

Appendix E, Curbfront Requirements

Appendix E – Curbfront Requirements

This appendix contains a description of the curbfront demand/capacity analysis and future requirements for the curbfront facilities at T. F. Green Airport that was meant for use in the requirements chapter. This analysis was based on conditions at the curbfronts prior to the attacks of September 11, 2001. New legislation by the government and regulations enacted by the FAA has resulted in changes in how curbfronts are used at U.S. airports and there may be further changes in the future. Therefore, this information is largely out of date and was removed from the chapter. It is provided here to serve as a basis for future analysis.

The terminal curbfronts serve as a gateway to T. F. Green by providing a temporary storage area for vehicles transporting passengers to and from the surrounding roadway system. The development of the curbfront facility requirements was a two-step process. The first step involved a standard demand/capacity analysis based on observations and existing conditions at T. F. Green. The second step involved an analysis of how demand changes in response to congested conditions. The results of the first step were therefore adjusted to reflect changing conditions that are expected as demand increases.

The industry standard for analyzing curbfront demand and capacity is the “Foot-Minute Methodology,” which determines the curbfront demand and capacity in units of “foot-minutes.” The demand is calculated by multiplying the number of vehicles by the vehicle length (feet) and the dwell time (minutes). The capacity is calculated by multiplying the curb length (feet) by the time in the design period (minutes). The demand is then compared to the capacity to obtain a demand/capacity ratio.

At T. F. Green the curbfront demand is a function of four components:

- The total number of vehicles using the curbfront during the peak hour
- The physical length of each vehicle type, including maneuvering space
- The average time vehicles queue at the curbfront
- The number of times each vehicle stops at the curb

The highest concentration of traffic within the peak hour is typically realized in a 20-minute increment. Therefore, in addition to calculating the peak hour demand, the peak 20-minute demand was determined, which was defined as half the peak hour demand.

As mentioned, curbfront capacity is also calculated in units of foot-minutes and is a function of the length of curb (feet), the time in the design period (minutes), and the number of lanes adjacent to the curb. The number of lanes is important because double-parking may occur in the second or third lane of a multi-lane terminal roadway. A minimum of two lanes is required to safely accommodate vehicle activity. If double-parking is not permitted, the effective curb length is equal to the linear curb

length. If double-parking is permitted, the effective curb length can reach up to 170 percent of the actual physical curb length. In cases where the unloading zone is wide enough to permit triple parking without impacting the designated through lanes, the effective curb length can reach up to 200 percent of the actual curb length. The effective curb capacity (in foot-minutes) is calculated by multiplying the effective curb length (feet) by 60 minutes to account for the peak hour or by 20 minutes to account for the peak 20-minute time period.

A demand/capacity ratio was calculated for each year by dividing the curbfront demand by its effective capacity. A demand/capacity ratio less than 0.85 represents an acceptable LOS; a ratio between 0.85 and 1.0 indicates the curb space is approaching capacity. A ratio of 1.0 or higher indicates the curb is operating in excess of its designated operational capacity. Prudent planning also dictates that facilities be planned to an 85 percent design level in order to help ensure adequate curb capacity regardless of unforeseen peaking or incidents on the curb.

E.1 Existing Conditions

The terminal building is served by a two-level roadway system. An upper level roadway serves departing passengers while a lower level roadway serves arriving passengers. The lower level roadway is split between an inner and outer roadway separated by a raised median.

The upper level terminal curb serves departing (enplaning) passengers. The upper level roadway consists of three marked lanes – two are marked through lanes and the third lane is a double lane wide enough to accommodate two lanes of parked vehicles for active passenger drop off. The drop-off zone is approximately 735 feet long and is separated from the terminal entry doors by a concrete curb. The inner drop-off lane is slightly wider to provide additional area for passengers and bags to be off-loaded from vehicles. The drop-off lane is for short-term unloading (drivers remain with their vehicles). Vehicles at the drop-off lane include automobiles, taxis, hotel/motel shuttles, parking shuttles, door-to-door shuttles, and other miscellaneous vehicles. The through lanes are for access to the curb, parking garage access, and connection to the airport loop roadway. Skycap services are provided to assist passengers with their baggage.

The lower level terminal curb serves arriving (deplaning) passengers. The inner portion of the lower level roadway consists of three marked lanes – one for active passenger pick up, which can accommodate two lanes of parked vehicles, and two through lanes. The lower level pickup lane is for short-term passenger loading by automobiles, and the on-airport parking shuttle. The through lanes are for access to the curb, parking garage access, and connection to the airport loop roadway. The pick-up lane is approximately 747 feet long and is separated from the terminal by a 21-foot wide concrete curbside sidewalk.

