Memo

Date:	Tuesday, April 26, 2022
Project:	State Street Transit Operational Analysis (TOA)
To:	Stephen Hunt, Valley Regional Transit
From:	Lewis Kelley, HDR Tom Shook, HDR Cameron Waite, HDR
Subject:	Time Saving Results

1 Introduction

The purpose of this memo is to present findings from an analysis of potential transit travel and dwell time savings for the Route 9 bus along the State Street corridor. The time savings are generated from a set of potential capital and operational improvements packaged together as part of the Transit Operations Analysis (TOA) project.

In 2011, Valley Regional Transit (VRT) and Ada County Highway District (ACHD) prepared State Street Transit and Traffic Operations Plan (TTOP), which identified a vision for the State Street Corridor in the Treasure Valley. The TTOP included enhanced bus service on State Street and high occupancy vehicle (HOV) lanes on State Street between 23rd Street and Glenwood Street. However, the State of Idaho has not authorized implementing HOV lane operations on the corridor. Given the time it takes to implement major roadway widening projects, the ACHD is strategically adding the additional lane capacity at individual locations along the corridor, but without the HOV designation. The TOA package of improvements are designed as cost-effective and quick build near-term investments that can be made to the corridor to improve overall transit operations while taking steps toward the long-term vision for the corridor.

2 Existing Route 9 Performance

VRT Route 9 commuter bus is approximately 7 miles in length with travelling from its terminus at Gary Lane/Bunch Lane to downtown Boise. There are 22 outbound stops and 20 inbound stops. VRT Route 9 operates with 15-minute headways from 5AM through 10PM during the weekday schedule. In total, 50 inbound and outbound cycles occur over the course of the day along State Street with an average cycle length of 50.8 minutes from a bus leaving and returning to the Main Street Station. The average cycle time differs somewhat during the AM and PM peak hours, with the former averaging 50.5 minutes and the latter averaging 52 minutes, a difference of only 3 percent. PM peak period performance is slightly slower due to increased congestion during the PM peak hours.

Transit operational “heat maps” were produced using travel time and location data collected on all Route 9 buses on Tuesday, May 25, 2021. These heat maps provide key input in identifying operational bottlenecks and locations that may warrant transit priority features to improve travel time and reliability. Figure A and Figure B detail transit speeds along Route 9 from downtown Boise to Glenwood Street by location and time of day in each direction of travel. The posted speed limit on the corridor is generally 35mph or above, which corresponds with the blue in the figures below. The vertical lines made up of red colors generally correspond with transit stops. The darker and wider vertical band corresponds with longer dwell-times at a given stop.

