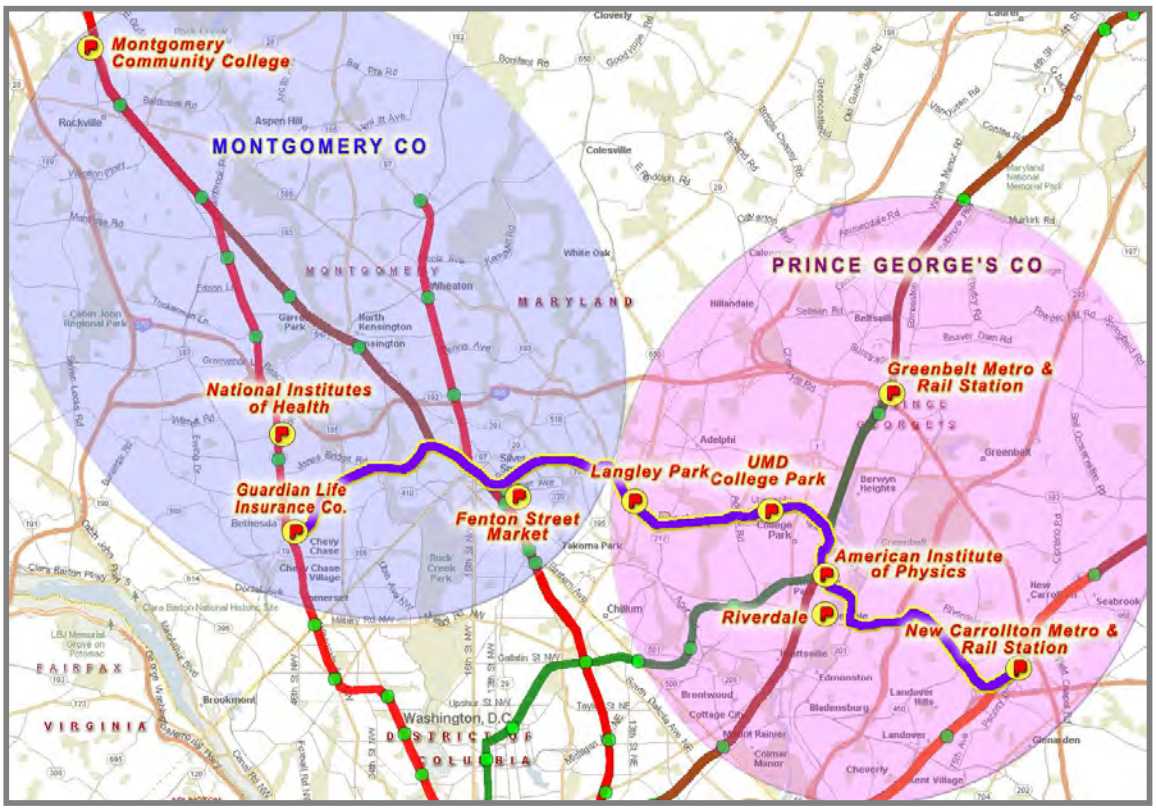


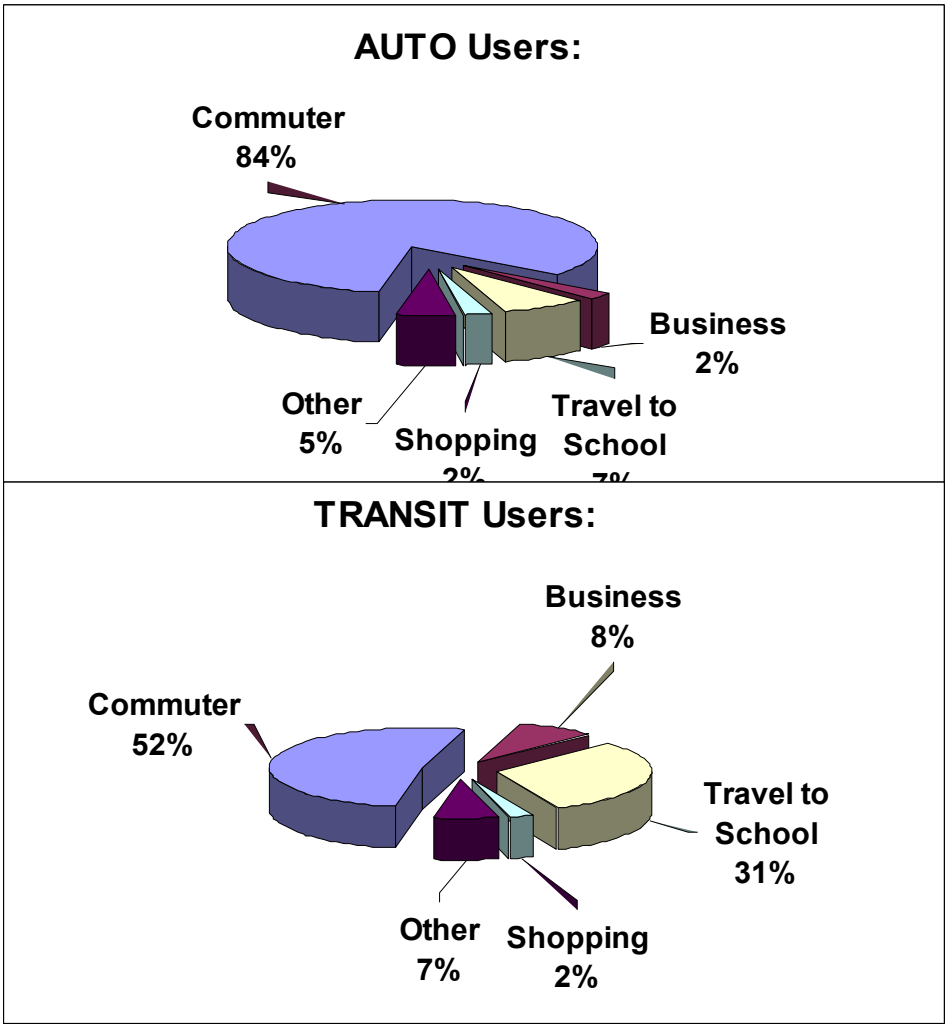
Exhibit B.5: Stated Preference Surveys Collected by Mode and Purpose

	Business	Commuter	Other	Total
Auto	60	1863	328	2251
Transit	111	538	474	1123
Total	**171**	**2401**	**802**	**3374**

B.4 PERSONAL PROFILE DATA

Exhibit B.6 shows the trip purposes of the potential Purple Line users. Commuting to/from work is the main purpose of travel for both auto users (84%) and transit users (52%), followed by travel to school (7% for auto users and 31% for transit users). It is easy to see that the total share of travelers who go either to work or to school comprise no less than 80% of auto as well as transit travelers. 5-7% of travelers indicate their trip purpose as 'other', which might include vacation/recreation, tourism/sightseeing or visiting family/friends. The share of shoppers is 2% for both auto and transit users, while the share of business travelers is higher for transit (8%) than for auto (2%).

Exhibit B.6: Trip Purpose of Survey Respondents (by Mode)



Employment status of survey respondents is presented in Exhibit B.7, separately for auto and transit users. It is seen that, for auto users 90% are employed, while for transit users only 62% have jobs. However, 33% of transit users are students, while only 7% of auto users are students. Workers and students represent over 95 percent of travelers for both modes. Also, in the poll of Transit users more respondents indicated themselves as unemployed (3%) than in the poll of auto users (1%). In both auto and transit poll of respondents 1% identified themselves as retired and 1% did not provide any identification of the employment status.

Exhibit B.7: Employment Status of Survey Respondents (by Mode)

