Sugar, Alissa(ENE)

From:

Callan, Dennis [DCallan@mrc.ca]

Sent:

September 11, 2009 10:04 AM

To:

Sugar, Alissa(ENE)

Cc:

Bricks, Mike; Lam Watt, Dana; Mike.Lepage@rwdi.com; Scott Shayko; James O'Mara;

Colleen Bell

Subject:

GO Georgetown S. EPR _ Assumptions behind GHG calculations

Importance:

High

Attachments: GSSE displaced emissions -- Original Analysis.pdf; GSSE displaced emissions -- UPRL.pdf;

Summary Assumptions for EPR GHG Emissions .doc; Locomotive emmission factors

summary table.xlsx

Alissa



Attached please find the data requested concerning the assumptions behind the GHG calculations in section 6.2.4.3 of the EPR. While some of the assumptions behind this are indicated on page 387 of Section 6.2.4, I have attached a consolidated summary of the main assumptions. In addition the full analysis is attached indicated by "original analysis" in the file heading. There is also a spreadsheet related to the locomotive emission factors. These calculations were prepared by RWDI for us.

GHG emissions calculations related the Union Pearson Rail Link were not in the EPR but are included here ("UPRL" is in the file title) for your further reference.

Please feel free to call me if you require any clarification.

Regards

Dennis



Dennis Callan, P.Eng., Manager, Planning & Transportation Services McCormick Rankin Corporation | A member of MMM Group

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Trip Distance Trips/Day Passenger trips/day Days/year	30 184 349600 260	km				
GO Transit				Light Duty Passenger Vehi	cles (gasoline)	
Power	5000	bhp		Fuel consumption	8 11	L/100 km small cars L/100 km large cars
				Vehicle mix	57%	small cars
Fuel Consumption	20.8	bhp-hr/Us gal	5.50 bhp-hr/litre	Ave. fuel consumption	9.3	L/100 km
Vehicle Speed	20.8 76	km/hr	5.50 bilp-in/litre	Vehicle Speed	50	km/hr
Passengers	1900	people/vehicle		Passengers	1.1	people/vehicle
1 0330116013	1500	people/ verticie		1 4336118613		, ,
CO2e	2.7	kg/litre	0.49 kg/bhp-hr	CO2e	2.4	kg/litre
СО	1.5	g/bhp-hr	5 , ,	со	6.5	g/mile
NOX	5.50	g/bhp-hr		NOX	0.39	g/mile
PM	0.19	g/bhp-hr		PM	0.033	g/mile
HC	0.3	g/bhp-hr		НС	0.24	g/mile
CO2e	32	kg/km		CO2e	0.22	kg/km
СО	99	g/km		СО	4.04	g/km
NOX	362	g/km		NOX	0.24	g/km
PM	13	g/km		PM	0.02	g/km
HC	20	g/km		НС	0.15	g/km
CO2e	0.51	kg/passenger trip		CO2e	6.08	kg/passenger trip
CO	1.56	g/passenger trip		СО	110.18	g/passenger trip
NOX	5.71	g/passenger trip		NOX	6.61	g/passenger trip
PM	0.20	g/passenger trip		PM	0.56	g/passenger trip
HC	0.31	g/passenger trip		HC	4.07	g/passenger trip
						14.
CO2e	46	kilotonnes/year		CO2e	553	kilotonnes/year
CO	142	Tonnes/year		CO	10015	Tonnes/year
NOX	519	Tonnes/year		NOX	601	Tonnes/year
PM	18	Tonnes/year		PM	51	Tonnes/year
HC	28	Tonnes/year		HC	370	Tonnes/year