Figure A: Outbound Route 9 50th Percentile Travel Speeds

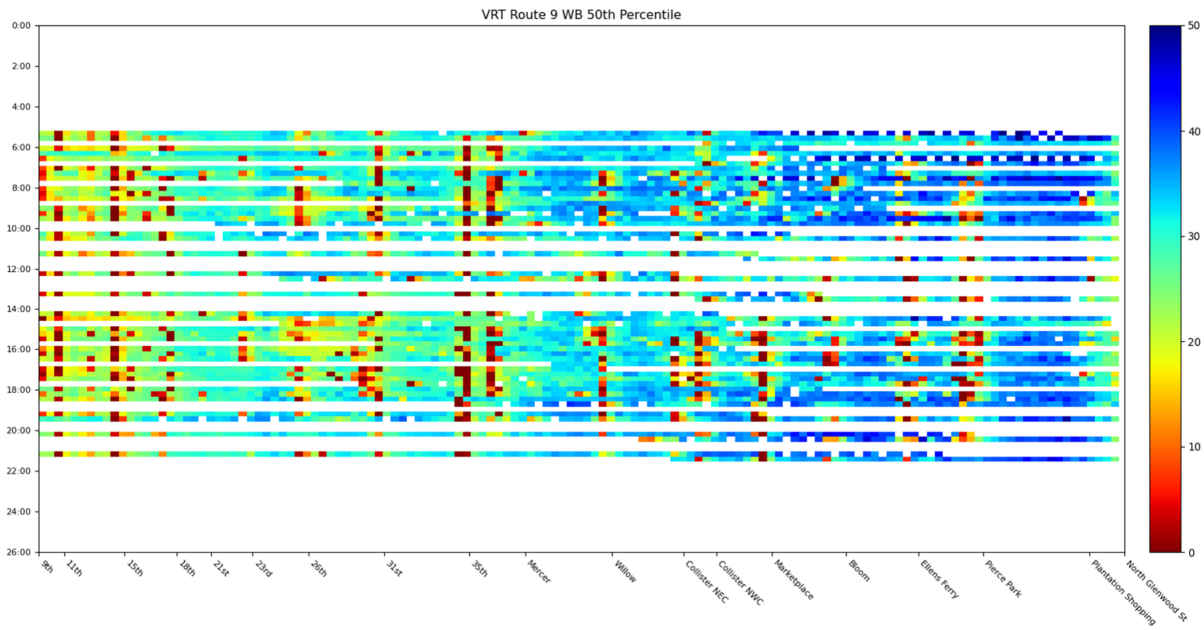
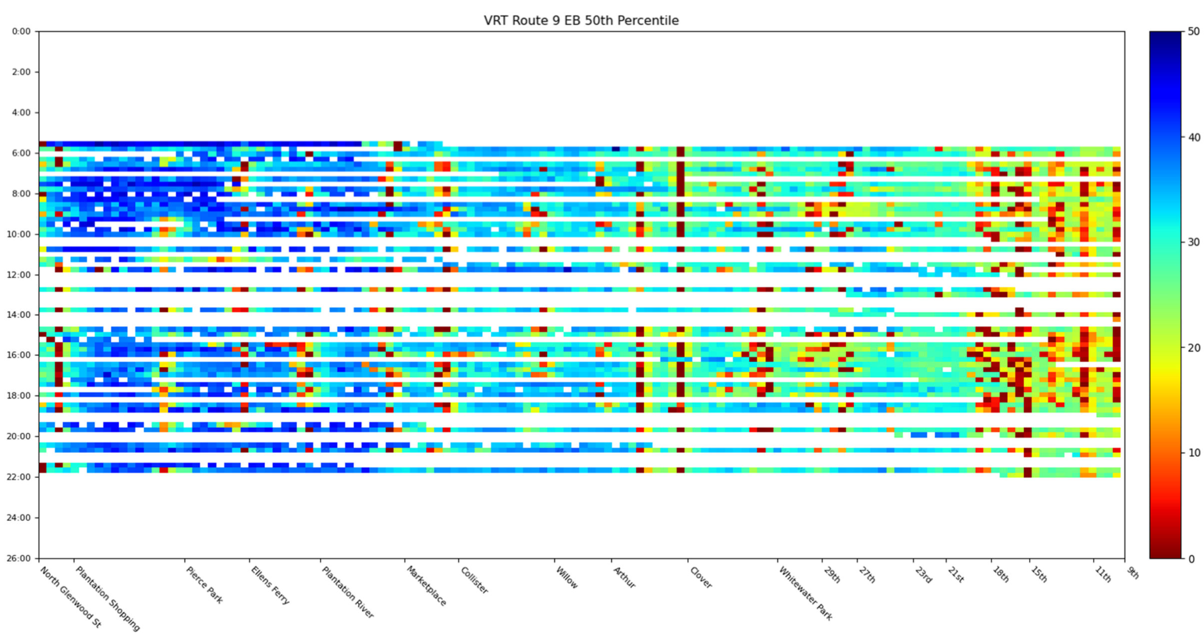


Figure B: Inbound Route 9 50^{th} Percentile Travel Speeds



Overall speeds are higher on the western half of the corridor where signalized intersections and stops are spaced further apart, more travel lanes are available, and posted speeds limits are higher. Average speeds slow east of Arthur Street as capacity on the corridor is more constrained and intersections and stops are spaced more closely together. This pattern is apparent east of 18th Street, where the downtown Boise street-grid features cross-streets spaced approximately every 400 feet.

Inbound performance is less affected by congestion levels compared to outbound performance, indicated by the higher proportion of blue and greens in Figure B, and by vertical bands of red at stops being relatively narrower, indicating shorter dwell-times and buses spending less time accessing and pulling-back into traffic. The outbound stop at 35th Street and inbound stop at Clover Drive show prominent vertical red bands, indicating all-day delay associated with the mid-route scheduled timepoint in each direction. The outbound stops at 31st, 25th, and Mercer streets show up prominently in Figure A, where the red bands at each stop become stretched horizontally. During the PM peak, the average speed dips below 10 mph for five or six pixels. The outbound stops at Marketplace Lane, Ellens Ferry Drive, and Pierce Park Lane also show up prominently in Figure A, but dwell-time impacts are less consistent throughout the day. This is likely to ridership patterns that are inconsistent throughout the day and the impact of congestion at nearby intersections.

3 Planned Transit Improvements

This section presents the planned TOA improvements and how they relate to improving the operational performance of Route 9 along State Street. Table A and Table B show the improvements planned for both the outbound and inbound journeys of Route 9 buses, respectively. The TOA process has developed a series of investments, operational changes, and stop consolidations along State Street with the purpose of improving travel times and reducing dwell-time for transit vehicles. More information on the set of improvements is available in the *State Street Corridor Operational Analysis* and the *Dwell-Time Reduction Toolkit.*

Table A: TOA Outbound Improvements Contributing to Improved Transit Operations

ID	Stop	Outbound Improvements						
		Off-Board Fare Payment	All-Door Boarding	Near Level Boarding	Far Side Stop	In-Lane Stop	Bike Behind Stop	Bus Priority
1	State 23rd	X	X	X	X	X		
2	State 27th	X	X	X		X	X	X
3	State/Whitewater/31st	X	X	X	X			
4	State/Dewey/Clover	X	X	X		X		
5	State/VMP	X	X	X				X
6	State/Willow	X	X	X	X	X		
7	State/Collister	X	X	X		X	X	X
8	State/Marketplace	X	X	X		X		X
9	State/Plantation/Bloom							

