Long Range Transportation Plan 2011 Update

Appendix F – Green House Gas and Energy Analysis

2011 Greenhouse Gas and Energy Analysis Process

Detailed below are the steps that were taken in an effort to complete the greenhouse gas and energy analysis required for the Syracuse Metropolitan Transportation Council's (SMTC) Long-Range Transportation Plan (LRTP) 2011 Update.

The detailed results of the analysis can be found in the following steps. The steps that were followed are consistent with the guidance documents listed below, as amended through consultation with the New York State Department of Transportation's Environmental Science Bureau (NYSDOT ESB).

- *Air Quality Analysis of Transportation Improvement Programs, Regional Transportation Plans, and Capital Project programs – Technical Guidance to Assist Metropolitan Planning Organizations and Department of Transportation Regional Offices Meet the Objectives of the 2002 New York State Energy Plan* (January 21, 2003);

- *Development of Revised NYSDOT Energy Analysis Guidelines (Draft), Subtask 12a: Energy Analysis Guidelines for TIPs and Plans* (June 21, 2002); and

- *Development of Revised NYSDOT Energy Analysis Guidelines (Draft), Subtask 12b: Greenhouse Gases (CO2) Emissions Estimates for TIPs and Plans* (June 21, 2002)

Step #1 – Identification of all Non-Exempt and Regionally Significant Projects

The first step in this process was determining those projects that would be subject to analysis. All of the projects included in the 2011-2015 Transportation Improvement Program (TIP) and the LRTP 2011 Update were reviewed for their significance in affecting energy consumption as per the guidance provided in 6 NYCRR Part 240.6 (h)(2). In general, projects that maintain current levels of service or capacity, such as safety improvements, resurfacing, bridge repair, or bus replacements were considered exempt from the analysis. Similarly, projects that result in operational improvements, but without an increase in capacity (such as intersection widening) were also considered exempt and excluded from the analysis.

A **Regionally Significant** project is, according to 6 NYCRR Part 240.2 (38)**,** "a transportation project (other than an exempt project) that is on a facility which serves regional transportation needs (such as access to and from an area outside the region, major activity centers in the region, major planned developments such as new retail malls, sports complexes, etc., or transportation terminals as well as most terminals themselves) and would normally be included in the modeling of a metropolitan area's transportation network, including, at a minimum, all principal arterial highways and all fixed guideway transit facilities that offer an alternative to regional highway travel."

Non-exempt projects include highway and road projects that increase capacity by at least one travel lane, and transit projects that change capacity on a fixed route system. The non-exempt determination was made if the project type is not found in the list of exempt projects derived from “Table 2- Exempt Projects” in 40 CFR Part 93.126, 93.127 and NYCRR Part 240.27 per interagency consultation.

As mentioned above, the project list for the SMTC’s greenhouse gas and energy analysis consisted of the projects included in the 2011-2015 TIP and the LRTP 2011 Update. Four projects from the 2011-2015 TIP, noted below, were categorized as non-exempt projects. However, three of these projects were unable to be analyzed utilizing the indirect energy lane-mile approach, consistent with *Subtask 12a: Energy Analysis Guidelines for Tips and Plans* because the projects entail signal improvements only, with no additional lane miles of construction.

- Route 31 Reconstruction, Mud Mill Creek to Sherwood Circle – Widen roadway to accommodate center turn lane

- Geddes/Genesee and Lodi/Salina Signal Interconnection – Update signals and inclusion in existing traffic interconnect system.

- N, S, E, W Signal Interconnect Expansion - Update signals and inclusion in existing traffic interconnect system.

- Electronics/Henry Clay Signal Interconnect – Upgrading and interconnect of signals.

The LRTP 2011 Update includes twelve projects that are considered essential to the region’s transportation system in order to service anticipated future development, although these projects are not currently programmed on the TIP. Eight of these projects, denoted with an asterisk, were included in the greenhouse gas and energy analysis.