Trip Distance	30 140	km				
Trips/Day	7840					
Passenger trips/day Days/year	7840 365					
Days/year	303					
UPRL Trains				Light Duty Passenger Vehicl	es (gasoline)	
Power	2000	bhp		Fuel consumption	8	L/100 km small cars
					11	L/100 km large cars
				Vehicle mix	57%	small cars
Fuel Consumption	20.8	bhp-hr/Us gal	5.50 bhp-hr/litre	Ave. fuel consumption	9.3	L/100 km
Vehicle Speed	76	km/hr		Vehicle Speed	50	km/hr
Passengers	56	people/vehicle		Passengers	1.1	people/vehicle
CO2e	2.7	kg/litre	0.49 kg/bhp-hr	CO2e	2.4	kg/litre
CO	1.5	g/bhp-hr	יוו קוום פאו כדיט	CO	6.5	g/mile
NOX	5.50	g/bhp-hr		NOX	0.39	g/mile
PM	0.1	g/bhp-hr		PM	0.033	g/mile
HC	0.3	g/bhp-hr		HC	0.24	g/mile
	0.0	B) =b				
CO2e	13	kg/km		CO2e	0.22	kg/km
СО	39	g/km		со	4.04	g/km
NOX	145	g/km		NOX	0.24	g/km
PM	3	g/km		PM	0.02	g/km
НС	8	g/km		НС	0.15	g/km
CO2-	6.93	ka/nossongar trin		CO2e	6.08	kg/passenger trip
CO2e CO	21.15	kg/passenger trip		COZE	110.18	g/passenger trip
NOX	77.54	g/passenger trip		NOX	6.61	g/passenger trip
PM	77.54 1.41	g/passenger trip		PM	0.56	g/passenger trip
HC	4.23	g/passenger trip g/passenger trip		HC	4.07	g/passenger trip
пс	4.25	g/passeriger trip		TIC	4.07	8) basseriger crip
			equivalent 30 k			
CO2e	20	kilotonnes/year	2.9E+06 car trips	CO2e	17	kilotonnes/year
СО	61	Tonnes/year	4.8E+05	со	315	Tonnes/year
NOX	222	Tonnes/year	2.9E+07	NOX	19	Tonnes/year
PM	4	Tonnes/year	6.3E+06	PM	2	Tonnes/year
HC	12	Tonnes/year	2.6E+06	HC	12	Tonnes/year

Assumption for GHG Emission Estimates in the EPR

For Maximum Annual GHG Emission Calculation

- 1. Three types of passenger trains (VIA, GO, and UPRL) and two types of freight trains (CPR, and CNR) are considered for the analysis;
- 2. The number of trains per day for UPRL, VIA, CPR, and CNR are 140, 12, 21, and 4 respectively;
- 3. The numbers of Georgetown, Bolton, Milton, and Barrie GO trains per day are 109, 12, 88, and 86 respectively.
- 4. The number of operating days per year is considered 365 days
- 5. Please refer to the attached spreadsheet for emission factors

For Net Impacts of GHGs

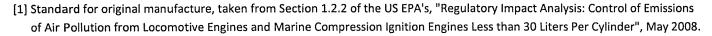
- 1. Automobile emissions based on winter temperatures. Overestimates actual annual emissions.
- 2. Locomotive emissions based on full power. Overestimates actual emissions.
- 3. Criteria contaminant emissions for automobile based on anticipated emissions in 2024
- 4. CO2e emissions based on present day fuel consumption data (2006)
- 5. Trips per day based on average number of GO trips along the Georgetown South Corridor, Strachan to Highway 427, in the year 2024
- 6. Days per year based on 5 days/week of operation
- 7. Passengers per train based on load of 1900 riders
- 8. Assumed 1.1 passengers per automobile
- 9. Average trip length in the Georgetown corridor is 30 km. based on 2006 TTS data
- 10. Train speed based on average of 76 km/hr along Georgetown South Corridor, Strachan to Highway 427
- 11. Car speed was based on an average of 50 km/hr. Has a small effect on the criteria pollutant emissions. No effect on CO2e calculation.
- 12. Automobile fuel consumption based on national average for 2006, from NRCan. Mix of highway and city driving.

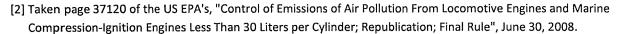
Note: UPRL trains were not included in these calculations

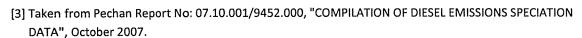
Mobile Locomotive Emission Factors

Emission factors have been collected from the various sources listed below the table.

	CPR, CNR, VIA		GO	UPRL	
Pollutant	Tier 0 ^[1]	Tier 1 ^[1]	Tier 2 ^[1]	Tier 3 ^[2]	Units
Carbon Monoxide (CO)	5	2.2	1.5	1.5	g/bhp-hr
Nitrogen Oxides (NO _x)	9.5	7.4	5.5	5.5	g/bhp-hr
Total Particulate Matter (PM)	0.6	0.45	0.2	0.1	g/bhp-hr
Fine Particulate (PM ₁₀)	0.582	0.4365	0.194	0.097	g/bhp-hr
Inhalable Particulate (PM _{2.5})	0.56454	0.423405	0.18818	0.09409	g/bhp-hr
Hydorcarbons (HC)	1	0.55	0.3	0.3	g/bhp-hr
Volatile Organic Compounds (VOC)	1.053	0.57915	0.3159	0.3159	g/bhp-hr
Formaldehyde ^[3]	0.0272	0.0272	0.0272	0.0272	g/bhp-hr
Acetaldehyde ^[3]	0.015	0.015	0.015	0.015	g/bhp-hr
1,3 Butadiene ^[4]	0.07	0.0385	0.021	0.021	g/bhp-hr
Benzene ^[4]	0.079	0.04345	0.0237	0.0237	g/bhp-hr
Acrolein ^[3]	0.0035	0.0035	0.0035	0.0035	g/bhp-hr
Benzo[a]Pyrene ^[6]	2.5608E-06	1.9206E-06	8.536E-07	4.268E-07	g/bhp-hr
Sulphur Dioxide (SO ₂) ^[5]	0.00085	0.00085	0.00085	0.00085	kg/L
Carbon Dioxide (CO ₂) ^[5]	2.663	2.663	2.663	2.663	kg/L
Nitrous Oxide (N ₂ O) ^[5]	0.0011	0.0011	0.0011	0.0011	kg/L
Methane (CH ₄) ^[5]	0.00015	0.00015	0.00015	0.00015	kg/L







