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TECHNICAL MEMORANDUM

Date:	May 5, 2011
To:	Carl Springer
From:	Peter Chen
Subject:	Greenhouse Gas Analysis
cc:	Bill Ciz
Project Number:	274-2284-013
Project Name:	Congestion Pricing Proposals Analysis

INTRODUCTION

The Congestion Pricing Proposals Analysis (CPPA) evaluates the effects of tolling along two corridors: Cornelius Pass Road and Oregon Route 217 (OR 217).

Cornelius Pass Road

This project consists of a single point toll on Cornelius Pass Road near the US 30 junction in Multnomah County. The objectives of this project are to generate toll revenues that would be used to fund safety improvements along the corridor, and increase travel reliability on this regional route. For a more detailed description of the project, please refer to the *Technical Approach for Traffic and Transportation Analysis Memorandum.*[1]

OR 217 On-Ramp Tolls

This project consists of tolling on ramps at Wilshire Street, Walker Road, and Denny Road interchanges. The objectives of this project are to increase traffic safety, increase travel reliability, and reduce the amount of short-distance, local trips on the freeway. For a more detailed description of the project, please refer to the *Technical Approach for Traffic and Transportation Analysis Memorandum*.

Purpose

This technical memorandum analyzes the effects of these projects on greenhouse gas (GHG) emissions.

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[1] ***Congestion Pricing Proposals Analysis Task 3.3 Technical Approach for Traffic and Transportation Analysis,*** **DKS Associates, Inc., July 09, 2010**

METHODS

The methodologies used for this GHG analysis can be broken down into three components: approach, software, and modeling inputs and assumptions. A discussion on the limitations and caveats of this analysis is also provided.

Approach

Note: *The general approach to this GHG analysis was to provide a reasonably accurate and highly defensible analysis that makes efficient use of and builds on the demand forecasting and traffic operations analyses performed. It is important to note that this analysis and its conclusions are not intended to represent or convey the absolute amount of GHGs resulting from the project(s), rather this analysis is intended to highlight the differences between the No Build and Build scenarios for decision-making purposes.*

The GHG analysis is based on three umbrellas of data sets: transportation (demand forecasting), vehicle, and environmental data.

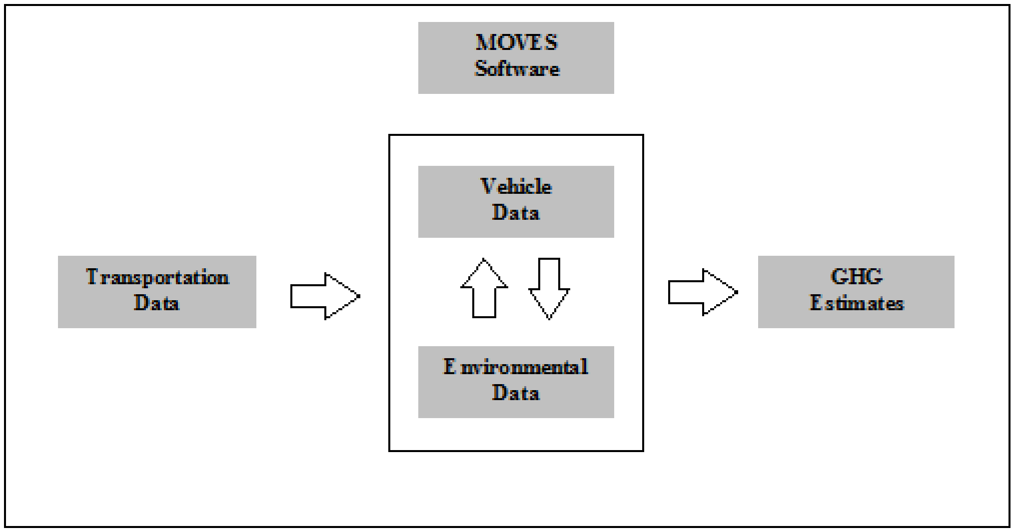
The transportation data was obtained from Metro's travel demand model, and the output data consisted of traffic volumes, distances travelled along each roadway type, operating speeds, and traffic stream composition (proportions of each vehicle class). The travel demand forecasting was performed by Metro and additional information on this analysis, including study areas and modeling assumptions, can be found in the *Technical Approach for Traffic and Transportation Analysis Memorandum.*

