

APPENDIX C

Estimated Ridership Methodology and Results



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Appendix C: Estimated Ridership Methodology and Results

This appendix explains the methodology used to estimate ridership for the proposed FY 2030 fixed-route system, and presents the results for weekdays, Saturdays and Sundays. Ridership estimation results are presented in **Chapter 3**.

C.1. Overview

Future-year ridership was estimated for each local bus route (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 and express bus 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.

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. FY 2019 average weekday boardings data by stop and route served as the baseline ridership for every route. 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, stops were either eliminated from the route, swapped to replace the eliminated service from another route, or added to the HRT system as new fixed-route coverage.

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 stops added to a route were estimated using the ridership from existing routes which serve those stops. First, the 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, the new route was allocated an even share of the existing boardings at the stop (i.e., the total existing boardings divided by the number of routes with proposed service 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 a similar route. Similar routes were identified separately for each new road segment, based on similarities in the areas served and service characteristics between the proposed service and existing routes.

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 ϵ represents the elasticity value and x represents either the span or headway.

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

In application, 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 headways 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.¹

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, although data limitations required adaptations in the analysis. Existing weekend ridership data was not available at the stop level, so the impacts of alignment changes on the weekend could not be directly estimated in the same way as they were for weekdays. Instead, the resulting percent change in boardings from alignment changes on the weekday was applied to the existing Saturday and Sunday ridership for each route. In addition, the lack of stop-level data required that routes with short turns be calculated as a whole, instead of split into short turn and full-route segments. In those cases, the span and headway elasticities were applied to the whole route using the existing and proposed level of service on the short turn segment. Finally, for routes which do not currently have Sunday service but will in the future, Sunday ridership was assumed to be 25 percent of the estimated weekday ridership, based on existing ridership patterns.

¹ 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.

C.5. Limited/Express Routes

Future-year ridership on limited and express routes, including PCS and MAX routes, Route 64, and Route 121 (which will be reclassified as a MAX route in FY 2021), 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 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 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, limitations in the existing ridership data created uncertainty for Saturday and Sunday estimates. The lack of stop-level ridership for weekend service required the assumption that realignments cause the same relative change to weekday and weekend ridership.

Finally, 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 2030 proposed fixed-route system. Regional Backbone Routes are highlighted with a light grey background, and routes with newly introduced Sunday 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 (FY 2019)			Forecasted Daily Ridership (FY 2030)			Percent Change		
		Weekday	Saturday	Sunday	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday
Southside Total		32,001	15,021	6,749	36,803	16,201	10,552	15%	8%	56%
Southside Routes	1	3,058	1,319	740	4,425	1,909	1,531	45%	45%	107%
	2	997	278	215	810	293	239	-19%	5%	11%
	3	2,214	1,018	681	2,035	939	925	-8%	-8%	36%
	4	331	160	110	386	178	131	17%	11%	19%
	5	279	150	0	0	0	0	Route Eliminated		
	6	823	363	104	1,210	363	115	47%	0%	10%
	8	1,343	821	492	1,931	795	831	44%	-3%	69%
	9	966	306	0	966	306	0	0%	0%	0%
	11	213	76	41	213	76	41	0%	0%	0%

