

APPENDIX C

# Estimated Ridership Methodology and Results

*FY 2022 - FY 2031*



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## Appendix C: Estimated Ridership Methodology and Results

This appendix explains the methodology used to estimate ridership for the proposed FY 2031 bus system (Regional Backbone, Local Priority, Coverage, and Limited/Express routes) and presents the results for weekdays, Saturdays, and Sundays. A summary of these results is presented in **Chapter 3**.

### C.1. Overview

Future-year ridership was estimated for fixed-route service (Regional Backbone, Local Priority, and Coverage service types) by estimating the ridership impact for every service change between the existing and proposed system. Three types of service changes were defined, with a separate estimation method for each: alignment changes, span changes, and headway changes. The impacts of these changes were estimated in order, starting with stop-level ridership adjustments caused by alignment changes, followed by the application of ridership demand elasticities for span and headway changes. These methods are described in further detail in the following sections.

Ridership for Limited/Express routes, including Peninsula Commuter Service (PCS) and Metro Area Express (MAX) routes, was estimated at the trip level. Ridership estimation was not conducted for service modes without proposed changes in **Chapter 3**, including demand response service, the Elizabeth River Ferry, and the Tide Light Rail.

Calendar year 2019 average weekday boardings data by stop and route served as the baseline ridership for every route. For all routes, ridership estimates were calculated separately for weekdays, Saturdays, and Sundays, according to the routes and levels of service provided on each service day. The estimates for these days were then used to find a total annual ridership estimate, based on the number of weekdays, Saturdays, and Sundays (or holidays) occurring in a calendar year.

### C.2. Alignment Changes

First, the ridership impacts of alignment changes were estimated at the stop level. In order to reflect the stops newly served or no longer served by a route due to realignment, boardings were added or subtracted from each route's baseline ridership.

For every realigned route, the existing stops served by the route before and after the proposed realignment were cataloged. From the existing alignment to the proposed alignment, there could be stops which are eliminated, stops which already exist but are being newly served by the route, or stops which are entirely new.

#### C.2.1 Stops Eliminated from a Route

Boardings at stops eliminated from a route were subtracted from the route's average daily ridership. In cases where one or more other routes were proposed to replace the route's service at a stop, those boardings were captured by those routes as described in the next section. In cases where all service to a stop is eliminated, those boardings were removed from the system entirely.

#### C.2.2 Stops Added to a Route

Boardings at existing stops added to a realigned route were estimated using the ridership from the existing routes which serve those stops. First, the realigned route captured any boardings belonging to a route that currently serves the stop but for which service at that stop (or along the whole route) is eliminated. In this way, the new route serves as a replacement for the eliminated service. At stops where no service was eliminated, all existing boardings at the stop were split proportionally between the routes according to the number of proposed daily trips (i.e., the number of proposed daily trips on each route divided by the total number of proposed daily trips across all routes at that stop).



### C.2.3 New Stops

Some proposed route alignments provide service along street segments that do not have existing HRT service. For those segments, the number of new bus stops was estimated using 1,000-foot spacing in each direction. The boardings at each new stop were then estimated using the average existing boardings per stop for the route.

## C.3. Level of Service Changes

Ridership impacts of the two types of level of service changes, span and headways, were estimated using ridership demand elasticities. These elasticities represent the change in transit demand, or ridership, caused by a change in level of service. The equation shown below demonstrates the usage of ridership demand elasticities, where  $\varepsilon$  represents the elasticity value and  $x$  represents either the span or headway.

$$Boardings_2 = Boardings_1 \cdot e^{\varepsilon \cdot \ln\left(\frac{60/x_1}{60/x_2}\right)}$$

The span elasticity value is positive, since an increase in span of service affects an increase in demand. In contrast, the headway elasticity value is negative, since an increase in headway (lower frequency) results in decreased demand. Elasticity values are calculated based on the observed effects of level of service changes on transit demand in existing fixed-route bus systems. The elasticity values used in this analysis were 0.83 for span and -0.46 for headways, which represent averages of the observed transit demand patterns of bus systems in the United States.<sup>1</sup>

### C.3.1 Span Elasticity

After estimating ridership changes due to realignments, the span elasticity was applied to each route. The total number of hours of daily service (not revenue hours) was calculated for the existing and proposed conditions. For routes with short turns, the span for the short turn and full-length segments were applied separately, according to the ridership along each segment.