Vehicle data consists of information on the vehicles that affect GHG emissions. Such data includes vehicle class (e.g. car, medium truck, heavy truck), vehicle age, fuel type, and others. These data are intrinsic to the vehicles and do not change depending on driver behavior or operating conditions.

Environmental data refers to factors that influence GHG emissions, but are independent of the transportation and vehicle data. Urban/rural distinctions, access spacing and restrictions, and ambient temperature are examples of environmental data that continue to occur independent of whether or not vehicles are present.

Vehicle and environmental data are used by an air quality model (see "Software" below) to generate emission rates for each vehicle class, roadway, operating speed, and analysis year. These emission rates are then applied to the output data (described above) from the Metro travel demand model to estimate the GHG emissions for each scenario. Exhibit 1 provides a highly simplified schematic diagram of these three data sets, their relationships, and process of developing GHG emission estimates.

Exhibit 1. GHG Analysis Components and Process



As shown and described above, GHG estimates are derived in part from vehicle and environmental data. Vehicle and environmental data have relatively small effects on GHG emissions compared to the effects of the transportation data and general fuel economy. This GHG analysis accounts for all vehicle data and environmental data within the Environmental Protection Agency's (EPA) Mobile Vehicle Emission Simulator (MOVES) software program, described below.

Software

The GHG emission estimates provided in this technical memorandum were derived in part from emission rates from EPA's MOVES (version MOVES2010a, release date August 26, 2010) software program. MOVES can be used to estimate GHG emissions for State Implementation Plans (SIPs), or can be used to generate GHG emission rates that can be applied to transportation data to estimate GHG emissions for a project.

Modeling Inputs and Assumptions

As described above, the scope of this GHG analysis is consistent with and based on the travel demand forecasting effort conducted by Metro. Information on the transportation modeling inputs and assumptions is provided in the *Benefits/Limitations of Travel Demand Modeling for Concept Viability Analysis Memorandum*[2].

The MOVES National scale was selected for this analysis. When the National scale is used, MOVES pre-aggregates (i.e., computes a weighted average of) all underlying data that is a function of geography (e.g., temperature, road types, etc.). This scale was selected because some data needed for the county or project level scales were unavailable and Metro, the region's Metropolitan Planning Organization, is still in the process of finalizing data, procedures, and recommendations[3].

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[2] ***Congestion Pricing Proposals Analysis Technical Memorandum 1B: Benefits/Limitations of Travel Demand Modeling for Concept Viability Analysis*, DKS Associates, Inc., June 22, 2010.**

[3] Bosa, Peter. 2010. Personal email from Aaron Breakstone (Metro) via Peter Bosa (Metro). December 9, 2010.

Weekdays in April were assumed to represent the typical and recurrent conditions, and the time spans conducted for analysis were based on the travel demand modeling effort performed by Metro. The time periods of analysis included:

- 2012 AM peak period (7:00-9:00 AM)
- 2012 Mid-Day peak period (12:00-1:00 PM)
- 2012 PM peak period (4:00-6:00 PM)
- 2035 AM peak period (7:00-9:00 AM)
- 2035 Mid-Day peak period (12:00-1:00 PM)
- 2035 PM peak period (4:00-6:00 PM)

In addition, the AM, Mid-Day and PM models are factored and combined to estimate daily travel. For the Cornelius Pass Road project, rural restricted and unrestricted road types were used. Urban restricted and unrestricted road types were assumed for the OR 217 On-Ramp Tolls project.