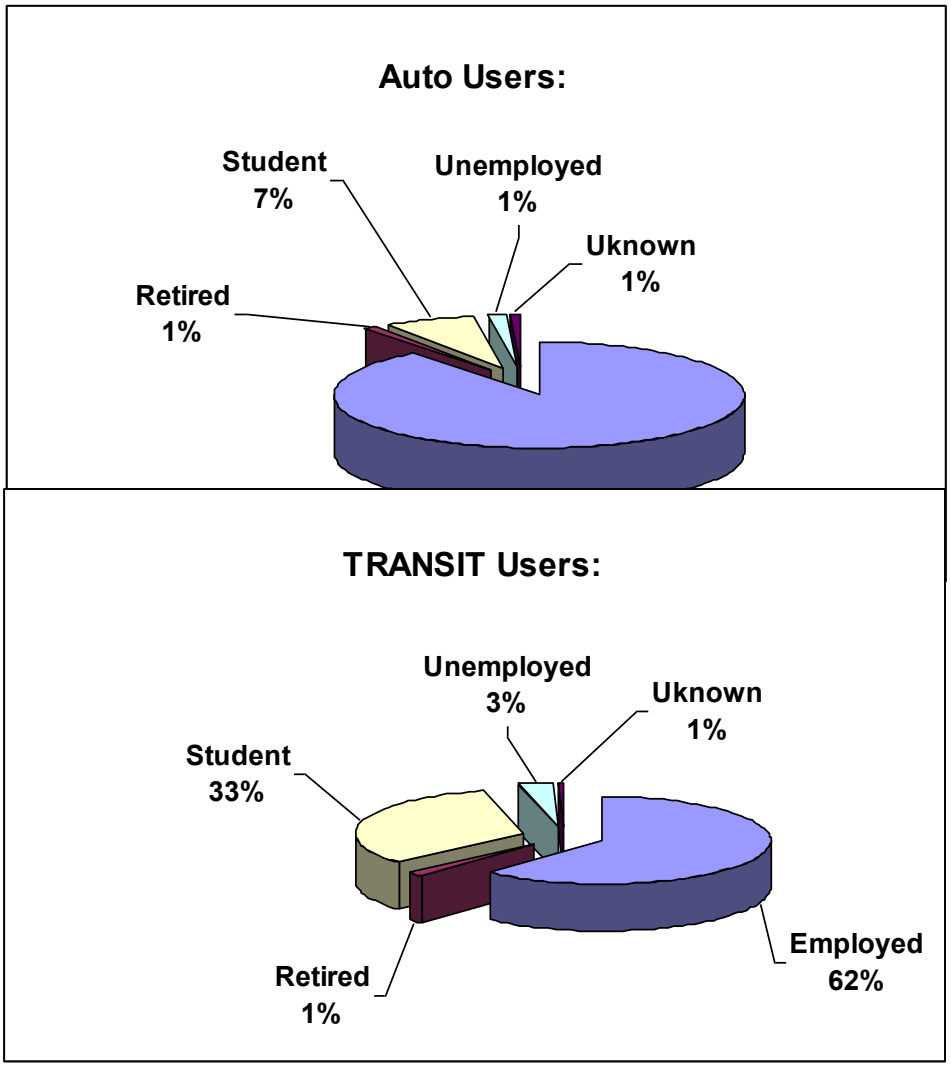


Exhibit B.8 illustrate employment distribution along the Purple Line corridor in comparison with statistical and survey data. It is seen in the Exhibit that Montgomery and Prince George's Counties have highest share of employed individuals and lowest share of retired and unemployed individuals based on statistical data from U.S. Census 2006-2008 American Community Survey data on 3-year estimates on Employment status[48]. The survey data is very similar to the statistical data showing the representativeness of the stated preference survey.