### C.3.2 Headway Elasticity

Following span elasticity, the headway elasticity was applied for each route. Many routes have varying headways throughout the day, so the existing and proposed PM Peak headways were used for calculating the impacts of headway changes. In the case that PM Peak headways did not change in the proposed plan, midday headways were used to apply headway elasticity. Similar to span elasticity, routes with short turns were split into the respective boardings on each segment, with the headway elasticity applied to each segment according to the effective headway.

## C.4. Weekend Ridership

Ridership for Saturday and Sunday planned service were estimated using the same methodology as weekday estimates. However, for routes which do not currently have weekend service but have proposed service on those days, Saturday and Sunday ridership were assumed to be 50 and 25 percent of the estimated weekday ridership, respectively, based on observed ridership patterns.

## C.5. Limited/Express Routes

Future-year ridership on Limited/Express routes, including PCS routes, MAX routes, and Route 64, was estimated at the trip level. For routes with eliminated trips, the observed average daily boardings for those specific trips were subtracted from the existing route's ridership. For routes with added trips, the route's existing average boardings per trip was added for each new trip.

## C.6. Limitations

The ridership estimates in this report contain a set of uncertainties which limit their potential accuracy. A major source of uncertainty for this methodology were the exclusion of future-year socioeconomic conditions. The

<sup>1</sup> TCRP Report 95, "Traveler Response to Transportation System Changes Chapter 9—Transit Scheduling and Frequency." It is important to note that these values carry uncertainties which limit the precision of final ridership estimates.

results of this analysis are based only on existing ridership levels and the estimated impacts of changes to level of service. This approach does not employ population, employment, or land use forecasts to develop estimates, though population increases and changes in land use patterns in the Hampton Roads region may cause greater ridership increases than have been estimated. While the proposed service changes are designed to accommodate anticipated changes to land use and employment destinations, the method of using existing ridership data as a base for estimating future ridership does not account for such changes to transit demand, which may have varying ridership effects on different areas or routes within the transit network.

In addition, the impacts of service changes on each route did not affect the results for other routes, since estimates for each route are calculated independently, with the exception of realignments that shift boardings at certain stops from one route to another. Changes in waiting times for transfers may result in further ridership changes that are not reflected in these estimates.

## C.7. Estimation Results

**Table C-1** shows the existing and forecasted average daily ridership by route for the FY 2031 proposed system. Regional Backbone Routes are highlighted with a light grey background, and routes with newly introduced service are marked with “New” in the percent change column.

*Table C-1: Weekday, Saturday, and Sunday Average Daily Ridership Estimates*

	Route	Existing Daily Ridership (CY 2019)			Forecasted Daily Ridership (FY 2031)			Percent Change		
		Weekday	Saturday	Sunday	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday
Southside Total		29,825	21,419	9,725	37,804	25,950	15,550	27%	21%	60%
Southside Routes	1	2,735	1,571	823	3,832	2,808	1,863	40%	79%	126%
	2	841	351	290	958	429	342	14%	22%	18%
	3	1,745	1,255	733	2,909	1,580	1,225	67%	26%	67%
	4	347	231	145	364	231	155	5%	0%	7%
	5	238	179	0	0	0	0	Route Eliminated		
	6	661	499	123	784	528	224	19%	6%	82%
	8	1,288	1,017	525	1,916	958	867	49%	-6%	65%
	9	809	369	0	838	369	210	4%	0%	New
	11	173	118	59	204	125	78	18%	7%	31%
	12	433	292	0	586	276	146	35%	-5%	New
	13	951	644	279	1,118	719	464	18%	12%	66%
	14	357	229	0	286	213	71	-20%	-7%	New
	15	2,219	1,463	593	2,905	1,864	731	31%	27%	23%
	18	131	80	0	136	80	34	3%	0%	New
	20	3,680	2,574	1,530	4,968	3,530	2,178	35%	37%	42%
	21	1,720	1,191	555	1,936	953	699	13%	-20%	26%
	22	322	206	0	374	274	94	16%	33%	New
	23	1,227	872	377	1,416	925	686	15%	6%	82%
	24	146	101	73	236	179	50	62%	78%	-31%