- Bear Street Extension* – Extend Bear Street from the Interstate 81 bridge to Hiawatha Boulevard, intersecting Hiawatha Boulevard at its current intersection with North Salina Street. The extension will consist of four travel lanes.

- Third Lane of Frontage Road* – Add a third travel lane to the Interstate 81 Frontage Road (SR 936F) from Exit 23B to Bear Street.

- Genant Street* – Genant Street will be rebuilt so that it accesses the Franklin Street ramp. Also, the I-81 SB exit to Franklin Street will be closed off.

- Third Lane of NY 31* – NY 31 from Legionnaire Drive to US 11 and from Lakeshore Road to Thompson Road in the Town of Cicero will feature a continuous center turn lane for left turns at intersections that do not feature separate turn lanes and for legal left turns allowed to driveways off the highway.

- Girden Road Extension* – Girden Road, running along the DeWitt-Manlius town line, will be extended southward beyond its current terminus at a dead end to the access road for the CSX Rail Yard. This road will act as the primary access to the facility for truck traffic from Interstate 481, generally replacing the current truck access off North Central Avenue near Fremont Road.

- Onondaga Lake Parkway – The speed on Onondaga Lake Parkway will be reduced to 45 MPH all year. Currently the parkway is posted at 55 MPH during the most of the year and 45 MPH from November 1st – March 31st.

- Route 31/81 Interchange Improvements* – To improve capacity issues there will be a complete interchange replacement. The interchange will be upgraded from the current configuration to a cloverleaf interchange.

- Soule Road & Route 31/481 Interchange* – Carling Road extension to Soule Road and reconfiguration of the Route 481 southbound on-ramp. Access to Route 481 will be from Route 31 only. Soule Road will end prior to reaching the NY Route 481 on-ramp and Carling Road will be extended to connect Route 31 with Soule Road.

- Access NY 481 Southbound at Exit 12 – Soule Road will be expanded from two lanes (one lane each direction) to three lanes (one lane each direction and a shared two-way left turn lane) for the section of this road under OCDOT jurisdiction. The bounds of this project are from Old Route 57 to Access NY 481 southbound at Exit 12.

- Verplank Road* – This project involves the expansion of shoulders and lane widths with a shared third lane along Verplank Road.

- Buckley Road – This project involves the addition of a shared turn lane along the entire length of Buckley Road (from Old Liverpool Road to Morgan Road). The intersection of Buckley/Bear will be expanded with the addition of EB left, EB thru and NB left turn lanes.

- Seventh North Street – The intersection of Seventh North/Buckley will be upgraded with the addition of SB and EB lefts, and NB and SB throughs.

Step #2 – Travel Demand Modeling

To determine the impact of future projects in the Syracuse Metropolitan Planning Area (MPA), the SMTC uses TransCAD travel simulation software. Like most other programs of this type, the model consists of a road network, land-use and employment data, trip generation, trip distribution, and trip assignment. The results generated by the program are then compared to known travel counts to calibrate the model. The SMTC travel demand model is calibrated based on 2007 base year traffic conditions, 2000 Census information and other socio-economic projections that was forecasted for 2007 (base year) and 2035 (horizon year). Background documentation and technical information related to the SMTC model are available at the SMTC.

The analysis includes a year 2035 No-Build scenario and a year 2035 Build scenario (as 2035 is the horizon year of the SMTC LRTP). The No-Build scenario includes the 2007 roadway network with 2035 land-use characteristics, while the Build scenario consists of the 2035 network and 2035 land-use characteristics.

Step #3 – Off-Line Model Analysis

A quantitative analysis was also undertaken to account for the visions of the 2035 LRTP that could not be modeled in TransCAD. Inclusion of transit and bicycle/pedestrian transportation modes is beyond the capabilities of the software. Using information developed by the SMTC and its member agencies, the SMTC calculated the reduction of vehicle miles traveled (VMT) as a result of transit and bicycle and pedestrian system improvements envisioned in the LRTP. Additionally, the SMTC accounted for reductions of volatile organic compounds, carbon monoxide, and oxides of nitrogen as a result of updating Centro's existing compressed natural gas (CNG) buses to newer, modern CNG buses.