10	State/Glenwood/Gary							X
11	Gary/Bunch	X	X	X				
12	State/Saxton							
13	State/Bogart	X	X	X				

Table B: TOA Inbound Improvements Contributing to Improved Transit Operations

ID	Stop	Inbound Improvements						
		Off-Board Fare Payment	All-Door Boarding	Near Level Boarding	Far Side Stop	In-Lane Stop	Bike Behind Stop	Bus Priority
1	State/Bogart	X	X	X				
2	State/Saxton	X	X	X				
3	Gary/Bunch							
4	State/Glenwood/Gary	X	X	X				X
5	State/Plantation/Bloom	X	X	X				
6	State/Marketplace	X	X	X		X	X	X
7	State/Collister	X	X	X		X	X	
8	State/Willow	X	X	X		X	X	
9	State/VMP							X
10	State/Dewey/Clover	X	X	X		X	X	
11	State/Whitewater/31st	X	X	X				X
12	State 27th	X	X	X				
13	State 23rd	X	X	X				

3.1 Stop Consolidations

As part of the TOA process, analysis was conducted on all Route 9 stops within the project area to identify possible stop consolidation candidates. Stops that generated the lowest ridership and/or were spaced close to stops generating more boardings were examined. Analysis was careful to consider access to transit so that walk access to the Route 9 was not adversely affected. The analysis resulted in the following five stops being identified for consolidation:

- State Street/21st Street(both inbound and outbound)
- State Street/29th Street (inbound)
- State Street/Collister Drive (outbound)
- State Street/Northgate Shopping Center (outbound)

3.2 Transit Signal Priority

Transit signal priority (TSP) is a technology that allows transit vehicles and traffic signals to communicate. When a transit vehicle approaches a traffic signal with the appropriate equipment installed, the traffic signal will adjust the signal phasing to allow the transit vehicle to move through the intersection more quickly. The improvements to State Street assume a blanket implementation of TSP technology at all signalized intersections in the corridor, resulting in a conservative 5 percent constant savings to travel time for Route 9 vehicles. TSP implementation generally saves between 2 and 18 percent according to Transit Cooperative Research Program (TCRP) Report 118 depending on a corridor's characteristics. A factor on the lower end of the range was chosen because of relatively high on-time performance for Route 9 and congestion levels indicate a corridor already performing relatively well for transit vehicles; thus, TSP implementation would result in minimal benefits.

4 Methodology and Assumptions

This section provides an overview of the methods and assumptions used to develop the final time saving results for Route 9. Two analyses were conducted to produce the final time saving results: transit ridership projections and a travel-time and dwell-time savings analysis, both of which are explained below.

4.1 Ridership Projection Inputs

Travel demand is a function of the transit supply and the demand, which is linked to population and households. The analysis incorporated data and guidance from several local sources to better understand the travel demand and benefits associated with supply and demand components. National research and data from Community Planning Association of Southwest Idaho (COMPASS) supported the methodology. The assumptions were developed for a 2019 pre-pandemic scenario and an existing condition of 2022, a build model in the current condition, a horizon year of 2035 without improvements, and finally, a build condition for the 2035 year. The two build conditions included the following components.

4.1.1 Methodology for Near-Term and 2035 Ridership Projections

- Stop consolidation for five stations that improved travel time
    - Three outbound stations were consolidated
        - State Street @ 21st Street
        - State Street @ Collister Drive
        - State Street @ Northgate Shopping Center
    - Two inbound stations were consolidated
        - State Street @ 21st Street
        - State Street @ 29th Street
- Transit signal and roadway improvements, which resulted in travel time improvements.
- Collectively, travel time improved by over 3 minutes end-to-end, or 1.8 minutes for the average user (improvements outlined in Table A and Table B).
- Headway improvements included reducing AM and PM peak period headway from 15 minutes to 10 minutes.

The project team performed the following with the transit service data for 2022 and for 2035 obtained from VRT, COMPASS, and the project team.

- Verifying the alignment
- Matching stop locations with adjacent land use
- Checking location and capacity of park-and-ride lots
- Researching the competing/connecting bus service in the area
- Examining the travel time between stations (including dwell) and in-vehicle travel time into the downtown by time and direction
- Establishing the headways by time-period

Data included socio-economic data, demographic forecasts, counts, and surveys.

- Transit Counts
- 2021 COMPASS Onboard Survey
- Demographic data from COMPASS
- COMPASS Travel Model Outputs
- VRT usage data reported to the Federal Transit Administration (FTA) National Transit Database (NTD)

Analysis methodology involved researching elasticities of demand for travel time and elasticities produced by the following entities:

- Victoria Transportation Policy Institute
- American Planning Association Transportation Planning Handbook
- TCRP Research Results Digest (RRD) 61, Traveler Response to Transportation System Changes

4.1.2 Ridership Projections

The analysis examined the changes to existing 2022 and future 2035 service plan and ridership without travel time or headway improvements. The existing condition for the Route 9 was built entirely on existing ridership data and published service schedules. Mode of access to the stations was considered, focusing on walk access markets, on a park-and-ride lot, and connecting/competing bus service for the inner and outer stations. An average weekday was used as the starting point for the analysis for the near-term build alternatives. The 2022 demand is lower than pre-pandemic 2019 ridership reported by VRT, but it represented the best data set available for the near-term.