- [4] Based on speciation of VOCs from the EPA's Speciate 3.2 program.
- [5] Taken from page ix of the Railway Association of Canada (RAC), Environment Canada (EC), Transport Canada (TC) and Pollution Probe document, "Locomotive Emissions Monitoring Program 2007", 2007.
- [6] Taken from Table C4 of the U.S. EPA's, "DOCUMENTATION FOR AIRCRAFT, COMMERCIAL MARINE VESSEL, LOCOMOTIVE, AND OTHER NONROAD COMPONENTS OF THE NATIONAL EMISSIONS INVENTORY", September 30, 2005.



Frieght Train Volumes

2009 CPR Daily Train Volumes

The table below is a summary of average CPR movements along the Mactier Sub. For the purposes of this air quality assessment, the 'Total' column has been taken as the volumes that apply to the entire study corridor.

Data Year	Applicable	Time Period	CPR Mo	vement (Counts*
	Modelling Scenario		NW	SW	Total
2009	2024 no-build & 2024 build	24:00 - 06:00	3	3	6
		06:00 - 12:00	3	2	5
		12:00 - 18:00	2	3	5
		18:00 - 24:00	2	3	5
		Total Daily	10	11	21

^{*}Data received via email from Mike Bricks on 13/02/2009 12:11 pm.



2009 CNR Train Volumes

The table below is a summary of average CNR movements along the study corridor. The 4 movements were assumed to be evenly distributed throughout the day.

Data Year	Applicable Modelling Scenario	Time Period	CNR Movement Counts**
2009	2024 no-build & 2024 build	24:00 - 06:00	1
		06:00 - 12:00	1
		12:00 - 18:00	1
		18:00 - 24:00	1
		Total Daily	4

^{**}Data received via email from Dennis Callan on 27/02/2009 3:50 pm.







Appendix ##: Passenger Train Volumes - Raw Data

Raw data as provided by MRC. Projected volumes based on RTP data. Includes 10-car equivalent trains for both directions. Timed relative to arrival/departure from Union Station.