	Route	Existing Daily Ridership (FY 2019)			Forecasted Daily Ridership (FY 2030)			Percent Change		
		Weekday	Saturday	Sunday	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday
	12	566	265	0	753	246	0	33%	-7%	0%
	13	1,178	546	229	1,197	503	237	2%	-8%	3%
	14	465	175	0	379	140	0	-19%	-20%	0%
	15	2,543	1,179	525	2,322	1,447	688	-9%	23%	31%
	18	172	78	0	172	78	0	0%	0%	0%
	20	4,368	2,081	1,329	5,314	2,571	1,716	22%	24%	29%
	21	2,017	974	487	2,652	918	674	32%	-6%	38%
	22	348	135	0	0	0	0	Route Eliminated		
	23	1,441	711	313	1,499	495	530	4%	-30%	69%
	24	107	59	37	107	59	37	0%	0%	0%
	25	583	179	0	618	174	154	6%	-3%	New
	26	264	110	0	779	312	195	195%	182%	New
	27	436	175	0	403	143	101	-7%	-18%	New
	29	394	146	0	266	90	66	-33%	-38%	New
	30	551	605	533	551	605	533	0%	0%	0%
	31	118	161	148	118	161	148	0%	0%	0%
	33	518	247	45	518	247	45	0%	0%	0%
	35	64	70	55	64	70	55	0%	0%	0%
	36	656	269	0	1,289	537	322	97%	100%	New
	41	473	217	0	762	254	0	61%	17%	0%
	43	159	123	0	0	0	0	Route Eliminated		
	44	515	238	0	743	326	186	44%	37%	New
	45	1,711	882	441	1,742	828	652	2%	-6%	48%
	47	1,044	386	193	1,235	594	362	18%	54%	88%
	50	253	90	30	414	116	38	64%	29%	30%
	55	179	99	0	179	99	0	0%	0%	0%
	57	406	207	0	465	195	0	15%	-6%	0%
	58	251	120	0	289	132	0	15%	10%	0%
Peninsula Total		13,282	6,668	3,680	15,231	7,568	5,593	15%	13%	52%
Peninsula Routes	101	1,045	474	285	1,164	503	365	11%	6%	28%
	102	259	74	61	0	0	0	Route Eliminated		
	103	1,082	488	242	1,082	488	242	0%	0%	0%
	104	941	387	160	795	227	151	-15%	-41%	-5%
	105	769	444	248	810	468	261	5%	5%	6%
	106	1,351	627	347	1,616	542	311	20%	-14%	-10%

	Route	Existing Daily Ridership (FY 2019)			Forecasted Daily Ridership (FY 2030)			Percent Change		
		Weekday	Saturday	Sunday	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday
	107	986	555	337	879	473	320	-11%	-15%	-5%
	108	435	362	210	680	536	415	56%	48%	97%
	109	237	138	97	818	475	335	245%	243%	247%
	110	591	258	157	622	272	166	5%	5%	6%
	111	539	213	135	847	334	212	57%	57%	57%
	112	1,780	1,121	565	2,892	1,808	1,661	62%	61%	194%
	114	1,309	778	383	2,031	1,134	965	55%	46%	152%
	115	414	163	94	414	163	94	0%	0%	0%
	116	267	158	88	0	0	0	Route Eliminated		
	117	274	51	30	274	51	30	0%	0%	0%
	118	726	287	181	0	0	0	Route Eliminated		
	120	182	89	62	214	94	65	17%	5%	5%
	64	94	0	0	94	0	0	0%	0%	0%
PCS Total		284	0	0	432	0	0	52%	0%	0%
PCS Routes	403	25	0	0	49	0	0	100%	0%	0%
	405	51	0	0	102	0	0	100%	0%	0%
	414	112	0	0	112	0	0	0%	0%	0%
	415	26	0	0	51	0	0	100%	0%	0%
	430	71	0	0	118	0	0	67%	0%	0%
MAX Total		1,775	466	323	1,609	290	156	-9%	-38%	-52%
MAX Routes	121	37	0	0	37	0	0	0%	0%	0%
	919	153	0	0	145	0	0	-5%	0%	0%
	922	71	0	0	56	0	0	-21%	0%	0%
	960	269	176	168	126	0	0	-53%	-100%	-100%
	961	859	290	156	859	290	156	0%	0%	0%
	966	49	0	0	49	0	0	0%	0%	0%
	967	311	0	0	311	0	0	0%	0%	0%
	972	26	0	0	26	0	0	0%	0%	0%
System Total		47,341	22,156	10,752	54,075	24,059	16,301	14%	9%	52%