All the stations have a strong walk access market, with the terminal stop, which also has a small park-and-ride lot that is not expected to be expanded in the future. Some of the connecting/competing bus markets in this corridor include Routes 10 and 12. It was assumed that even though stops were being consolidated, the catchment area around the remaining stops was sufficient and overlapping with the removed stops to minimize any possible reduction in ridership from losing stops.

The future 2035 scenario was developed by examining the land use changes that are expected to occur in this corridor as referenced by COMPASS and the VRT Bus Rapid Transit Alternative Analysis. This corridor is anticipating significant growth, including an increase in households from 1,541 to 3,157 between 2019 and 2035. Employment and jobs are also estimated to grow from 3,829 in 2019 to over 12,595 by 2035. To estimate 2035 demand that accounts for the eventual return to pre-pandemic transit use, the 2019 ridership for the Route 9 was increased to estimate 2035 demand instead of the 2022 ridership data. This increase in households and employment create a need for travel options that the 2035 demand analysis shows exist in the future and the Route 9 helps serve.

Using research data on elasticities of demand nationally and implied from several COMPASS travel demand model tests, the relationships between travel time changes and headway changes for the peak and off-peak periods were calculated to produce weekday ridership changes by station due to the proposed improvements. The ridership demand for the Route 9 unlinked transit boardings was factored by 269 to get an annual estimate. The 269 was derived from the ratio of the 2019 VRT NTD submission for annual and weekday unlinked transit trips in the region.

The elasticity calculation was used to develop the demand for the Route 9 service with the improvements, but a mode-shift analysis was used to identify how many autos could be diverted to transit based on an appraisal of competing and connecting service. Since there was not a lot of other bus service in this corridor, a conservative estimate of 60 percent of the new Route 9 ridership was assumed to be auto diversions. A one-way travel distance of 7 miles was assumed for the route, which was then used to calculate the one-way vehicle miles traveled. Multiplying the auto diversions by the trip length helped produce the estimated vehicle miles travelled reduction. The reduced vehicle hours travelled was based on speed data along this corridor for the peak periods.

4.2 Time Savings

This section outlines and defines the travel-time and dwell-time savings reported in this memo. Two sets of time savings are considered for the proposed TOA transit improvements:

- Travel Time Savings – Travel time is any time a transit vehicle is devoted to traveling between two bus stops. Travel time improvements such as TSP and geometric transit priority treatments result in less time spent traveling along the corridor, which allows a transit vehicle to travel through a congested intersection more efficiently.
- Dwell Time Savings – Dwell time is any time a transit vehicle spends not moving at a scheduled stop to allow passengers to board and alight the vehicles. This also includes time spent accessing a stop or merging into traffic after leaving a stop as traffic congestion, or conflicts with turning vehicles that hinder a transit vehicle at stops, adding to delay.

Table C outlines the types of improvements proposed for the Route 9 bus and the categories of time savings they fall under for the purposes of this analysis.

Table C: Time Saving Investments and Categories

Time Saving Improvement	Definition	Time Saving Type	Saving Calculations
Bus Priority Lane	A travel lane used only for general purpose vehicles to turn right while transit vehicles may use the lane for through travel.	Travel Time	Synchro operations modeling
Queue Jump Lane	A short lane on the approach to a signalized intersection that is only for transit vehicles so that they may avoid vehicle congestion at an intersection.	Travel Time	Synchro operations modeling
Transit Signal Priority (TSP)	TSP is a system for transit vehicles and traffic signals to communicate that shortens the phasing cycle to speed transit operations through an intersection.	Travel Time	Synchro operations modeling
Off-Board Fare Payment	A ticketing system that allows payment of transit fares prior to boarding a transit vehicle, which saves time on passenger boardings.	Dwell Time	Per passenger savings

Time Saving Improvement	Definition	Time Saving Type	Saving Calculations
All-Door Boarding	Associated with Off-Board Fare Payment, allows for more passengers to board in a shorter period of time.	Dwell Time	Per passenger savings
Stop Consolidation	Streamlining the number of transit stops to focus on the stops that generate the most ridership. Time is saved by transit vehicles accessing fewer stops along a route.	Travel Time	Per stop savings
Far Side Stop Placement	When a near-side stop is moved to the far-side of an intersection, conflicts with turning vehicles and congestion that prevent a bus from accessing a stop are reduced.	Dwell Time	Per stop savings
In-Lane Stop	An in-lane stop allows a bus quicker access and reduced time merging back into traffic.	Dwell Time	Per passenger savings
Near Level Boarding	Near level boarding reduces boarding times and eases access for passengers with disabilities or using wheelchairs.	Dwell Time	Per passenger savings
Bikes Behind a Bus Stop	Moving bicycle traffic behind a transit platform reduces conflicts between buses and bicycles, saving time accessing a stop and when merging back into traffic.	Dwell Time	Per bike savings