A raised median (approximately 43 feet wide) separates the inner three-lane and outer two-lane lower level roadways. This median narrows to 34 feet in many areas to create sheltered loading areas served by the two through lanes on the lower level roadway. These sheltered pull-off loading areas are used by taxis, hotel/motel shuttles, off-airport parking shuttles, door-to-door shuttles, the Rhode Island Public Transit Authority (RIPTA) bus, and other miscellaneous vehicles while awaiting arriving passengers. These sheltered pull-off loading areas measure approximately 420 feet long.

The lower level pedestrian crosswalks lead from the four terminal doorways across the inner and outer lower level roadways to the main short-term parking lot. Flashing lights and stop signs require traffic to stop and yield to pedestrians before proceeding across each crosswalk. All pedestrians from the main parking lot must proceed across the crosswalks of the lower level inner and outer roadways to enter the terminal, with departing passengers proceeding to the second level via interior escalators.

E.2 Existing Curbfront Demand/Capacity

Table E-1 summarizes the physical characteristics of each curbfront, and the peak hour and peak 20-minute capacities for the upper and lower levels. As shown, the effective curb length on the upper level is 70 percent greater than its length, because of double-parking. Likewise, the inner curbfront on the lower level has an effective capacity 70 percent greater than its lineal length. Overall the upper and lower level curbs provide an effective curb length of 2,940 feet.

Table E-1
CURBFRONT CAPACITY
T.F. Green Airport

	<u>Upper Level</u>	<u>Lower Level Inner Lanes</u>	<u>Lower Level Outer Lanes</u>	<u>Total</u>
Linear Length of Curb (feet)	735	747	420	2,229
Number of Lanes Adjacent to Curb	2	2	1	N/A
Outside Lane Utilization Factor	1.7	1.7	1.0	N/A
Effective Curb Length (feet)	1,250	1,270	420	2,940
Peak Hour Capacity (foot-minute)	75,000	76,200	25,200	176,400
Peak 20-Minute Capacity (foot-minute)	25,000	25,400	8,400	58,800

As explained above, the demand on a curbside is defined in terms of the number of vehicles accessing the curbside, the operating length of each vehicle type, the vehicle's dwell time, and the number of times that a vehicle stops along the curbside. Vehicle demand and dwell time data were obtained from a survey taken in October 2000 for this study (see Appendix A, *Survey Results*).

Results from the survey show that the peak hour utilization of the departure (upper level) curbside was 498 vehicles - 199 (40.0 percent) in the peak 20 minutes. During this peak period, 77 percent of the vehicles were private autos, six percent were taxicabs, and the remainder were a mixture of hotel, rental car, and parking shuttles. During this peak period, double-parking in some areas was commonplace with occasional triple-parking by vehicles stopping in the inside through lane. Approximately 15 to 20 vehicles dwelled at one time with the maximum of 30 vehicles at 6:10 a.m. The average dwell time for private automobiles was 3 minutes and 43 seconds, with the median being 1 minute and 38 seconds. Courtesy shuttle vehicles typically stopped at the curbside for less than 30 seconds to 1.5 minutes.

Peak hour utilization of the arrival (lower level) curbside was 174 vehicles - 68 (39 percent) in the peak 20 minutes. For the most part, private autos and the on-airport parking shuttles used the inner curbside (66 in the peak hour). Taxis, rental car/hotel/off-airport parking shuttles, and other assorted commercial vehicles used the outer curbside (108 in the peak hour). Approximately 85 percent of the vehicles using the inner curbside were automobiles. Approximately 26 percent of the vehicles using the outer curbside were taxis, 65 percent were shuttles, and nine percent were other types of vehicles. During the peak hour, between 15 and 19 vehicles were dwelling at the curbside. The mean dwell time was 10 minutes and 10 seconds for private autos on the inner curbside, over 13 minutes for the taxis on the outer curbside, and two to five minutes for the assorted types of shuttles. Several vehicles were observed to dwell at the curbside for more than 20 minutes.

Based on the values above, the existing upper level is experiencing approximately 15,635 foot-minutes of activity (length of vehicle plus maneuvering area, times length of time dwelling at the curbside) during the peak 20 minutes. This is beyond the effective capacity of the curbside if double-parking is not considered (12,699 foot-minutes of capacity), but only 72 percent of the effective capacity of 21,590 foot-minutes if double-parking is permitted throughout the entire length.

The existing inner roadway on the lower level is experiencing 6,277 foot-minutes of activity – well within the effective capacity of the single curbside (12,699 foot-minutes of capacity) without considering double-parking. By contrast, primarily due to the high average dwell time of the taxis and some shuttles as they wait for customers, the activity level of 9,944 foot-minutes on the outer commercial curbside actually exceeds the capacity of 8,400 foot-minutes. This indicates that some vehicles are stopping in one of the through lanes or that dwell times in the peak 20-minute period are less than the average recorded over the hour.