					AM	Peak		Midday	Agreem of the	PM	Peak	W.C.	Evening
Data Year	Applicable	Corridor Segment	Carrier	5:30	6:30	7:30	8:30	9:30	15:30	16:30	17:30	18:30	19:30
Data icai	Modelling Scenario	(Approximate)		6:29	7:29	8:29	9:29	15:29	16:29	17:29	18:29	19:29	1:29
					0	0	0	0	0	0	0	0	0
2013	2024 No-build	HWY 427 - West Toronto Diamond	UPRL	0	1	and Saturday States	0	4	0	1	2	1	3
			VIA	0	0	1	3	12	2	3	2	2	12
		(=Georgetown GO)		0	3	<u>3</u>	3	16	2	4	4	3	15
			Total	1 0	3	4	3	1 10	<u> </u>	1 -	•		
			LIDDI	l 0	0	0	0	0	Ιο	0	0	0	0
		West Toronto Diamond - Lansdowne Ave.	UPRL	1			0	4	0	1	2	1	3
İ			VIA	0	0 5	. 1 6	5	12	4	6	3	3	12
		(=Georgetown + Milton GO)	GO Total	0	5	7	5	16	4	7	5	4	15
			TOTAL		<u> </u>			1 10	<u> </u>	<u> </u>		<u></u>	
		Landau Ava Chrahan Ava	UPRL	1 0	0	0	0	0	0	0	0	0	0
		Lansdowne Ave Strachan Ave.	VIA	0	0	1	0	4	0	1	2	1	3
		(=Georgetown + Milton + Barrie GO)	\$1000 P. S.	0	6	8	6	18	5	8	4	3	14
		(=Georgetown + Militon + Barrie GO)	Total	0	6	9	6	22	5	9	6	4	17
L				<u> </u>									36
2021	2024 Build	HWY 427 - Weston Rd.	UPRL	0	8	8	8	48	8	8	8	8	36
			VIA	0	0	1	0	4	0.5.	1	2 7	4	24
		(=Georgetown GO)		0	10	14	6	24	8	12 21	17	13	63
			Total	0	18	23	14	76	16	21	1 1/	15	L 03
				1 -			T 0	1 40		8	8	8	36
		Weston Rd Toronto West Diamond	UPRL	0	8	8	8	48	8	1	2	1	3
			VIA	0	0	1	0	4	9	15	8	5	24
		(=Georgetown + Bolton GO)		0	11	18	7	24 76	17	24	18	14	63
			Total	0	19	27	15] /6	1 1/	24	10	1 14	
			11001	1 .	1 0	8	8	48	8	8	8	8	36
		Toronto West Diamond - Lansdowne Ave.	UPRL	0	8	8	0	40		1 1550	2	1	3
			VIA	0	0 16	27	12	48	14	22	13	okinska Tarovino. 9	48
		(=Georgetown + Bolton + Milton GO)		0	24	36	20	100	22	31	23	18	87
			Total	0	24	30	20	1 100	1			<u> </u>	
		Landau Charles Ave	UPRL	1 0	8	8	8	48	8	8	8	8	36
		Lansdowne Ave Strachan Ave.	VIA	0	0	1	0	4	0	1	2	SELECT TOTAL	3
		(=Georgetown + Bolton + Milton + Barrie GO)	RECEIVACE AND	0	21	36	16	72	18	29	18	13	72
		(=Georgetown + Bolton + Millon + Barrie GO)	Total	0	29	45	24	124	26	38	28	22	111
	1		Liotai		4.5	7.7							





Appendix ##: Passenger Train Volumes - 24 Hour Distributions

Data from MRC distributed over a 24 hour period. Projected volumes based on RTP data. Includes 10-car equivalent trains for both directions. Timed relative to arrival/departure from Union Station.