4.2.1 Travel Time Savings

The travel time savings were produced using Synchro modeling software and the operational work undertaken during the State Street Corridor Transit Operations Analysis (TOA). The AM and PM peak periods in this study are from 7AM to 9AM and 4PM to 6PM, respectively. Travel time savings are calculated for two time periods, near-term and long-term implementation as described in Scenario Years (Section 4.3). The Synchro modeling software was used to generate near-term and long-term travel time savings that are a result of operational improvements at intersections. These improvements generally reduce the severity of congestion at or approaching an intersection and allow a transit vehicle to bypass congestion to move through an intersection faster. For a full accounting of the methods used in the operations modeling, please refer to the TOA memo, *State Street Corridor Operational Analysis.*

Future analysis year 2035 travel times savings account for demographic and traffic growth along the corridor. COMPASS provided future travel demand model data to compute future traffic volume inputs. Generally, traffic is estimated to grow on State Street at a rate of about 1.5 percent between 2021 and 2035, except between Whitewater Park Boulevard. and Gary Lane/Glenwood Street, where traffic is estimated to grow at about 2.5 percent. Because of planned roadway widening and other operational improvements along the corridor, future transit travel time savings are discounted compared to near-term benefits, as the package of TOA improvements will have relatively more impact under today's more congested conditions compared to future conditions.

4.2.2 Dwell Time Savings

The dwell time saving factors were created as part of the TOA *Dwell-Time Reduction Toolkit*. For the toolkit, a series of dwell-time reduction improvements were reviewed and selected that would fit the State Street corridor and help meet the operational objectives of improving transit operations VRT set for the corridor. A review of available research was then conducted to find accepted time-saving factors for each of the elements of the toolkit. Table D outlines the time saving factor used for each of the improvements outlined in Table C. The complete information on the Dwell-Time Reduction Toolkit and referenced research is available in the accompanying time saving spreadsheets.

Table D: Applied Dwell-Time Reduction Factors

Time Saving Improvement	Saving Calculations	Time Factor (sec)
Off-Board Fare Payment	Per passenger savings	5
All-Door Boarding	Per passenger savings	1
Stop Consolidation	Per stop savings	20
Far Side Stop Placement	Per stop savings	5
In-Lane Stop	Per passenger savings	0.5
Near Level Boarding	Per passenger savings	1
Bikes Behind a Bus Stop	Per bike savings	0.5
TSP	Constant	5% of travel time

The dwell time savings are calculated using several different methods but are primarily calculated on a per-passenger basis. Because many of the dwell time reduction improvements make the passenger payment and boarding process more efficient, a time value is applied to each passenger at a stop where improvements are planned. VRT provided average daily ridership at each stop, which was used to calculate the dwell time savings for those improvements calculated on a per-passenger basis.

The dwell-time improvements for stop consolidation and far-side placement are both calculated on a per-stop basis; therefore, each has a constant value for each instance along the corridor. The savings from placing bikes behind a bus stop occur when a bike and bus are no longer in conflict while a bus is pulling into or out of a bus stop. These are calculated using a probability that a bus and bike will meet at a given stop based on the Route 9 schedule and limited bike counts available along the corridor.

4.3 Scenario Years

The time saving analysis were calculated for two separate time periods:

- Near-term benefits assume implementation with existing 2021 traffic volumes, roadway configurations, transit operations, and transit ridership.
- Future Year 2035 benefits assume implementation with future population and traffic volume growth, 2035 transit operations that include reduced headways in the peak hours, and increased roadway capacities as outline in the *State Street Corridor Operational Analysis.*

4.4 Near-Term Benefits

The near-term time savings were calculated for the corridor and assume the listed improvements in Table A and Table B implemented under existing 2021 conditions. To calculate total time savings, ridership at each transit stop is a required input for most of the dwell-time reduction strategies. Ridership data was collected from VRT spanning the 2019 and 2022 operation years. A blend of pre- and post-COVID-19 ridership was created to simulate partial recovery of ridership to pre-COVID-19 levels in the 2022 modeling year.

Travel-time savings and dwell-time savings are combined to create the total time savings for the Route 9 bus. The travel-time savings were provided by Fehr & Peers, using the Synchro traffic operations software to calculate delay and level of service (LOS) measures at each study intersections. A full explanation of the methods used in the Synchro modeling is available in the *State Street Corridor Operational Analysis* memo. Total time savings are reported for each intersection or stop-pair and aggregated to the extent of the bus route.

4.5 Future Year 2035 Benefits

The second set of time saving calculations are for the future year 2035 and assume a growth in transit ridership based on two factors. The first growth factor is consistent with the COMPASS growth factors in their regional travel demand model and take into account population and employment growth. The second factor is a set of transit ridership projections that use the base time savings calculated for the 2022 modeling year to establish a rate of inducement attracting new transit riders from other modes as a result of improved operations. Both factors are explained in detail below.