Exhibit B.8: Employment Distribution – Statistical Data and Survey Data

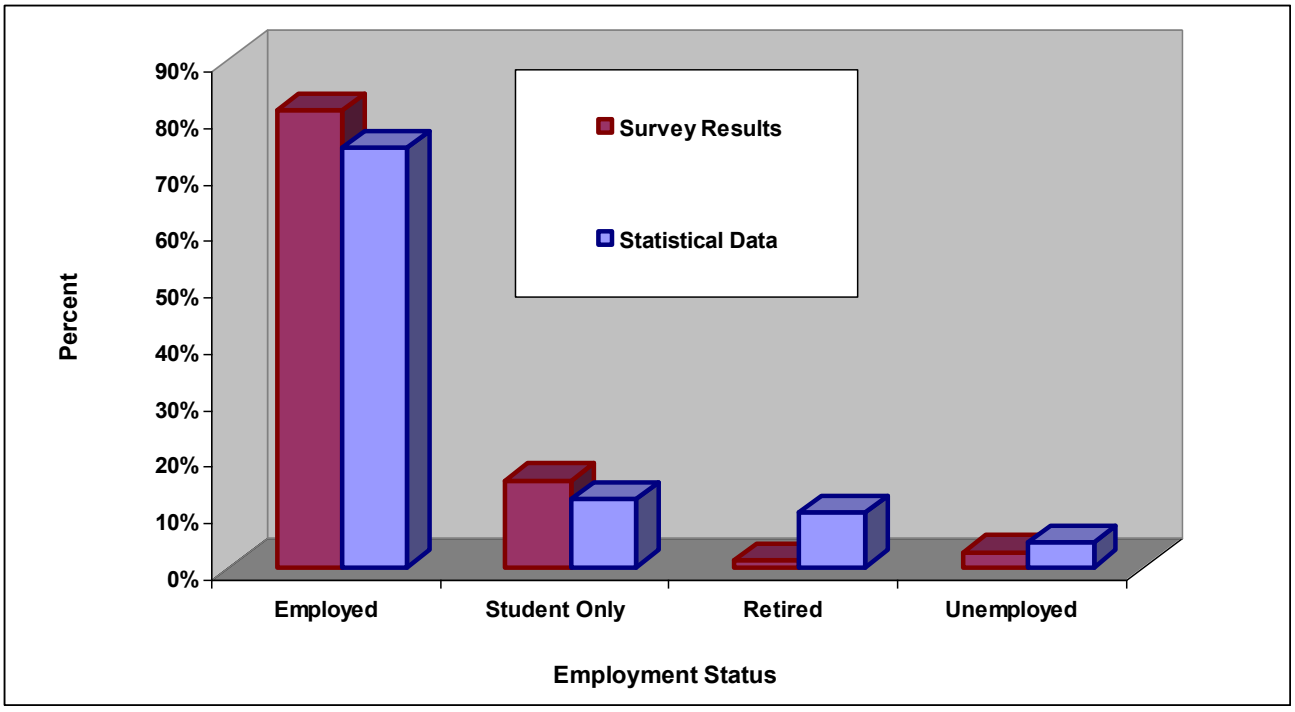
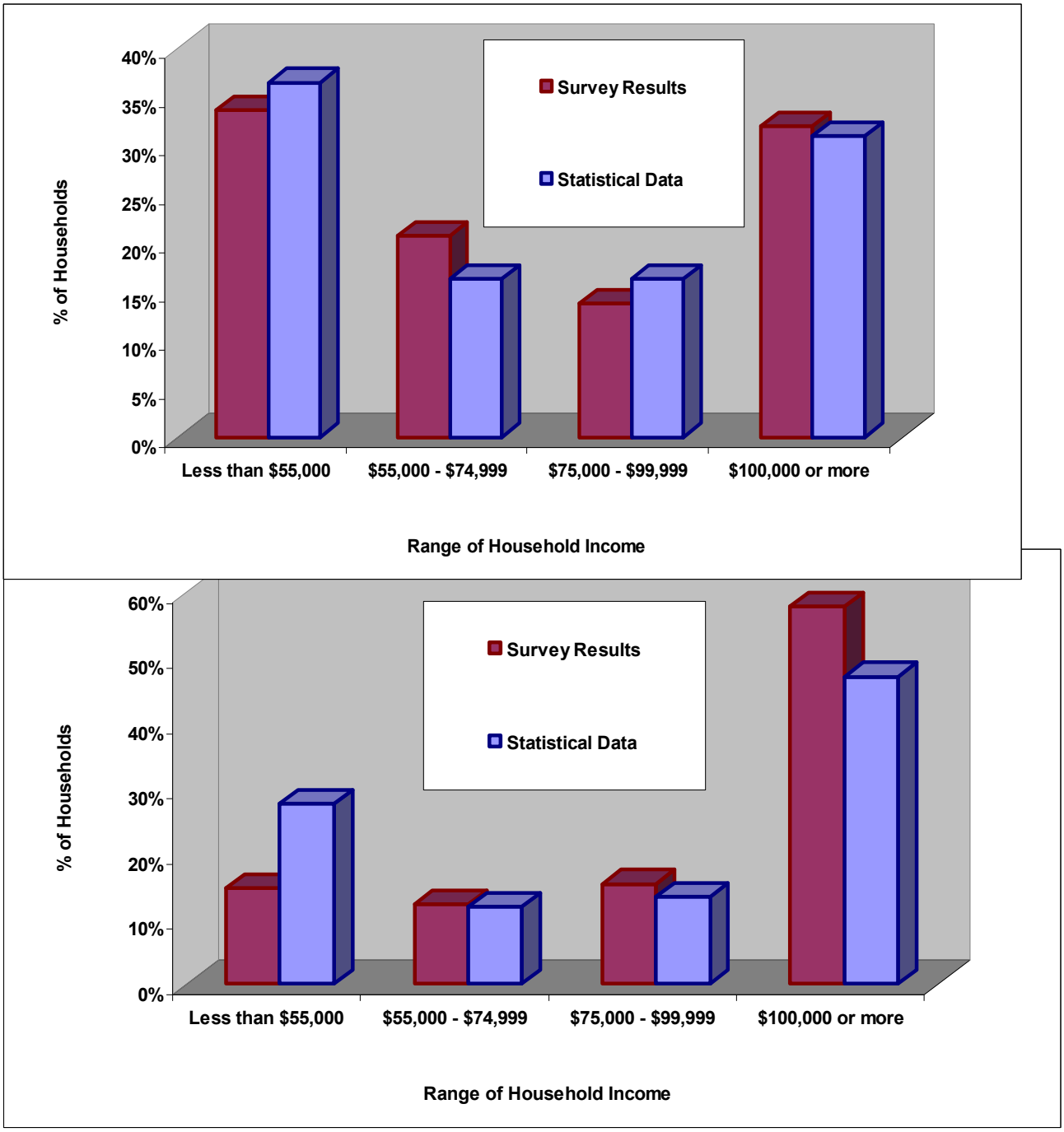