These off-model VMT reductions were then factored into the TransCAD outputs to better demonstrate the Build scenario provided for in the LRTP. This process differed from that used in the Transportation Conformity determination where only the results of VMT from TransCAD were utilized. VMT reductions were included to account for expected increases in bicycle and pedestrian trips (VMT reduction of 0.2% in 2035) and in transit ridership (increase of approximately 33,000 daily riders with an average trip length of 5 miles in 2035). The results can be found in Table 1.

Step #4 - Regional Emissions Modeling

As stated earlier, TransCAD estimates the VMT for various scenarios provided for in the planning process. To calculate the regional emissions that will result from the transportation system envisioned in the LRTP Build scenario, this VMT information is utilized in conjunction with the latest MOBILE6.2 emission factors developed by the US Environmental Protection Agency (EPA).

Emission estimates were determined using the VMT data and MOBILE6.2 emission factors. This process involves the utilization of traffic volume and speed data provided by the SMTC, the most recent vehicle fleet characteristics, and other traffic and meteorological parameters established by NYSDOT in cooperation with the New York State Department of Environmental Conservation (NYSDEC). MOBILE6.2 incorporates these parameters to develop estimated emission factors.

For this analysis the SMTC utilized emissions factors by road type and speed for Volatile Organic Compounds (VOC), Nitrogen Oxides (NO_x) and Carbon Monoxide (CO) for both the Build and No-Build scenarios. The SMTC then calculated the number of grams of pollutant produced for each scenario. An additional emissions reduction was included, relying on input from Centro to account for the updating of Centro's compressed natural gas fleet. These results can be found in Table 1.

Step #5 – Direct Energy Analysis

Direct energy represents the energy consumed by vehicles using a transportation facility (for this analysis, "facility" is defined as the roadway segments in the SMTC's regional travel demand model). Direct vehicle energy was calculated using the VMT Fuel Consumption Method as described in *Subtask 12a: Energy Analysis Guidelines for TIPs and Plans*. The calculations were based on VMT (not seasonally-adjusted) reported by the 2035 No-Build and Build scenarios and a calculated vehicle type. Vehicle classification data were based on aggregating data obtained from NYSDOT's *Mobile 6 Region 3 1999 Summer Time Emissions Factors*. NYSDOT Region 3 includes the majority of the Syracuse MPA. Therefore, it was determined those factors would accurately reflect vehicle distribution for the model. The classification data in the MOBILE6.2 table is based on 28 vehicle classifications, determined by the EPA, which is not directly comparable to the three vehicle types used in the direct energy analysis guidance. For this analysis, it was assumed that, taken together, vehicle classifications 1-5, 14-16, and 28 are equivalent to "light duty vehicles", classifications 6-9 and 17-20 are equivalent to "medium trucks", and classifications 10-13 and 21-27 represent "heavy trucks". Since the table lists percentages of type of vehicle by functional class, an average of all functional classes was calculated and then summarized to represent the percentage by the three vehicle types required for energy analysis. Each of the three vehicle types have a fuel economy rate per year based on the fuel type used.

For each scenario, the total VMT was multiplied by the percentage of each vehicle type to determine vehicle type VMT. That vehicle type VMT was then divided by the fuel economy rate to calculate the number of gallons of fuel used. These fuel consumption values were then converted to British Thermal Units (BTUs) by multiplying each gallon by 125,000. Finally, the total direct energy consumption, in BTUs, was summarized for all vehicles in each scenario. These results can be found in Table 2.

Step #6 – Indirect Energy Analysis

Indirect energy represents the energy required to construct and maintain the transportation system. For this analysis, per ESB guidelines, only the energy used in construction activities for Regionally Significant, Non-Exempt or future anticipated projects, including new construction, reconstruction, rehabilitation, and widening was analyzed. Certain non-exempt projects, such as ridesharing, include no energy-consuming construction or maintenance activities, and therefore, an indirect energy calculation is not applicable. The intent of the indirect energy calculations is to measure the energy used in the construction of the projects included in the 2035 Build scenario. The indirect energy value of the 2035 No-Build scenario is zero; therefore, it is not possible to compute the percentage difference between the two scenarios.