Limitations and Caveats

The study area for this analysis consists of all freeways, highways, and principal arterials within the Portland Metro region (as covered by Metro travel demand model). At this scale, the amount of time and effort required to construct a traffic operations model is substantial, and by many accounts, unreasonable. As a result, the transportation data used in this analysis were obtained from Metro’s travel demand model.

The primary data used from Metro’s travel demand model, VMT per speed range, is estimated by the model as a function of the amount of travel demand in relation to the roadways. Speeds that are derived in this fashion do not fully capture driver-to-driver interactions or driver-to-environment interactions and, therefore, may not represent actual travel speeds as well as an operations model.

Similarly, travel demand models utilize delay functions based on intersection volumes, as opposed to accounting for signal timings and phasings, and intersection delay is not as accurate as an operations model.

While operating speeds and intersection delay are not as accurately accounted for in travel demand models, these data are reasonable enough for comparative analyses and are readily available for large areas that would otherwise be unreasonable to model in a traffic operations model.

ANALYSIS RESULTS

Cornelius Pass Road

This project analyzed the future (2012 and 2035) conditions associated with the No Build and three Build scenarios (Toll Low, Toll Medium, and Toll High).

The VMT is shown in Exhibit 2.

Exhibit 2. Cornelius Pass Road – Vehicle Miles Travelled (VMT)

	No Build	Toll Low	Toll Medium	Toll High
2012				
AM Peak (7-9 AM)	7,715,657	7,716,708	7,716,994	7,717,245
MD Peak (12-1 PM)	2,879,617	2,880,066	2,880,182	2,880,295
PM Peak (4-6 PM)	7,679,924	7,680,863	7,681,120	7,681,366
3 Peak Total (5 hrs)	18,275,198	18,277,637	18,278,296	18,278,906
Daily (24 hrs)	53,165,299	53,172,976	53,175,002	53,176,920
2035				
AM Peak (7-9 AM)	10,158,211	10,159,371	10,159,681	10,159,909
MD Peak (12-1 PM)	3,809,877	3,810,473	3,810,637	3,810,769
PM Peak (4-6 PM)	10,079,756	10,081,009	10,081,358	10,081,624
3 Peak Total (5 hrs)	24,047,844	24,050,853	24,051,677	24,052,302
Daily (24 hrs)	70,142,724	70,152,567	70,155,268	70,157,386

In 2012, the No Build scenario is expected to have the lowest VMT during the three peak periods as well as daily. As the toll increases, VMT is also expected to increase as a result of trip diversion.

In 2035, the relative differences in VMT between the four scenarios are the same as in 2012.

Exhibit 3 summarizes the GHG emissions for each scenario.

Exhibit 3. Cornelius Pass Road – GHG Emission Estimates (metric tonnes of CO_2e)

	No Build	Toll Low	Toll Medium	Toll High
2012				
AM Peak (7-9 AM)	3,485	3,485	3,485	3,485
MD Peak (12-1 PM)	1,264	1,265	1,265	1,265
PM Peak (4-6 PM)	3,311	3,311	3,311	3,311
3 Peak Total (5 hrs)	8,060	8,061	8,061	8,061
Daily (24 hrs)	23,397	23,404	23,405	23,405
2035				
AM Peak (7-9 AM)	3,725	3,725	3,725	3,725

MD Peak (12-1 PM)	1,368	1,368	1,368	1,368
PM Peak (4-6 PM)	3,503	3,504	3,505	3,505
3 Peak Total (5 hrs)	8,596	8,597	8,597	8,597
Daily (24 hrs)	25,150	25,151	25,151	25,152

In 2012, the No Build scenario has the lowest GHG emissions, followed by Toll Low, Toll Medium, and the Toll High scenario has the highest GHG emissions. This trend correlates to the VMT associated with each scenario – as the tolls increase, VMT and GHG emissions also increase as a result of trip diversion.

