Future Year Model Sensitivity Testing Overview

Start: November 11, 2020 Last Revision: January 7, 2021

Overview

Seven sensitivity tests of the SKATS Regional Travel Demand Forecasting Model were conducted in November and December 2020. These tests were undertaken to measure the responsiveness of the model when different 'levers' are changed that would be expected influence the model output as measured by a **range of metrics**. The metrics used for these tests include the number of trips produced (both by income and total). calculated mode split, the vehicle miles traveled (**VMT**), vehicle hours of travel (**VHT**), vehicle hours of delay (**VHD**).

For planning purposes, SKATS develops a 2043 household and employment forecast and allocation (using information on vacant and underutilized land and Comprehensive Plan designations) which is considered as inputs to the 2043 SKATS "base case" travel model. Each sensitivity test described in this paper focused on changing ***one*** input used in the base case to create a new scenario -- to understanding how changing that input would affect travel in the SKATS area[1].

In order to test how far an input "lever" might need to be modified in order to see a measureable change in the model outputs, for this testing we went far beyond what we might realistically expect to see, as far as land use and transit service in Salem-Keizer by 2043. For the scenarios where we altered the land use inputs, we ignored whether there were available vacant or underutilized land that could accommodate the increased densities and just assumed that those housing and employment densities could exist for the scenario.

The other major factor to keep in mind is that the changes made to the scenarios only have an affect to trips that have both ends within the SKATS area. No changes were made to the external trips (trips where one trip-end is inside SKATS and the other end is outside SKATS) and through trips (e.g., trips on I-5 that go through the area). Because external trips make a large contribution to overall VMT, this must be kept in mind.

Tests

The following tests were implemented. (Test 1 corresponds to scenario 1, etc.):

1. Household Size stratification is changed so that Household size 1 (HH1 – one person) and HH4 (4+ person households) are more (40% each) and HH2 (two-person) and HH3 (three person) are less (10% each)
    a. This test was meant to see what would happen if there is a bifurcation of the size of households to the one-person household (HH1) and the large family household (HH4)
    b. **NOTE: Due to the way the model inputs are structured, it is not clear if this was actually what was tested. We are not showing the results of this test.**

[1] In reality a single change would never occur. Supporting actions would happen, whether due to public, private or joint action. These will be explored in the next stage of testing.

2. Income Size stratification is changed so that Income size 1 (I1 under $25k[2]) and I4 (greater than $100k) have more households (I1 = 50%, I4 = 30%), while reducing the number of households in I2 ($25k – $50k) and I3 ($50k - $100k) by10% each.
    a. This was to test what happens if in the future the household income is mostly in either the lowest (I1) or the highest (I4) brackets. This follows the discussion that the middle class is disappearing.
    b. **NOTE: Due to the way the model inputs are structured, it is not clear if this was actually what was tested. We are not showing the results of this test.**

3. This scenario represents a significant increase in residential density adjacent to the core transit network. All new single-family households (i.e., 24,500 total households forecast to be created within SKATS from 2017 to 2043) are developed as duplexes near transit lines with 15-minute service (note: these are the transit lines that had 15-minute service in 2019). The growth in multi-family (non-duplex) households remained the same as the base case. See **Map 1**, which shows the allocation of the 24,500 households placed along 15-minute transit service.
    a. The discussion on the 'missing middle' housing and the directives of HB2001 are explored here.
    b. Only household locations are changed, no employment or transportation related modifications were made.

4. For this scenario, the forecasted new housing (24,500 single family households) units were placed in the TAZs with existing high employment, representing a scenario with greater mixed residential and employment areas. The forecasted multi-family growth is placed in TAZs as in the base case (i.e., according to the current comprehensive plans). See **Map 2**.