Indirect vehicle energy was calculated using the Lane Mile Approach as described in *Subtask 12a: Energy Analysis Guidelines for TIPs and Plans*. As previously mentioned, the three non-exempt signal interconnect projects on the 2011-2015 TIP do not lend themselves to analysis using the lane mile approach. However, the Route 31 center lane project contained on the 2011-2015 TIP, along with eight of the twelve anticipated projects noted in Step #1 one rehabilitation project, two reconstruction projects, four road widening projects, and two new construction projects from the LRTP 2011 Update were included in the indirect energy analysis. The number of lane miles for each project was multiplied by a rate of Construction Energy Consumed per lane mile (from Table 4 of *Subtask 12a*) and the total

Construction Energy Consumed, in BTU's, was calculated. Results of this analysis are shown in Table 3.

Step #7 – CO_2 Emissions Estimates from Direct Energy Consumption

Carbon dioxide (CO_2) is a product of fossil fuel combustion, as well as other processes. It is considered a greenhouse gas, as it traps heat radiated by the Earth into the atmosphere and thereby contributes to the potential for global warming. Carbon dioxide emissions were calculated as described in *Subtask 12b: Greenhouse Gases (CO2) Emissions Estimates Guidelines for TIPs and Plans*. The carbon dioxide emissions from direct energy consumption were based on the results calculated previously in Step 5.

Subtask 12b, Table 1 lists Carbon Emission coefficients based on vehicle type. The Direct Energy consumed (by vehicle type) was multiplied by the Carbon Emission Coefficients for both gasoline and diesel engines and then by a factor representing the amount of carbon that is oxidized. This process created a value representing total tons of carbon dioxide emitted. The results can be found in Table 4.

Step #8 – CO_2 Emissions Estimates from Indirect Energy Consumption

The indirect energy consumed as a result of the Build scenario was determined in Step 6 above. *Subtask 12b, Table 1* lists Carbon Emission coefficients based on vehicle type. Similar to Step 7 above, the indirect energy consumed was multiplied by the Carbon Emission Coefficients for diesel vehicles and then by a factor representing the amount of carbon that is oxidized, resulting in the total tons of Carbon emitted. The results can be found in Table 5.

Step #9 - Documentation

A summary of the results of the quantitative analyses is presented in Table 6. These results indicate that the Build scenario of the LRTP 2011 Update and supporting TIP will result in a decrease in VMT and associated decreases in VOC, NO_x, CO, CO_2, and the amount of direct energy used by vehicles in the Syracuse MPA over the No-Build scenario.