5 Ridership Projection Results

The analysis examined three years (2019, 2022, and 2035) and two build alternatives. The Route 9 commuter bus is approximately 7 miles in length with travelling from its terminus at Gary Lane/Bunch Lane to downtown Boise. It operates at 15-minute headways in the peaks between 5:15AM and 9:39PM on weekdays. Travel times vary slightly depending on direction and time-period, but generally ranges from 20 minutes to 25 minutes. There are 22 outbound stops and 20 inbound stops.

The 2019 pre-pandemic scenario had approximately 810 boardings daily, with a little more than half going outbound when compared to the inbound direction. Many of the bus stops attract between 20 to 30 boardings daily with three attracting more than 40 boardings daily. The pandemic has reduced ridership for a variety of reasons, including telecommuting, changes in workforce, and transit attractiveness has been reduced to being in a confined space with other passengers. The 2021 daily boardings were 530 and the 2022 daily boardings were 470. These numbers are likely to improve with time, but it may take a few years to get back to 2019 pre-pandemic levels. The changes in demand associated with the pandemic are shown in Table E and Table F. Table G highlights the automotive impacts as improvements in transit operations are predicted to divert auto mode trips to transit.

The Route 9 travel time improvements associated with the near-term 2022 findings resulted in 2.6 to 3.4 minutes of improvement in-vehicle travel time for the entire route depending on direction and time-period. When the peak period headway is improved from 15 minutes to 10 minutes in conjunction with travel time improvements, boardings increase by 14.5 percent. Annually, these improvements lead to an increase in Route 9 ridership of 8,800 for travel time improvements to 18,500 for both travel time and headway improvements. Of these new transit riders to the Route 9 service, between 5,300 and 11,100 were estimated as auto diversions which resulted in an annual reduction of between 37,000 and 77,500 vehicle miles travelled (VMT).

The Route 9 travel time improvements associated with the 2035 findings resulted in 2.6 to 3.7 minutes of improvement in vehicle travel time for the entire route depending on direction and time period. This translates into approximately between 1.3 and 1.8 minutes of travel time benefit for the average rider. When the peak period headway is improved from 15 minutes to 10 minutes in conjunction with travel time improvements, boardings are estimated to increase by 13.4 percent. Annually, these improvements could lead to an increase in Route 9 ridership of 39,700 for travel time improvements to 82,000 for both travel time and headway improvements. Of these new transit riders to the Route 9 service, between 23,800 and 49,200 were estimated as auto diversions, which resulted in an annual reduction of between 166,800 and 344,500 VMT.

Table E: Travel Demand Results: Transit Boardings

Route 9	Boardings					
Alternative	2019 Base	2021 Base	2022 Base	2022 Bld	2035 Nbld	2035 Bld
Daily						
Westbound Summary	445	307	278	318	1,335	1,514
Eastbound Summary	366	224	195	223	934	1,060
Total	811	531	473	541	2,269	2,574
Delta				69		305
Percent Change				14.5%		13.4%
Annual						
Westbound Summary	119,682	82,511	74,662	85,641	359,046	407,292
Eastbound Summary	98,465	60,269	52,465	59,949	251,333	285,104
Total	218,147	142,781	127,127	145,590	610,379	692,396
Delta				18,463		82,017
Percent Change				14.5%		13.4%

Table F: Travel Demand Results: Transit Metrics

Route 9	Transit Metrics	
Alternative	2022_Bld	2035_Bld
Change in Daily		
Linked Transit Trips	41	183
Unlinked Transit Trips	54	241
Change in Annual		
Linked Transit Trips	11,078	49,210
Unlinked Transit Trips	14,623	64,958

Table G: Travel Demand Results: Auto Metrics

Route 9	Automotive Metrics	
Annual Auto Benefits	2022_Bld	2035_Bld
Auto Diversions	11,078	49,210
VMT Reduction	77,546	344,473
VHT reduction	2,915	14,413

6 Time Saving Results

6.1 Near-Term 2022 Time Savings

Table H and Table I present time savings results for an individual outbound and inbound cycle of a Route 9 bus during both the AM and PM peak periods. Total cycle savings during the AM period are estimated at 5.6 minutes while PM period savings total 7.2 minutes. This estimate is 28 percent higher when compared to the AM period due to the PM period experiencing more overall congestion and thus greater travel-time benefits from the package of improvements. Dwell-time savings stay relatively constant between the two periods. An average outbound/inbound cycle during the AM and PM period ranges from 50.5 minutes to 51.9 minutes, equating to an average cycle savings between 11 percent and 13 percent.

