# Technical Memorandum

Date: September 11, 2009

To: UTA, HDR

From: Kyle Cook, Robin Hutcheson, Fehr & Peers

Subject: Impact of Sugar House Streetcar on Transit Ridership, VMT, and Air Quality

The purpose of this memorandum is to provide a summary of assumptions and findings related to the change in travel patterns and corresponding vehicle emissions as a result of constructing an streetcar transit facility in Salt Lake City, and South Salt Lake City Utah. This analysis supports UTA and the Cities of Salt Lake City and South Salt Lake in preparation for application of Federal funding assistance through the American Recovery and Reinvestment Act (ARRA) Transportation Improvement Generating Economic Recovery (TIGER) grant program.

**Summary**

Fehr & Peers used results from travel demand forecasting to estimate transit ridership and the corresponding change in vehicle miles traveled (VMT) between Build and No Build scenarios. The scenario VMT was disaggregated into discrete speed bins for input into an air quality model. Fehr & Peers found that the proposed streetcar influences traveler mode choice by shifting trips to streetcar that would otherwise be made by automobile. These shifted trips represent a measurable reduction in VMT and resulting automobile emissions.

**Methodology**

Fehr & Peers completed these travel demand forecasts using the WFRC/MAG Regional Travel Demand Model, Version 6.1. Because the proposed streetcar route is relatively short, the regional travel model exhibited minimal sensitivity to local land uses and the pedestrian scale at which the proposed system will operate. In addition, regional forecasting models often underestimate the impact of added infrastructure on shorter links within the model. Therefore, Fehr & Peers applied a Direct Ridership Forecast model to supplement the regional model output.

Direct Ridership Models use multivariate regression based on empirical local data to determine the station characteristics that most influence transit patronage for light rail, commuter rail, and heavy rail. Fehr & Peers worked previously with UTA and WFRC to a customized tool using data from both agencies, and it is calibrated to the UTA system. This model is based on empirical data from the UTA TRAX light rail system. Station variables included in the model are:

- Population and employment within one-quarter mile of station
- Peak period feeder bus service level
- Population of the area fro which the station is the closest rail transit station
- Regional transit accessibility measure
- Regional automobile accessibility measure

Fehr & Peers used base- and future-year model outputs from the regional travel model to estimate changes in mode choice, including shift in trips to streetcar from automobile, bus, and

BRT. The proportion of shifted trips for each mode (relative to route ridership) was used to estimate the magnitude of shifted trips for ridership projections obtained from the Direct Ridership Forecast model. Results are shown below.

| Scenario Attribute | 2012 | | 2030 | |
|---|---|---|---|---|
| | *Trips* | *% of Trips* | *Trips* | *% of Trips* |
| Route Ridership | 2995 | | 4065 | |
| Auto trips diverted | 816 | 0.22% | 1108 | 0.30% |
| Trips diverted from bus transit | 481 | 0.13% | 652 | 0.18% |
| Trips diverted from BRT or Express Bus | 162 | 0.04% | 220 | 0.06% |
| New rail transit trips | 1545 | 0.42% | 2098 | 0.57% |
| Trips diverted from auto peak hour | 451 | 0.12% | 612 | 0.17% |
| Low income ridership | 178 | 0.05% | 241 | 0.07% |
| Pedestrian access to transit | 1448 | 0.39% | 1965 | 0.54% |
| VMT Reduction (miles) | 5,027 | | 10,225 | |
| Vehicle Emissions Avoided Daily (grams) | 2,543,769 | | 5,174,069 | |
| Vehicle Emissions Avoided Annually (grams) | 742,780,692 | | 1,510,828,043 | |
| Average Trip Length | 6.2 miles | | | |
| Travel time (transit) | 8 min. | | | |
| Percent of traffic in peak period | 20% | | | |
| Transit headways | 15 min. | | | |
| Fare policy | $1.50 for LRT, uncertain for Streetcar | | | |



VMT reductions associated with the proposed streetcar route were estimated by applying average trip length to the net decrease in automobile trips. Daily vehicle emissions were estimated for 2012 and 2030 travel conditions. Annual emissions were estimated assuming there are 292 transit operating days in a calendar year.

Vehicle emission factors are from the Caltrans Emission Factor model CT-EMFAC 2.6. CT-EMFAC is a modified version of the California Air Resource Board's EMFAC 2007 model and was chosen because, unlike Mobile 6, it is sensitive to carbon dioxide ($CO_2$) emissions as a function of travel speed. CT-EMFAC allows quantification of automobile emissions, including $CO_2$, from projects that provide congestion relief by shifting VMT into more efficient speed bins.
CT-EMFAC uses assumptions from the California Air Resources Board specific to each air basin regarding fleet mix, average annual temperature, and humidity. For the purposes of the TIGER grant application Fehr & Peers used the Lake Tahoe Air Basin parameters, which are representative of conditions in the Wasatch Front.

