Federal Road Benefit Cost Analysis Narrative

Overview - Harris County staff derived forecasts for annual vehicle-hours of travel savings due to the construction of the grade separation of Federal Road at the PTRA mainline crossing. The following data sources were obtained for this purpose:

1. H-GAC travel demand forecasts for 2015, 2018, 2025 and 2040, made available as ArcGIS shapefiles – furnished as a linked file from the 2015 TIP Call for Projects web page
2. H-GAC Benefit Analysis Worksheet, Congestion/Delay Reduction – furnished as a linked file from the 2015 TIP Call for Projects web page
3. Harris County Freight Rail Grade Crossing Study, prepared by DMJM+Harris, dated July 2004 (hereinafter "2004 Grade Crossing Study")
4. October 2013 traffic count, as published within Harris County's March 31, 2014 update of the countywide traffic volumes report
5. "Federal Road Grade Separation Traffic Study: Traffic Data Collection/Summary Analysis", prepared by TEDSI Infrastructure Group, dated June 13, 2014 (hereinafter "2014 Traffic Study")

Context - Federal Road is a four-lane, median divided thoroughfare running north-south between the Washburn Tunnel and IH 10. It serves a variety of trip purposes, including tunnel through traffic, industrial traffic along the ship channel, as well as residential, commercial and industrial traffic for Galena Park.

The nature of the delay problem stems from the frequent, and often lengthy gate closures at the PTRA grade crossing. This being the case, annual vehicle hours of delay are computed directly and input within the Benefit Analysis Worksheet's "Calculations" tab. The following approach describes how these delay estimates were derived.

Methodology – From May 11 to 17, 2014, the 2014 Traffic Study collected three types of data: seven days of rail gate actuations (video recordings), five weekdays of queue length observations in feet (video recordings), and 24-hour mechanical vehicle classification counts for Tuesday through Thursday. The gate arm and corresponding vehicle queue information with summaries was appended to the Benefit Analysis Worksheet as the "Gate Arm Observations" tab.

STEP 1 – No. of gate actuations/day

From the summaries, it is first noted that the five-day average number of gate actuations was **17.2 per day**. Note here that this figure represents a significant increase from the 12 actuations per day observed in Appendix D of the 2004 Grade Crossing Study. This information will be used to compute the trend in train activity at the crossing. This growth trend should be expected to continue into the future, corresponding with PTRA's initiative to double the number of lines at this crossing location.

STEP 2 – Total hours of delay per weekday

Since the observed queue lengths are reported in feet, it was important to first convert these observations into total vehicles by approach. This was accomplished by assuming an average of 25 feet per queued vehicle, and that both lanes of each approach were occupied equally. These conversions appear in columns E and F in the Gate Arm Observations tab to the nearest hundredth vehicle.

Total Gate Closure delays for each of the observed days follows recognized computation methods for presumed normal arrivals. The particular source cited here is the Southern California International Gateway EIR (Appendix G3 Draft dated September 2011), where:

$V = ½ [(qT_G^2)/(1-q/d)]$

V = total no. of vehicle-minutes of delay

q = arrival rate in vehicles/minute

(As defined, this variable assumes a uniform arrival rate during the period of gate closure, so q is derived from total vehicles in queue and total gate down time, T_G)

T_G = gate down time in minutes

d = departure rate in vehicles/minute

(This is an average velocity of departing vehicles, to determine how quickly the queue dissipates. Vehicles are accelerating from 0 to 45 mph; assuming 25 ft per vehicle, and 20 mph average travel speed, that equates to 70 veh/min departing)

In the Gate Arm Observations tab, columns for the variables q, T_G, and V are labeled on row 21 and units are displayed in the column headers. Total daily vehicle-hours of delay are summed in column M, and the five-day average total daily delay appears in column N. This value was computed to be **161.88494 hours/day**.

As a back check on the computation method, the average delay per vehicle by approach was calculated for each gate closure instance and compared with the duration of the closure. These appear in columns O and P for the northbound and southbound approaches, respectively.

STEP 3 – AADT forecast for analysis period

Following consultation with H-GAC staff, an analysis period of 20 years was determined. This is conservatively short, given the design life of the bridge and its context in the regional transportation network. The Year 2013 bi-directional traffic volume for Federal Road published by Harris County is 21,412 vpd. H-GAC travel demand forecasts for Years 2015, 2018, 2025, and 2040 were used to develop corresponding forecast year bi-directional traffic volumes, which appear to be reasonable given the design characteristics of the road and related features. This information, which is found in column G of the "Direct Delay Calcs" tab, will be used to establish trends in roadway activity at the crossing.

STEP 4 – Compute annual delay for all years

The annual delay in hours for Year 2014 was calculated to be the average hours of delay per weekday from STEP 2 multiplied by the number of Annual Days of Travel, provided by H-GAC in cell B8 of the "Calculations" tab. This discounts delays incurred from weekend gate closures. However, it also does not take into consideration variations in travel patterns due to holidays and potential seasonal fluctuations. As such, this appears to be a reasonable simplifying assumption.

Year 2018, 20205 and 2040 annual delays were developed from applying the combined growth factors for vehicle traffic and gate actuations by year. These figures appear in column I of the "Direct Delay Calcs" tab and in the corresponding rows of the "Calculations" tab under the Annual VHT Savings heading. Intermediate years were derived on this worksheet by interpolation. The value of the delay savings were computed for years 2018 through 2038, in keeping with the 20-year analysis period from STEP 3. Project Delay Benefit/Cost Ratio is then computed using the total project budget.