VMT Calculations

2035 No Build

Functional Classification		Daily VMT	Avg speed (mph)	CO rate (g/mi)	CO Sum (g/day)	VOC rate (g/mi)	VOC Sum (g/day)	NOx rate (g/mi)	NOx Sum (g/day)	
11/12	Interstate/ Freeway	4,096,261.00	61.20	11.67	47,786,980.83	0.18	737,326.98	0.17	716,026.42	
14	Principal arterial	1,427,221.00	27.80	10.44	14,897,903.69	0.22	320,268.39	0.14	206,090.71	
16	Minor arterial	2,136,224.00	27.20	10.45	22,326,958.76	0.23	481,932.13	0.15	311,034.21	
17	Urban collector	697,357.00	27.10	10.59	7,386,544.82	0.22	154,534.31	0.14	97,629.98	
19	Local roads	1,349,242.00	19.70	10.95	14,774,199.90	0.26	356,469.74	0.16	216,688.27	
14	Low capacity ramp	46,429.00	27.30	10.45	485,155.19	0.23	10,465.10	0.15	6,750.78	
11/12	High capacity ramp	230,609.00	29.70	10.13	2,335,561.83	0.22	51,010.71	0.15	34,591.35	
1	Interstate	718,140.00	66.10	11.26	8,086,256.40	0.18	129,265.20	0.22	157,990.80	
2	Principal arterial	315,464.00	45.10	10.73	3,383,603.77	0.19	59,875.07	0.15	47,319.60	
6	Minor arterial	170,989.00	47.60	10.87	1,858,787.22	0.18	31,598.77	0.15	25,648.35	
7	Major Collector	401,486.00	35.10	10.27	4,121,334.09	0.20	80,216.90	0.14	56,208.04	
8	Minor collector	242,384.00	37.40	10.38	2,517,109.36	0.20	47,313.36	0.14	33,933.76	
9	Local roads	1,510,935.00	33.00	10.26	15,496,149.36	0.21	314,274.48	0.14	211,530.90	
2	Low capacity ramp	5,274.00	26.90	10.27	54,167.14	0.23	1,225.68	0.15	791.10	
1	High capacity ramp	14,534.00	26.40	9.63	139,979.86	0.25	3,697.45	0.16	2,325.44	
	TOTAL	**13,362,549.00**			**145,650,692.22**	**g/day**	**2,779,474.26**	**g/day**	**2,124,559.71**	**g/day**
					160.55	**tons/day**	**3.06**	**tons/day**	**2.34**	**tons/day**

2035 Build

Functional Classification		Daily VMT	Avg speed (mph)	CO rate (g/mi)	CO Sum (g/day)	VOC rate (g/mi)	VOC Sum (g/day)	NOx rate (g/mi)	NOx Sum (g/day)	
11/12	Interstate/ Freeway	4,098,983.00	61.20	11.67	47,818,735.68	0.18	737,816.94	0.17	716,502.23	
14	Principal arterial	1,430,315.00	27.70	10.44	14,933,346.79	0.22	321,248.75	0.14	206,823.55	
16	Minor arterial	2,150,520.00	27.30	10.45	22,471,643.69	0.23	484,727.21	0.15	312,685.61	
17	Urban collector	694,798.00	27.10	10.59	7,359,439.38	0.22	153,967.24	0.14	97,271.72	
19	Local roads	1,354,733.00	19.80	10.94	14,820,779.02	0.26	356,023.83	0.16	217,299.17	
14	Low capacity ramp	45,577.00	27.50	10.45	476,051.77	0.23	10,254.83	0.15	6,608.67	
11/12	High capacity ramp	231,649.00	30.10	10.12	2,344,241.55	0.22	50,916.45	0.15	34,701.02	
1	Interstate	719,555.00	66.10	11.26	8,102,189.30	0.18	129,519.90	0.22	158,302.10	
2	Principal arterial	315,416.00	45.10	11.02	3,474,559.57	0.19	59,929.04	0.15	47,375.48	
6	Minor arterial	171,129.00	47.60	10.87	1,860,309.13	0.18	31,624.64	0.15	25,669.35	
7	Major Collector	400,325.00	35.10	10.27	4,109,416.19	0.20	79,984.94	0.14	56,045.50	
8	Minor collector	241,079.00	37.40	10.38	2,503,557.20	0.20	47,058.62	0.14	33,751.06	
9	Local roads	1,506,938.00	33.00	10.26	15,455,156.13	0.21	313,443.10	0.14	210,971.32	
2	Low capacity ramp	4,964.00	27.30	10.26	50,931.63	0.23	1,145.69	0.15	744.60	
1	High capacity ramp	14,266.00	26.80	9.61	137,159.03	0.25	3,606.44	0.16	2,282.56	
	TOTAL	**13,380,247.00**			**145,917,516.05**	**g/day**	**2,781,267.62**	**g/day**	**2,127,033.94**	**g/day**
					160.84	**tons/day**	**3.07**	**tons/day**	**2.34**	**tons/day**