E.3 Future Curbfront Demand/Capacity

Future demand levels were forecast for each mode classification (vehicles, busses, taxis, shuttle vans, etc.) by developing a relationship between enplanements and curbfrent demand levels. It was assumed that the demand experienced at the curbs would grow at the same rate as originating enplanements. It was assumed that the connecting percentages for international originating enplanements would be the same as for forecast domestic enplanements. The draft forecast passenger levels used in this analysis are summarized in **Table E-2**.

Table E-2
PEAK HOUR ENPLANEMENT/DEPLANEMENT ACTIVITY
T. F. Green Airport

<u>Year</u>	<u>Originating Enplanements</u>	<u>Percent Increase From Existing</u>	<u>Terminating Deplanements</u>	<u>Percent Increase From Existing</u>
2000	1,049	N/A	947	N/A
2005	1,272	21.3%	1,176	24.2%
2010	1,517	44.6%	1,403	48.2%
2015	1,765	68.3%	1,633	72.4%
2020	2,053	95.7%	1,898	100.4%

Note: Based on draft forecasts prior to development of final forecasts.

If there is no noticeable shift in the mode split in travel to the airport and no changes to the existing dwell times by vehicle type, the peak 20-minute utilization should increase in general proportion to the increase in peak hour passengers. **Table E-3** shows projected growth in peak hour activity (based on the draft forecasts).

Table E-3
PROJECTED PEAK 20-MINUTE CURBFRONT UTILIZATION
T.F. Green Airport

<u>Year</u>	<u>Upper Level All Vehicles</u>			<u>Lower Level Private Autos</u>			<u>Lower Level Commercial Vehicles</u>		
	<u>Effective Capacity</u>	<u>Forecast Demand</u>	<u>D/C</u>	<u>Effective Capacity</u>	<u>Forecast Demand</u>	<u>D/C</u>	<u>Effective Capacity</u>	<u>Forecast Demand</u>	<u>D/C</u>
2000	21,250	15,635	0.74	21,590	6,277	0.29	7,140	9,944	1.39
2005	21,250	18,965	0.89	21,590	7,796	0.36	7,140	12,062	1.69
2010	21,250	22,688	1.07	21,590	9,303	0.43	7,140	14,379	2.01
2015	21,250	26,314	1.24	21,590	10,822	0.50	7,140	16,736	2.34
2020	21,250	30,598	1.44	21,590	12,579	0.58	7,140	19,460	2.73

Notes: Requirements were calculated based on the draft forecasts and were not updated to reflect the final forecasts.

Capacity and demand numbers expressed in foot-minutes.

The above would indicate that the upper level will be operating at an unacceptable LOS by 2005, while the commercial vehicles loading passengers and baggage on the outer roadway of the lower level already exceeds its theoretical capacity.

E.4 Adjusted Curbfront Requirements

The above analysis determined that based on operating procedures in place in 2000 and 2001, additional curb capacity would be needed in the 20-year planning horizon. However, minor changes in the operating procedures of the curbfront would allow it to serve forecast demand. The requirements identified in the first step of the analysis were therefore adjusted to reflect the following changes in utilization patterns:

- Reduce dwell times for private automobiles dropping off passengers on the upper level from nearly four minutes to 2-2.5 minutes.
- On the lower level outer commercial curb, the long dwell times for taxis could be altered by limiting the number of cabs that are permitted to queue at any one time and having the remaining cabs wait in a holding area before being called to the terminal for a pick-up. RIAC provides a holding area near the belly cargo facility so this could be easily accomplished.
- The average dwell time for door-to-door vans (nearly 17 minutes) and for the various shuttles (three to five minutes) could be reduced by providing a holding area in the vicinity of the terminal.

Many of these changes occur naturally as congestion increases. For example, average dwell times typically decline as more patrons are forced to double-park – a situation that typically encourages shorter duration for loading and unloading. As activity increases, commercial carriers and shuttle bus operators frequently change to larger vehicles rather than increase frequency. The result is shorter dwell time per person transported. Also, as congestion at terminal curbs increases, airports typically increase enforcement in order to further reduce the average dwell time. In addition, the use of rental car shuttle buses will be eliminated once the planned Intermodal Station is constructed in mid-2005, further reducing curbfront traffic.

There have been many changes in the way the curbfront operates since September 11 that have actually accelerated the implementation of the above operational procedures and improved the capacity of the curbfront. For example, vehicles are no longer permitted to stand at the curb if they are not actively loading or unloading (this is enforced by police officers and reduces dwell times). In addition, no more than three taxi cabs are permitted to queue at the curb, all others must wait in a holding area. If these conditions continue, the existing curbfront would be sufficient to serve T. F. Green virtually to the year 2020.