Exhibit B.9 and B.10 illustrate household income groups (in Montgomery and Prince George's Counties respectively) distributed in accordance with statistical from U.S. Census 2006-2008 American Community Survey data on 3-year estimates on household income and survey data. It is easy to see in Exhibit B.9 that in Prince George's County the share of households in each of four groups calculated based on statistical and survey data is almost the same (the difference is 5% or less). In Montgomery County the shares of two medium income groups, based on statistical and survey data are almost identical. Also in Montgomery County, there was a higher share of survey respondents from high-income households and lower share of those who belong to low-income households in comparison with the average statistical data. This is because some of the proposed Purple Line stations – such as Bethesda or Connecticut Avenue, are located in the center of the luxury communities in Montgomery County. Thus, in 2008 median household income was $130,637 in Bethesda and $211,349 in Chevy Chase (Connecticut Avenue station). For comparison, in 2008 median household income for Montgomery County was $94,319.

[48] American FactFinder database, http://factfinder.census.gov and MapPoint demographic database.

Exhibit B.9: Household Income Distribution in Prince George's County – Statistical and Survey Data



A comparison of the results of the stated preference survey such as employment and household income data with that of the U.S. Census statistical data shows that the employment and income distributions by mode are representative of statistical data. This means that the database will be representative of the Purple Line corridor value of time, values of frequency and values of access.

B.5 BEHAVIORAL ATTRIBUTES

Behavioral attributes reflect the behavior of the respondent when travel conditions change. For the purpose of this study using stated preference surveys we collected information necessary to identify the Value of Time (VOT) for all travelers, the Value of Frequency (VOF) and the Value of Access (VOA).

Each of these three variables (VOT, VOF and VOA) has been analyzed using the "trade-off' method. This method aims at deriving VOT (VOF or VOA) by examining the pattern of trades a respondent makes among the various situations described in a travel behavior part of a questionnaire form. In this way a VOT (VOF or VOA) estimate can be assigned to each respondent. Exhibit B.11 through B.13 provides the example of the respondent's trading behavior and illustrates how VOT is calculated using 'trade-off' method. The VOT is calculated for the 'neutral point' located in the intersection between the line indicating 'no preference' and the line connecting the points indicated by the respondent. As seen in Exhibit B.11 the neutral point or no preference line is located at the fourth row indicating that the respondent is willing to spend $12 more for 45 minutes less. This implies the respondent is willing to spend $16 more for 1 hour of time saving. Thus, the respondent has a VOT value of 16 dollars per hour.

Not all survey respondents illustrated perfect trading behavior (similar to those shown in Exhibit B.11 or B.12). About 6% of the respondents were identified as 'non-traders'. VOT calculated based on the example shown in Exhibit B.13 is assumed to be $45 for 3 hours (15 dollar per hour) or less as there is no trading, and the individual is showing a preference to spend time rather than money.