**Results**

The following tables illustrate VMT organized by speed bin for Build and No Build conditions for forecasts years 2005 and 2030. As shown, there is a modest increase in VMT under Build conditions as a result of the additional infrastructure and improved access to the area. However, the distribution of VMT changes such that VMT shifts from less efficient to more efficient speed bins. Results from the emissions model suggests that there is actually a **reduction in emissions** under Build conditions due to network operational improvements.

These results capture the net effect on travel resulting from the Build alternative, including increased system efficiency, transit mode shift, and induced travel demand. An additional benefit of the Build scenario is increased transit ridership; in year-2030, 4,070 riders daily will use the streetcar, with approximately 1,100 auto trips diverted as a result. Assuming an average trip length of 5.7 miles to and from the study area, a total of approximately 10,300 VMT are saved as a result of the project, which is used to calculate the following emissions in grams and tons. These calcuations are shown in the table below.

| Pollutant | Daily Saved Emission (grams)* | Annual Saved Emissions (g) | Annual Tons | Lifecycle Savings |
|---|---|---|---|---|
| TOG_exh | 3,255 | 950,515 | 1.05 | 16.62 |
| SO2 | 49 | 14,346 | 0.02 | 0.25 |
| Diesel | 203 | 59,241 | 0.07 | 1.04 |
| PM2.5 | 343 | 100,219 | 0.11 | 1.75 |
| PM10 | 373 | 108,819 | 0.12 | 1.9 |
| Nox | 12,761 | 3,726,198 | 4.11 | 65.13 |
| **CO2** | 5,086,632 | 1,485,296,422 | 1637.26 | 25,963.34 |
| CO | 70,453 | 20,572,284 | 22.68 | 359.61 |
| **Total grams** | 3,255 | 950,515 | 1.05 | 16.62 |

| EMFAC2007 Running Emissions Factors in Grams per Mile for Year 2009 Conditions in Lake Tahoe Air Basin | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Speed Bin (MPH) | Total Organic Gasses (TOG) | Sulfur Dioxide (SO2) | Diesel Particulate Matter (Diesel PM) | Particulate Matter < 2.5 microns (PM 2.5) | Particulate Matter < 10 microns (PM10) | Oxides of Nitrigen (NOx) | Carbon Dioxide (CO2) | Carbon Monoxide (CO) |
| 0-5 | 1.364 | 0.012 | 0.07095 | 0.143 | 0.155 | 2.073 | 1,267.33 | 14.409 |
| 5-10 | 0.91 | 0.009 | 0.050028 | 0.097 | 0.105 | 1.632 | 964.945 | 11.261 |
| 10-15 | 0.626 | 0.007 | 0.034782 | 0.067 | 0.073 | 1.345 | 763.085 | 9.179 |
| 15-20 | 0.461 | 0.006 | 0.025608 | 0.05 | 0.054 | 1.197 | 627.154 | 7.768 |
| 20-25 | 0.368 | 0.005 | 0.021516 | 0.04 | 0.043 | 1.122 | 538.237 | 6.801 |
| 25-30 | 0.307 | 0.005 | 0.018414 | 0.033 | 0.036 | 1.073 | 478.431 | 6.13 |
| 30-35 | 0.268 | 0.004 | 0.016236 | 0.029 | 0.031 | 1.046 | 439.881 | 5.684 |
| 35-40 | 0.245 | 0.004 | 0.014982 | 0.026 | 0.028 | 1.04 | 417.934 | 5.425 |
| 40-45 | 0.235 | 0.004 | 0.014586 | 0.025 | 0.027 | 1.054 | 410.123 | 5.344 |
| 45-50 | 0.237 | 0.004 | 0.014982 | 0.025 | 0.027 | 1.09 | 415.659 | 5.456 |
| 50-55 | 0.252 | 0.004 | 0.016104 | 0.027 | 0.029 | 1.152 | 435.275 | 5.807 |
| 55-60 | 0.282 | 0.005 | 0.018018 | 0.03 | 0.032 | 1.245 | 471.372 | 6.49 |
| 60-65 | 0.33 | 0.005 | 0.020658 | 0.034 | 0.037 | 1.382 | 528.52 | 7.672 |
| 60-70 | 0.361 | 0.005 | 0.02409 | 0.037 | 0.041 | 1.519 | 536.875 | 8.419 |
| 70-75 | 0.409 | 0.005 | 0.028314 | 0.041 | 0.045 | 1.721 | 550.068 | 9.701 |
| Source: CTEMFAC 2.6, UC Davis and Caltrans, May 26, 2008. Model Run By: Fehr & Peers, 2009 | | | | | | | | |