2035 Build with off-model assumptions

Functional Classification		(Model) Daily VMT	Avg speed (mph)	VMT reductions Bike/ped*	Transit**	Reduced VMT	CO rate (g/mi)	CO Sum (g/day)	VOC rate (g/mi)	VOC Sum (g/day)	NOx rate (g/mi)	NOx Sum (g/day)	
11/12	Interstate/ Freeway	4,098,983.00	46.26	0.00	-50,320.37	4,048,662.63	11.67	47,231,698.27	0.18	728,759.27	0.17	707,706.23	
14	Principal arterial	1,430,315.00	31.37	0.00	-17,558.98	1,412,756.02	10.44	14,750,020.46	0.22	317,305.00	0.14	204,284.52	
16	Minor arterial	2,150,520.00	29.60	-13,701.97	-26,400.44	2,110,417.59	10.45	22,052,597.55	0.23	475,688.12	0.15	306,854.72	
17	Urban collector	694,798.00	32.49	-4,426.88	-8,529.55	681,841.56	10.59	7,222,202.21	0.22	151,096.09	0.14	95,457.82	
19	Local roads	1,354,733.00	27.20	-8,631.64	-16,631.12	1,329,470.24	10.94	14,544,404.48	0.26	349,384.78	0.16	213,247.03	
14	Low capacity ramp	45,577.00	14.56	0.00	-559.52	45,017.48	10.45	470,207.61	0.23	10,128.93	0.15	6,527.54	
11/12	High capacity ramp	231,649.00	32.02	0.00	-2,843.79	228,805.21	10.12	2,315,462.92	0.22	50,291.38	0.15	34,275.02	
1	Interstate	719,555.00	46.84	0.00	-8,833.48	710,721.52	11.26	8,002,724.35	0.18	127,929.87	0.22	156,358.74	
2	Principal arterial	315,416.00	42.35	0.00	-3,872.14	311,543.86	11.02	3,431,904.82	0.19	59,193.33	0.15	46,793.89	
6	Minor arterial	171,129.00	46.17	0.00	-2,100.83	169,028.17	10.87	1,837,471.41	0.18	31,236.41	0.15	25,354.23	
7	Major Collector	400,325.00	40.53	0.00	-4,914.51	395,410.49	10.27	4,058,967.74	0.20	79,003.02	0.14	55,357.47	
8	Minor collector	241,079.00	40.93	0.00	-2,959.56	238,119.44	10.38	2,472,822.77	0.20	46,480.91	0.14	33,336.72	
9	Local roads	1,506,938.00	42.04	0.00	-18,499.63	1,488,438.37	10.26	15,265,423.91	0.21	309,595.18	0.14	208,381.37	
2	Low capacity ramp	4,964.00	12.06	0.00	-60.94	4,903.06	10.26	50,306.38	0.23	1,131.63	0.15	735.46	
1	High capacity ramp	14,266.00	34.99	0.00	-175.13	14,090.87	9.61	135,475.22	0.25	3,562.17	0.16	2,254.54	
	TOTAL	**13,380,247.00**		**-26,760.49**	**-164,260.00**	**13,189,226.51**		143,841,690.10	g/day	2,740,786.11	g/day	2,096,925.27	g/day
							CNG bus emission reductions***	-2,124,720.00	g/day	-75,090.00	g/day	-698,090.00	g/day
							Adjusted total	**141,716,970.10**	**g/day**	**2,665,696.11**	**g/day**	**1,398,835.27**	**g/day**
								156.21	**tons/day**	**2.94**	**tons/day**	**1.54**	**tons/day**

Emission Factors (rates) from:
MOBILE6.2 Emission Factor Tables (NYSDOT ESB)

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*bike/ped reduction assumes decrease of 0.2% VMT in 2035 build scenario = -26,760 miles/day
**transit reduction assumes 32,852 daily riders with 5 mile average trip length in 2035 build scenario = -164,260 miles/day
***Emission reductions resulting from Centro updating older CNG fleet with newer CNG buses based on Centro data