	Route	Existing Daily Ridership (CY 2019)			Forecasted Daily Ridership (FY 2031)			Percent Change		
		Weekday	Saturday	Sunday	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday
	25	485	262	0	514	265	129	6%	1%	New
	26	193	130	0	354	217	88	83%	67%	New
	27	382	271	0	659	443	165	72%	63%	New
	29	315	228	0	221	158	55	-30%	-31%	New
	30	1,986	2,472	1,759	1,986	2,472	1,759	0%	0%	0%
	31	397	553	413	397	553	413	0%	0%	0%
	33	457	345	63	485	328	66	6%	-5%	4%
	35	633	686	478	633	686	478	0%	0%	0%
	36	530	301	0	1,391	844	348	162%	180%	New
	41	374	264	0	1,034	720	258	176%	173%	New
	43	174	142	0	0	0	0	Route Eliminated		
	44	423	290	105	450	316	113	6%	9%	7%
	45	1,598	1,102	509	1,713	1,381	924	7%	25%	81%
	47	932	499	217	1,240	910	458	33%	82%	112%
	50	199	118	78	339	223	73	71%	90%	-6%
	55	190	137	0	0	0	0	Route Eliminated		
	57	360	271	0	425	283	106	18%	5%	New
	58	175	108	0	198	111	0	13%	3%	New
<b>Peninsula Total</b>		<b>11,785</b>	<b>8,831</b>	<b>4,800</b>	<b>15,884</b>	<b>10,868</b>	<b>8,040</b>	<b>35%</b>	<b>23%</b>	<b>67%</b>
<b>Peninsula Routes</b>	101	829	613	369	1,541	736	776	86%	20%	110%
	102	223	125	103	0	0	0	Route Eliminated		
	103	882	682	317	983	763	311	11%	12%	-2%
	104	680	524	189	547	284	185	-20%	-46%	-2%
	105	661	540	310	860	664	316	30%	23%	2%
	106	1,130	810	474	1,472	945	628	30%	17%	32%
	107	949	765	457	860	608	399	-9%	-20%	-13%
	108	541	515	293	628	496	324	16%	-4%	11%
	109	211	161	106	1,335	797	269	534%	395%	154%
	110	480	319	204	469	319	147	-2%	0%	-28%
	111	402	290	187	762	492	293	89%	70%	57%
	112	1,687	1,378	662	3,246	2,574	2,423	92%	87%	266%
	114	1,284	1,098	473	2,190	1,697	1,663	71%	55%	252%
	115	358	211	126	923	492	306	158%	134%	143%
	116	452	233	140	0	0	0	Route Eliminated		
	117	230	71	46	0	0	0	Route Eliminated		





	Route	Existing Daily Ridership (CY 2019)			Forecasted Daily Ridership (FY 2031)			Percent Change		
		Weekday	Saturday	Sunday	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday
	118	550	367	247	0	0	0	Route Eliminated		
	120	169	131	98	0	0	0	Route Eliminated		
	64	69	0	0	69	0	0	0%	0%	0%
<b>PCS Total</b>		<b>312</b>	<b>0</b>	<b>0</b>	<b>460</b>	<b>0</b>	<b>0</b>	<b>48%</b>	<b>0%</b>	<b>0%</b>
<b>PCS Routes</b>	403	29	0	0	60	0	0	102%	0%	0%
	405	50	0	0	93	0	0	85%	0%	0%
	414	109	0	0	109	0	0	0%	0%	0%
	415	30	0	0	54	0	0	80%	0%	0%
	430	93	0	0	145	0	0	56%	0%	0%
<b>MAX Total</b>		<b>1,547</b>	<b>626</b>	<b>503</b>	<b>1,759</b>	<b>732</b>	<b>513</b>	<b>14%</b>	<b>17%</b>	<b>2%</b>
<b>MAX Routes</b>	121	48	0	0	48	0	0	0%	0%	0%
	919	80	0	0	63	0	0	-21%	0%	0%
	922	63	0	0	49	0	0	-23%	0%	0%
	960	272	170	265	249	230	233	-9%	35%	-12%
	961	725	455	238	725	455	238	0%	0%	0%
	966	92	0	0	139	0	0	51%	0%	0%
	967	222	0	0	222	0	0	0%	0%	0%
	970	0	0	0	85	0	0	New	0%	0%
	972	44	0	0	94	0	0	113%	0%	0%
	975	0	0	0	21	0	0	New	0%	0%
	980	0	0	0	64	46	43	New	New	New
<b>System Total</b>		<b>43,469</b>	<b>30,876</b>	<b>15,028</b>	<b>55,907</b>	<b>37,550</b>	<b>24,104</b>	<b>29%</b>	<b>22%</b>	<b>60%</b>