The high degree of correlation between VMT and GHG emissions continues in 2035 and a similar pattern is experienced. A few individual peak periods deviate from this VMT trend by a negligible amount (not reflected without additional decimal places) as a result of differing distributions of travel speeds, which affect fuel economy, but the overall trend, three-peak total, and daily emissions are consistent with the general VMT trend.

OR 217 On-Ramp Tolls

This project analyzed the future conditions associated with the No Build and three toll scenarios (Toll Low, Toll Medium, and Toll High) in 2012 and 2035.

The VMT is shown in Exhibit 4.

Exhibit 4. OR 217 – Vehicle Miles Travelled (VMT)

	No Build	Toll Low	Toll Base	Toll High
2012				
AM Peak (7-9 AM)	7,715,657	7,716,981	7,717,184	7,717,430
MD Peak (12-1 PM)	2,879,617	2,879,963	2,880,021	2,880,080
PM Peak (4-6 PM)	7,679,924	7,680,905	7,681,034	7,681,238
3 Peaks (5 hrs)	18,275,198	18,277,849	18,278,239	18,278,748
Daily (24 hrs)	53,165,301	53,172,363	53,173,472	53,174,759
2035				
AM Peak (7-9 AM)	10,158,211	10,158,943	10,159,062	10,159,169
MD Peak (12-1 PM)	3,809,877	3,810,507	3,810,585	3,810,684
PM Peak (4-6 PM)	10,079,756	10,081,320	10,081,564	10,081,789
3 Peaks (5 hrs)	24,047,844	24,050,770	24,051,211	24,051,643
Daily (24 hrs)	70,142,724	70,152,761	70,154,122	70,155,658

In 2012, the No Build scenario has the lowest VMT during the three peak periods as well daily, followed by Toll Low, Toll Medium, and Toll High has the highest VMT. The general trend for these scenarios is that as the toll increases, VMT follows as a result of trip diversion.

The same trend, VMT increases as tolls increase, is also exhibited in 2035.

Exhibit 5 summarizes the GHG emissions for each scenario.

Exhibit 5. OR 217 – GHG Emission Estimates (metric tonnes of CO_2e)

	No Build	Toll Low	Toll Base	Toll High
2012				
AM Peak (7-9 AM)	3,436	3,436	3,437	3,437
MD Peak (12-1 PM)	1,242	1,242	1,242	1,243
PM Peak (4-6 PM)	3,270	3,270	3,270	3,271
3 Peaks (5 hrs)	7,948	7,949	7,950	7,951
Daily (24 hrs)	23,027	23,030	23,031	23,033
2035				
AM Peak (7-9 AM)	3,650	3,650	3,651	3,651
MD Peak (12-1 PM)	1,336	1,336	1,336	1,336
PM Peak (4-6 PM)	3,447	3,448	3,448	3,449
3 Peaks (5 hrs)	8,432	8,435	8,435	8,436
Daily (24 hrs)	24,580	24,586	24,586	24,588

Because GHG emissions are largely influenced by VMT, the GHG emissions associated with each scenario follow a similar trend as the VMT – as tolls increase, trip lengths increase as a result of diversion, which increases both VMT and GHG emissions. This trend is applicable for both 2012 and 2035.

CONCLUSIONS

For both the Cornelius Pass Road and OR 217 projects, the potential benefits of higher operating speeds associated with tolling would be offset by increased VMT due to trip diversion. Although the relationship between VMT and GHG emissions is non-linear, there is a strong correlation. For both projects, each higher toll structure would result in increased VMT, which would in turn result in higher daily GHG emissions. While the amount of VMT and GHG emissions associated with each toll scenario would be less than 0.1 percent higher compared to No Build, each toll scenario showed a consistent trend for VMT and GHG emissions in 2012 and 2035 – as the toll rate increases, VMT increases as a result of trip diversion, which then increases GHG emissions.