Table H: Near-Term Average Per Bus Peak Period Outbound Time Savings

ID	Stop Location	Near Term Time Savings (min)*			
		Travel Time Savings		Dwell Time Savings	
		AM Peak	PM Peak	AM Peak	PM Peak
1	State/23rd	-	-	0.10	0.10
2	State/27th	0.05	0.15	0.02	0.03
3	State/Whitewater/31st	-	-	0.10	0.10
4	State/Dewey/Clover	-	-	0.01	0.02
5	State/VMP	0.05	0.10	-	-
6	State/Willow	-	-	0.10	0.11
7	State/Collister	0.05	0.15	0.02	0.03
8	State/Marketplace	0.05	0.15	0.05	0.07

ID	Stop Location	Near Term Time Savings (min)*			
		Travel Time Savings		Dwell Time Savings	
		AM Peak	PM Peak	AM Peak	PM Peak
9	State/Plantation/Bloom	-	-	-	-
10	State/Glenwood/Gary	0.05	0.10		
11	Gary/Bunch			0.10	0.13
12	State/Saxton	-	-	-	-
13	State/Bogart	-	-	-	-
Stop Consolidations (3 outbound)				**1.00**	**1.00**
TSP Implementation (5% constant on travel time)		**1.00**	**1.25**		
Total Travel Time Savings		**1.25**	**1.90**		
Total Dwell Time Savings				**1.50**	**1.58**
**All savings reported in minutes, for a single, directional transit run.*					

Table I: Near-Term Average Per Bus Peak Period Inbound Time Savings

ID	Stop Location	Near Term Time Savings (min)*			
		Travel Time Savings		Dwell Time Savings	
		AM Peak	PM Peak	AM Peak	PM Peak
1	State/Bogart			0.08	0.10
2	State/Saxton			0.14	0.19
3	Gary/Bunch			-	-
4	State/Glenwood/Gary	0.05	0.10	-	-
5	State/Plantation/Bloom			0.11	0.15
6	State/Marketplace	0.05	0.15	0.12	0.16
7	State/Collister	0.05	0.15	0.08	0.11
8	State/Willow			0.06	0.09
9	State/VMP	0.05	0.10	-	-
10	State/Dewey/Clover	0.10		0.15	0.20
11	State/Whitewater/31st			0.03	0.05
12	State/27th	0.05	0.15	0.03	0.05
13	State/23rd			0.01	0.02
Stop Consolidations (2 Inbound)				**0.67**	**0.67**
TSP Implementation (5% constant on travel time)		**1.00**	**1.25**		
Total Travel Time Savings		***1.35***	***1.90***		
Total Dwell Time Savings				***1.50***	***1.77***
**All savings reported in minutes, for a single, directional transit run.*					

Table J presents time savings during both the cumulative two-hour AM and PM peak periods and for a full day of Route 9 operations along State Street. Cumulative time savings total 44 minutes in the AM period and 53 minutes during the PM period, equating to 11 percent and 13 percent savings, respectively. Most of these savings, 66 percent during the AM period and 55 percent during the PM period, come from stop consolidations and TSP investments at intersections along the entire corridor. The three intersections with improvements generating the greatest time savings include 27th Street, Collister Drive, and Marketplace Lane. Combined, these intersections are projected to generate 11 percent and 20 percent of overall time savings during the AM and PM periods. Marketplace Lane generates the most savings for a single stop, totaling 6.5 minutes for both the AM and PM periods. This is in part due to its balanced inbound and outbound ridership profile that generates consistent ridership, and thus savings, throughout the day.

Table J: Near-Term Cumulative Daily and Peak Period Time Savings

ID	Stop	Near-Term Benefits		
		Total Daily Time Saving (min)	Time Saving Benefit (min)	
			AM*	PM*
1	State/23rd	4.87	0.88	0.94
2	State/27th	8.36	1.21	2.96
3	State/Whitewater/31st	7.15	1.84	1.17
4	State/Dewey/Clover	4.38	1.32	1.76
5	State/VMP	5.22	0.80	1.60
6	State/Willow	6.36	1.32	1.55
7	State/Collister	9.66	1.60	3.47
8	State/Marketplace	11.60	2.19	4.25
9	State/Plantation/Bloom	2.95	0.89	1.17
10	State/Glenwood/Gary	5.22	0.80	1.60
11	Gary/Bunch	2.61	0.79	1.04
12	State/Saxton	3.85	1.15	1.55
13	State/Bogart	2.04	0.61	0.81
Stop Consolidations		83.33	13.33	13.33
Transit Signal Priority (TSP)		95.29	15.15	15.57
Total Transit Travel Time Savings		**252.92**	**43.86**	**52.79**
Average Transit Cycle Time (Round Trip)		**50.82**	**50.5**	**51.9**
Existing Transit Travel Time (Total/AM/PM Peak)		**2541**	**404**	**415.2**
Transit Travel Time Savings %		**9.95%**	**10.9%**	**12.7%**
** Travel time benefits are reported for the entire, two-hour AM and PM peak periods.*				

6.2 Future Year 2035

Table K and Table L present time savings results for an individual outbound and inbound cycle of Route 9 bus during both the AM and PM peak periods in the 2035 year of operation. Total cycle savings during the AM period are estimated at 8.2 minutes while PM period savings total 10.4 minutes. This is 26 percent more compared to the AM period due to the PM period experiencing more overall congestion and ridership, thus greater overall savings from the package of improvements. Compared to the near-term time saving benefits, the projected 2035 savings are approximately 50 percent greater. This is due to projected ridership increases by 2035 leading to the improvements returning larger dwell-time saving benefits in the future. With the improvements in place, 2035 ridership is projected to by grow by a factor of 4.5 compared to 2022 ridership as shown in Table E.