Table 1 - Emissions Analysis
SMTC Long-Range Plan *2035* Energy Analysis

Scenario	Daily VMT	VOC (grams)	NO_X (grams)	CO (grams)
2035 No-build	13,362,549	2,779,474	2,124,560	145,650,692
2035 Build	13,380,247	2,781,268	2,127,034	145,917,516
2035 Build with off-model transit and bike/ped assumptions	13,189,227	2,665,696	1,398,835	141,716,970

Table 2 - Direct Vehicle Energy
SMTC Long-Range Plan *2035* Energy Analysis

Scenario	Total VMT	Light Duty Vehicles					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2035 no-build	13,362,549	91.94%	12,284,859	20.79	590,902	73,862,791,144	-1.30
2035 build	13,189,227	91.94%	12,125,515	20.79	583,238	72,904,734,177	

Scenario	Total VMT	Medium Trucks					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2035 no-build	13,362,549	2.51%	334,955	8.54	39,222	4,902,730,703	-1.30
2035 build	13,189,227	2.51%	330,610	8.54	38,713	4,839,138,531	

Scenario	Total VMT	Heavy Trucks					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2035 no-build	13,362,549	5.56%	742,735	6.51	114,091	14,261,425,024	-1.30
2035 build	13,189,227	5.56%	733,101	6.51	112,612	14,076,443,420	

Scenario	Total VMT	All Vehicles					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2035 no-build	13,362,549	100.00%	13,362,549	n/a	744,216	**93,026,946,871**	-1.30
2035 build	13,189,227	100.00%	13,189,227	n/a	734,563	**91,820,316,127**	

Notes:

*From Table 2 - Fuel Correction Factors NYSDOT Subtask 12a: Energy Analysis Guidelines for TIPs and Plans

2035 Build scenario includes off model transit and bike/ped assumptions.

%of total: Vehicle split was estimated based on aggregating the 27 vehicle types from the 1999 Summer Time Vehicle Distributions Region 3, April, 2004 NYSDOT and then averaging their percentages.

Vehicle Type VMT: Calculated by multiplying the percentage of each vehicle type by the total VMT.

Fuel Used: Calculated by dividing Vehicle VMT by the fuel economy.

Direct Energy Consumption: Calculated by multiplying the rate of 125,000 BTU per gallon by the fuel used .

Table 3 - Indirect Energy
SMTC Long-Range Plan *2035* Energy Analysis

Roadway Construction Energy Consumed

Project Description*	Type of Improvement	Distance (miles)	Lanes	Lane Miles	Urban / Rural	Constr. Energy per Lane Mile (rate)	Constr. Energy Consumed (BTUs)
Route 31 reconstruction	Widen from 2 to 3 lanes	0.9	1	0.9	Urban	6	5,400,000,000
Bear Street Extension	New construction (4 lanes)	0.4	4	1.4	Urban	15.24	21,336,000,000
Third Lane of Frontage Road	Widen from 2 to 3 lanes	0.1	1	0.1	Urban	6	600,000,000
Genant Street	New construction (2 lanes)	0.03	2	0.06	Urban	15.24	914,400,000
Additional Travel Lane on NY 31	Widen from 2 to 5 lanes	1.0	3	3.06	Urban	6	18,360,000,000
Girden Road rehabilitation	Rehabilitation	0.6	2	1.2	Urban	2.76	3,312,000,000
Route 31/81 Interchange Improvements	Reconstruction	1.6	1	1.6	Urban	6.24	9,984,000,000
Soule Rd & Rt 31/481 Interchange	Reconstruction	0.3	2	0.54	Urban	6.24	3,369,600,000
Verplank Road	Minor widening	5.6	2	11.2	Rural	2.28	25,536,000,000
						TOTAL	**83,412,000,000**

Projects with no construction

Project Description	Type of Improvement
NYSDOT Bridge Painting 2013	Maintenance
NYSDOT Bridge Painting 2014	Maintenance

Notes:
**There are four non-exempt projects in the SMTC 2011-2015 TIP but are not included in the above table. The projects listed are included in SMTC's long-range planning and are considered essential transportation projects to service anticipated development, although they are not programmed on the current TIP.*

Indirect vehicle energy was calculated using the Lane Mile Approach as described in Subtask 12a: Energy Analysis Guidelines for TIPs and Plans. Table 4 of Subtask 12a provides a table that associates a rate of Construction Energy Consumed per lane mile based on several types of improvements. The number of lane miles for each project was then multiplied by that rate, and a rate of Construction Energy Consumed in BTU's was calculated.