Exhibit B.11: VOT calculation based on "Trade-Off" Method: "Trading Behavior"- Example # 1

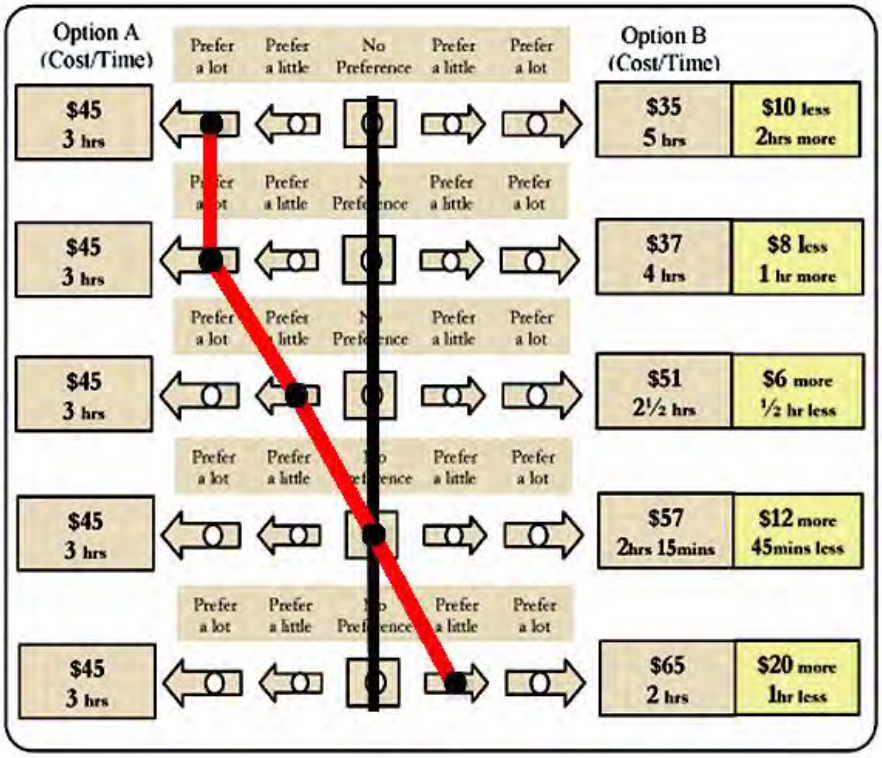


Exhibit B.12: VOT calculation based on "Trade-Off" Method: "Trading Behavior" - Example # 2

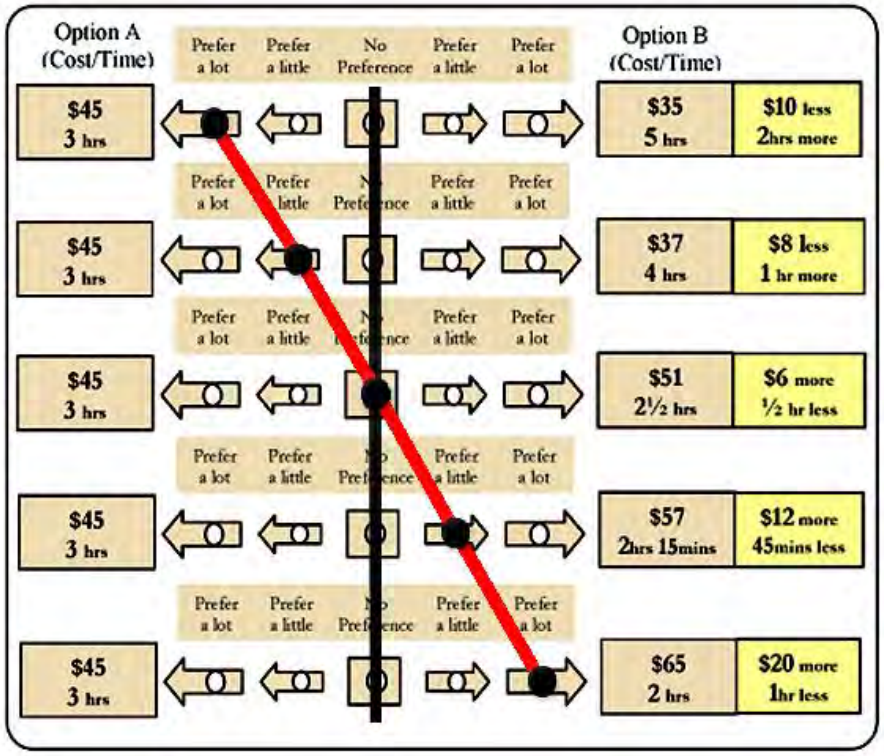
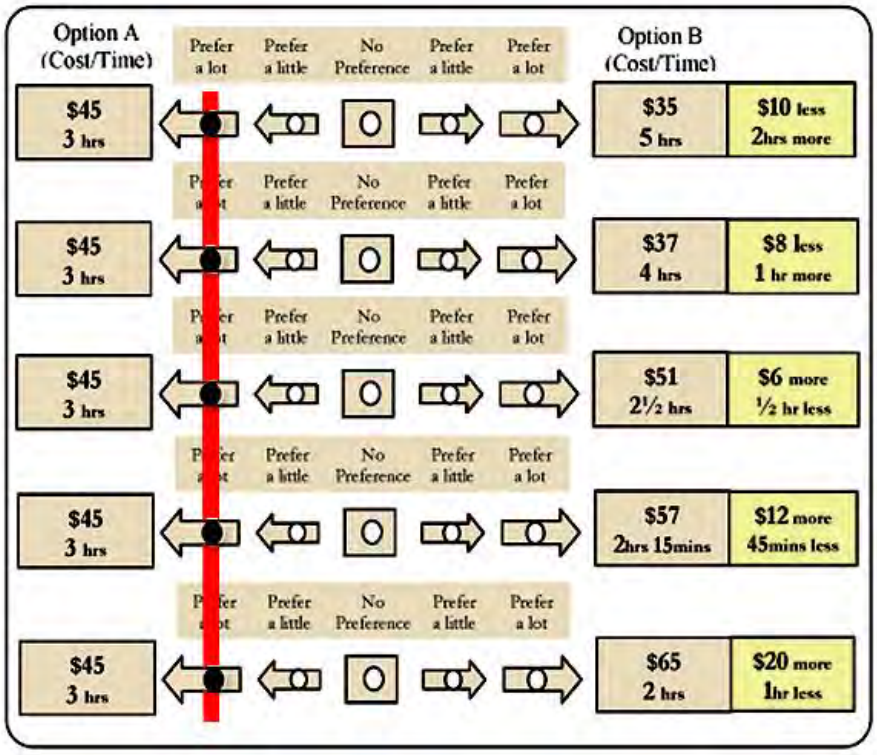