Travel-time savings will decrease slightly compared to the near-term benefits as other capacity and operational improvements to the corridor will reduce the impact of congestion on bus travel-time performance. As stated above, dwell-time savings are responsible for the growth in time savings, with total dwell-time savings doubling between the 2022 baseline and 2035 years.

Table K: 2035 Average Per Bus Peak Period Inbound and Outbound Time Savings

ID	Stop Location	2035 Time Savings (min)*			
		Travel Time Savings		Dwell Time Savings	
		AM Peak	PM Peak	AM Peak	PM Peak
1	State/23rd	-	-	0.14	0.16
2	State/27th	0.035	0.09	0.11	0.15
3	State/Whitewater/31st	-	-	0.15	0.17
4	State/Dewey/Clover	-	-	0.18	0.24
5	State/VMP	0.035	0.06	-	-
6	State/Willow	-	-	0.18	0.21
7	State/Collister	0.035	0.09	0.02	0.02
8	State/Marketplace	0.035	0.09	0.23	0.30
9	State/Plantation/Bloom	-	-	-	-
10	State/Glenwood/Gary	0.035	0.06	-	-
11	Gary/Bunch			0.33	0.44
12	State/Saxton	-	-	-	-
13	State/Bogart	-	-	-	-
Stop Consolidations (3 outbound)				**1.00**	**1.00**
TSP Implementation (5% constant on travel time)		**1.00**	**1.25**		
Total Travel Time Savings		**1.18**	**1.64**		
Total Dwell Time Savings				**2.34**	**2.71**
** Travel time benefits are reported for the entire, two-hour AM and PM peak periods.*					

Table L: 2035 Average Per Bus Peak Period Inbound Time Savings

ID	Stop Location	2035 Time Savings (min)*			
		Travel Time Savings		Dwell Time Savings	
		AM Peak	PM Peak	AM Peak	PM Peak
1	State/Bogart			0.08	0.10
2	State/Saxton			0.62	0.83
3	Gary/Bunch			-	-
4	State/Glenwood/Gary	0.035	0.06	-	-
5	State/Plantation/Bloom			0.06	0.07
6	State/Marketplace	0.035	0.09	0.55	0.74
7	State/Collister	0.035	0.09	0.06	0.09
8	State/Willow			0.35	0.47
9	State/VMP	0.035	0.06	-	-
10	State/Dewey/Clover	0.07		0.67	0.89
11	State/Whitewater/31st			0.17	0.23
12	State/27th	0.035	0.09	0.17	0.23
13	State/23rd			0.07	0.09
Stop Consolidations (2 Inbound)				**0.67**	**0.67**
TSP Implementation (5% constant on travel time)		**1.00**	**1.25**		
Total Travel Time Savings		***1.25***	***1.64***		
Total Dwell Time Savings				***3.47***	***4.41***
** Travel time benefits are reported for the entire, two-hour AM and PM peak periods.*					

Table M presents time savings during both the cumulative two-hour AM and PM peak periods and for a full day of Route 9 operations along State Street in the 2035 year of operation.

Table M: 2035 Cumulative Daily and Peak Period Time Savings

ID	Stop	Near-Term Benefits		
		Total Daily Time Saving (min)	Time Saving Benefit (min)	
			AM*	PM*
1	State/23rd	7.66	1.69	2.02
2	State/27th	12.27	2.31	3.08
3	State/Whitewater/31st	12.04	2.60	3.25
4	State/Dewey/Clover	23.13	6.75	9.00
5	State/VMP	3.31	0.56	1.44
6	State/Willow	16.42	4.24	5.44
7	State/Collister	6.63	0.66	0.88
8	State/Marketplace	25.74	6.24	8.32
9	State/Plantation/Bloom	1.52	0.44	0.59
10	State/Glenwood/Gary	3.31	0.56	0.96
11	Gary/Bunch	9.10	2.65	3.54
12	State/Saxton	17.03	4.96	6.62
13	State/Bogart	2.10	0.61	0.82
Stop Consolidations		83.33	13.33	13.33
Transit Signal Priority (TSP)		110.53	22.73	23.36
Total Transit Travel Time Savings		**334.11**	**70.34**	**82.64**
Average Transit Cycle Time (Round Trip)		**50.8**	**50.5**	**51.9**
Existing Transit Travel Time (Total/AM/PM Peak)		**2948**	**606**	**622.8**
Transit Travel Time Savings %		**11.3%**	**11.6%**	**13.3%**
** Travel time benefits are reported for the entire, two-hour AM and PM peak periods.*				

Cumulative time savings in the AM period total 70 minutes and 83 minutes during the PM period, equating to 12 percent and 13 percent savings, respectively. Most of these savings, 52 percent during the AM period and 44 percent during the PM period, come from stop consolidations and TSP investments at intersections along the entire corridor. The three intersections with improvements generating the greatest time savings include Dewey Street/Clover Drive, Marketplace Lane, and Saxton Drive due to increased boardings at these locations. Combined, these intersections are projected to generate 26 percent and 29 percent of time savings during the AM and PM periods.