	inite to annual auto-	•														7			00.20	21:30	22:30	23:30	0:30	1:30	2:30	3:30	4:30	DAILY
Data Year	Applicable	Corridor Segment	Carrier	5:30	6;30	7:30	8:30	9:30	10:30	11:30	12:30	13;30	14:30	15:30	16:30	17:30	18:30	19:30	20:30 21:29	The state of the state of the	23:29	0:29	1:29	2:29	3:29	Sales of the sales	191	TOTAL
	Modelling Scenario	(Approximate)	4000	6:29	7:29	8:29	9:29	10:29	11:29	12:29	13:29	14:29	15:29	16:29	17:29	18:29	19:29	20:29	# £1:23	*******	# 23.23 F	(30. U-L) (1		38-23-22			
							0	0	0	0	0	0	0	0	O	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	2024 No-build	HWY 427 - West Toronto Diamond	UPRL	0 X43023036	U COST TAKE	0	0	0.67	0.67	0.67	0,67	0.67	0.67	0	1	142		0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0	12
1		1	VIA	. 0	0	1	AND THE PROPERTY OF	LICENSIA MANAGEMENT	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	0	0	0	0	42
1	İ	(=Georgetown GO)		0	3	3	3	2		2.67	2.67	2.67	2.67	2	4	4	3	2.5	2.5	2.5	2.5	2.5	2.5	0	0	0	0	54
	1		Total	0	3	4	3	2.67	2.67	2.07	2.07	2.07	2.07			l	<u> </u>	<u> </u>										
			т							1 0	0	0	^	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	}	West Toronto Diamond - Lansdowne Ave.	UPRL	0	0	0	0	0	0	0.67	0.67		0.67	0	1	2.5	esi 1 336	0.5	0.5	0.5	0.5	w. 0.5	0.5	0	0	. 0	0	12
			VIA	0	0.	1.50	0	0.67	0.67 2	2	2	2	7	4	6	3	3	2	2	2	2	2	2	0	0	0	0	56
		(=Georgetown + Milton GO)		0	5	6	5	2			2.67	2.67	2.67	4	7	5	4	2.5	2.5	2.5	2.5	2.5	2.5	0	0	0	0	68
			Total	0	5	7	5	2.67	2.67	2.67	2.67	2.07	2.07		<u> </u>					·						,		
								0	0	0	1 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
İ	1	Lansdowne Ave Strachan Ave.	UPRL	0	0	0	0	1 T	0.67	0.67	0.67	0.67	0.67	0	630100	2	1 1	0.5	0.5	0.5	0.5	0.5	0.5	0	. 0	0	0	12
			VIA	0	. 0	1	6	0.67 3	3	3	3	3	3	5	8	4	3	2.33	2.33	2.33	2.33	2.33	2.33	0	0	0	0	72
		(=Georgetown + Milton + Barrie GO)		0	6	8 9	6	3.67	3.67	3.67	3.67	3.67	3.67	5	9	6	4	2.83	2.83	2.83	2.83	2.83	2.83	0	0	0	0	84
			Total	0	6	9	1 0	3.07	3.07	3.07	1 3.07	J.57				· · · · · · · · · · · · · · · · · · ·	1 -		-		6	6	6	Τ ο	0	0	0	140
2021	2024 Build	HWY 427 - Weston Rd.	UPRL	0	8	8	8	8	8	8	8	8	8	8	8	8	8	0	6	0.5	0.5	0.5	0.5		0	0	. 0	12
			VIA	. 0	0	2021 in	2.0.1	0.67	0.67	0.67	0.67		0.67	0		22	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	0.5	0.5	W-2 16	4	4	A CONTRACTOR	0	0	0	0	109
1	1	(=Georgetown GO)	GO	0	10	14	6	4	4	4	4	4	4	8	12	7	4	10.5	10.5	10.5	10.5	10.5	10.5	0	0	0	0	261
			Total	0	18	23	14	12.67	12.67	12.67	12.67	12.67	12.67	16	21	17	13	10.5	10.5	1 10.5	10.5	10.5	1 20.5			1		
															8		T .	6	6	6	6	6	6	0	0	0	0	140
		Weston Rd Toronto West Diamond	UPRL	0	8	8	8	8	8	8	8	8	8	8	- 1 m/s m 2 m s - 1	135.3	l i	0.5	0.5	0.5	0.5	0,5	0.5	0	0	.0	.0.	. 12
	ļ		VIA	0	0,	4261	0	0.67	0,67	0.67	0.67		0.67	9	15 15	8	5	idan Membandi A	A A	4	4	4	4	0	0	0	0	121
		(=Georgetown + Bolton GO)		0	11	18	7	4	4	4	4	4	12.67		24	18	14	10.5	10.5	10.5	10.5	10.5	10.5	0	0	0	0	273
			Total	0	19	27	15	12.67	12.67	12.67	12.67	12.67	12.67	17	24	10	14	10.5	1 20.0	1 2010								
			,										8	8	8	8		6	6	6	6	6	6	0	0	0	0	140
		Toronto West Diamond - Lansdowne Ave.	UPRL	0	8	8	8	8	8	8	8	8			100000	2	1.31	0.5	0.5	0.5	0.5	0.5	0.5	0	. 0	0	. 0	12
			VIA.	0.0	0	65x 1 5.0	0.		0.67	0.67	0.67	0.67 8	0.67 8	0 14	22	13 13 ±	((a) 4) (A) (A) (A) (A) (A) (A) (A) (A) (A) (A	R 8	8	8	8	8	8	0	0	0	0	209
		(=Georgetown + Bolton + Milton GO)		0	16	27	12	8	8	8	8		16.67	22	31	23	18	14.5	14.5	14.5	14.5	14.5	14.5	0	0	0	0	361
			Total	0	24	36	20	16.67	16.67	16.67	16.67	16.67	10.0/		1 31	1 23	1 10	1 17.0		1								
										-	T .		8	8	8	8	8	6	6	6	6	6	6	0	0	0	0	140
1		Lansdowne Ave Strachan Ave.	UPRL	0	8	8	8	8	8	8	8	8		, o	1	2	1	0.5	0.5	0.5	0.5	0.5	0.5	0 .	0	0	0	12
			VIA.	. 0	0	dai ka	. 0	0.67	0.67	0.67	0.67	0.67	0.67 12	18	29	18	13	12	12	12	12	12	12	0	0	0	0	295
		(=Georgetown + Bolton + Milton + Barrie GO)		0	21	36	16	12	12	12	20.67	20.67	20.67	26	38	28	22	18.5	18.5	18.5	18.5	18.5	18.5	0	0	0	0	447
			Total	0	29	45	24	20.67	20.67	20.67	20.67	20.67	20.67	26	38	20	1 22	1 10.5		1								-





Appendix ##1; Passenger Train Volumes - Shifted 24 Hour Distributions

Date have 1400 distributed many 2.26 hour paried. Projected reduces based on RTP date. Includes 10-car amplicable broke for both direction

Date from MRC distributed over a 24 hour period. Project

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