Exhibit B.13: VOT calculation based on "'Trade-Off" Method: "Non Trading Behavior"



VOT, VOF and VOA calculated on the base of Stated Preference Survey were carefully checked for statistical significance. In accordance with the general statistical theory, results are considered statistically significant if they are normally distributed and 68% of the results fall in the range: $(m-\sigma; m+\sigma)$, where m is mean and σ is standard deviation[49]. All travel demand variables calculated using data from the Purple Line Stated Preference Survey, were found statistically significant. Exhibit B.14 illustrates the VOT distribution for auto commuter travelers. It is easy to see that 80% of the results fall in the required range.

Exhibit B.15 provides the information about the number of survey forms used in calculation of VOT, VOF and VOA by each mode and purpose. Since one transit survey form could be used for both transit VOF and VOT analysis, the total number of forms used for calculation as shown in Exhibit B.14 are higher than the total number of forms received as shown in Exhibit B.5.

The Purple Line Stated Preference Survey results of VOT, VOF and VOA calculated for two modes (auto and transit) and three types of purpose (commuter, business and other) are presented in Exhibit B.16 and b4.17. Based on the calculations, the following observations were made:

- The VOT, VOF and VOA values are larger for auto than for transit;
- Business trips have larger VOT, VOF and VOA values than commuter and other trips;
- The VOT, VOF and VOA values are consistent with those of previous studies (e.g., Bay Bridge Travel Survey, 2006) after adjusting to 2010 dollars for similar trip length.

[49] T.T. Soong, Fundamentals of Probability and Statistics for Engineers, John Wiley & Sons Inc., 2004, p204.

Exhibit B.14: VOT Distribution: Auto Users (Commuter)