Table 4- CO_2 Emissions Estimates from Direct Energy Consumption
SMTC Long-Range Plan *2035* Energy Analysis

Scenario	Direct Energy (BTUs)			Carbon Emission Coefficients *			Metric Tons Carbon Emitted** (100% oxidation)			Total Metric Tons Carbon Emitted***			Total Tons Carbon Emitted****			
	Light Duty Vehicle	Medium Truck	Heavy Truck	Light Duty Vehicle	Medium Truck	Heavy Truck	Light Duty Vehicle	Medium Truck	Heavy Truck	Light Duty Vehicle	Medium Truck	Heavy Truck	Light Duty Vehicle	Medium Truck	Heavy Truck	All Vehicles
2035 no-build	73,862,791,144	4,902,730,703	14,261,425,024	19.34	19.95	19.95	1,429	98	285	1,414	97	282	1,558	107	310	**1,976**
2035 build	72,904,734,177	4,839,138,531	14,076,443,420	19.34	19.95	19.95	1,410	97	281	1,396	96	278	1,538	105	306	**1,950**

Difference: 2035 no-build minus build **-26**

2035 Build scenario includes off model transit and bike/ped assumptions.

* For this analysis, all Light Duty Vehicles are assumed to use gasoline and all trucks are assumed to use diesel

As per NYSDOT Subtask 12b: Greenhouse Gases (CO2) Emissions Estimates Guidelines for TIPs and Plans:

** Metric Tons C emitted (assuming 100% oxidation) = Total direct energy for roadway projects (BTUs) x Carbon emission coefficient (10^6 metric tons of Carbon/10^{15} BTU)

*** a small portion (1%) of total carbon does not oxidize during combustion

**** 1 metric ton = 1.102 tons

Table 5 - CO_2 Emissions Estimates from Indirect Energy Consumption
SMTC Long-Range Plan *2035* Energy Analysis

Scenario	Indirect Energy (BTUs)	Carbon Emission Coefficient	Metric Tons Carbon Emitted	Total Metric Tons Carbon Emitted	Total Tons Carbon Emitted
2035 build	83,412,000,000.00	19.95	1,664.07	1,647.43	**1,815.47**

Table 6 - Summary
SMTC Long-Range Plan *2035* Energy Analysis

		Air Pollution Emissions			Energy		Greenhouse Gas (CO_2) Emissions	
Scenario	**VMT**	**VOC g/day**	**NO_x g/day**	**CO g/day**	**Direct (BTUs)**	**Indirect* (BTUs)**	**Direct (tons)**	**Indirect (tons)**
2035 No-Build	13,362,549	2,779,474	2,124,560	145,650,692	93,026,946,871	0	1,976	0
2035 Build (with off-model assumptions)	13,189,227	2,665,696	1,398,835	141,716,970	91,820,316,127	83,412,000,000	1,950	1,815
Change (Build - No Build)	-173,322	-113,778	-725,724	-3,933,722	-1,206,630,744	--	-26	--
Percent Change (Build - No Build)	-1.30%	-4.09%	-34.16%	-2.70%	-1.30%	--	-1.30%	--

** The intent of the indirect energy and greenhouse gas calculations was to measure the impact of the construction of the projects in the SMTC Long-Range Plan. The indirect energy used in the 2035 No-Build scenario is zero (as is the greenhouse gas emissions arising from the indirect energy used); therefore it is not possible to compute the percentage difference between the two scenarios.*