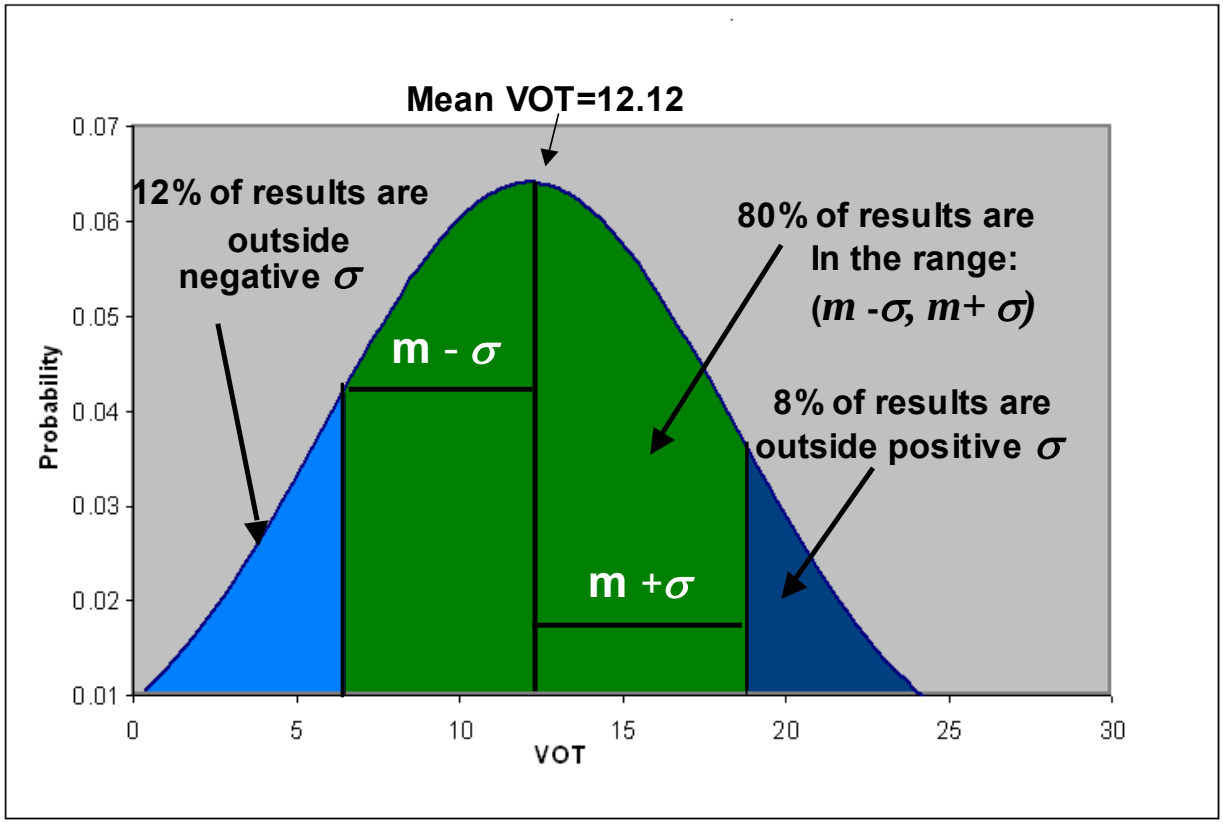


Exhibit B.15: Stated Preference Surveys Used to identify VOT, VOF and VOA (by Mode and Purpose)

	Business	Commuter	Other	Total
Auto	60	1863	328	2251
Transit	192	900	801	1893
Total	**252**	**2763**	**1129**	**4144**

Exhibit B.16: Purple Line Stated Preference Survey Results on Value of Time - VOT (Auto and Transit)

Value of Time - VOT	Business	Commuter	Other
Auto	$16.83	$12.12	$11.60
Transit	$11.31	$8.91	$7.74

Exhibit B.17: Purple Line Stated Preference Survey Results for Transit for Value of Frequency - VOF and Value of Access -VOA (Transit)

Transit	Business	Commuter	Other
Value of Frequency - VOF	$8.45	$7.17	$6.17
Value of Access - VOA	$21.62	$17.46	$15.36

The comparison between Auto VOT values from the 2010 Purple Line and TEMS 2006 Bay Bridge Stated Preference Surveys are shown in Exhibit B.18. The Bay Bridge Auto VOT is inflated from 2006 dollars to 2010 dollars using corresponding CPI index and factored by trip length (i.e., in the Bay Bridge survey the average trip length was 25% longer than that of the Purple Line survey). As seen in Exhibit B.18, factored Bay Bridge Auto VOT values are close to Auto VOT values obtained from the Purple Line survey.

Exhibit B.18: Comparison between Auto VOT from 2010 Purple Line and 2006 Bay Bridge Stated Preference Surveys

Auto Value of Time (VOT)	Business	Commuter	Other
Bay Bridge Survey, $2006	$19.17	$15.98	$12.46
Bay Bridge Survey, $2010	$20.75	$17.29	$13.48
Bay Bridge Survey, $2010 (factored by Trip Length)	$15.56	$12.97	$10.11
Purple Line Survey, $2010	$16.83	$12.12	$11.60

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