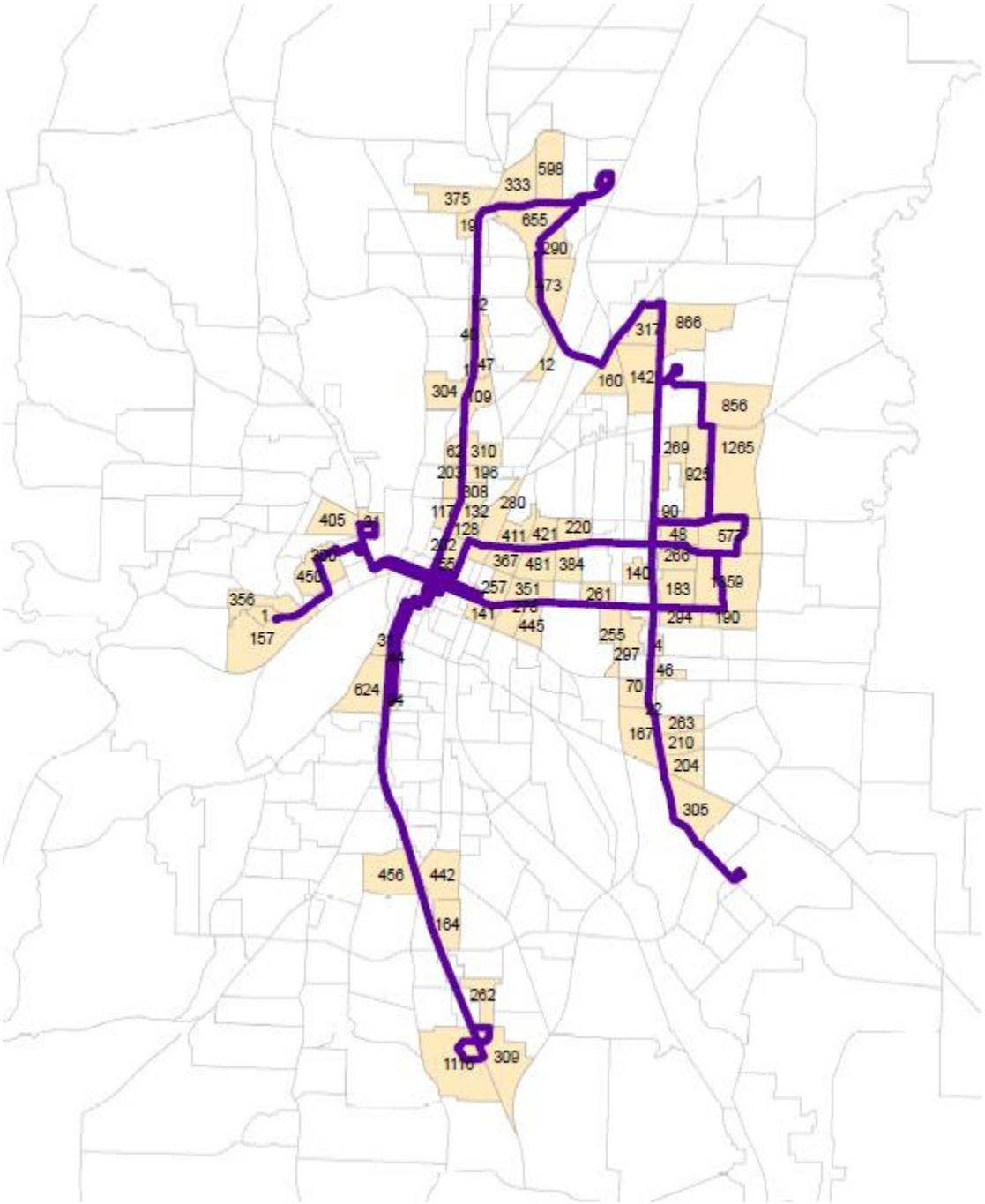
5. Using the 2043 base allocation of households and employment, the frequency for all transit routes was decreased to 10-minute headways, with a maximum seated capacity of 40 people and "crush load" of 80 people.
    a. The transit network was not changed in any other way – stops and routes are as they are in all the other scenarios, including the base 2043.

6. Reflecting changed travel patterns in 2020 due to the COVID pandemic, including a shift of a sizeable fraction of jobs to working from home, this scenario was to test that working from home and more online shopping would continue in 2043. The percentage reduction in trips are based on professional judgement and some reporting of trends in 2020.
    a. Home-Based Work (HBW) trips are reduced by 15 percent, Home-Based Shopping (HBS) trips are reduced by 10 percent, and Non-Home-Based Non-Work (NHBNW) trips are increased by 5% (to account for presumptive increase in delivery vehicles of all types).

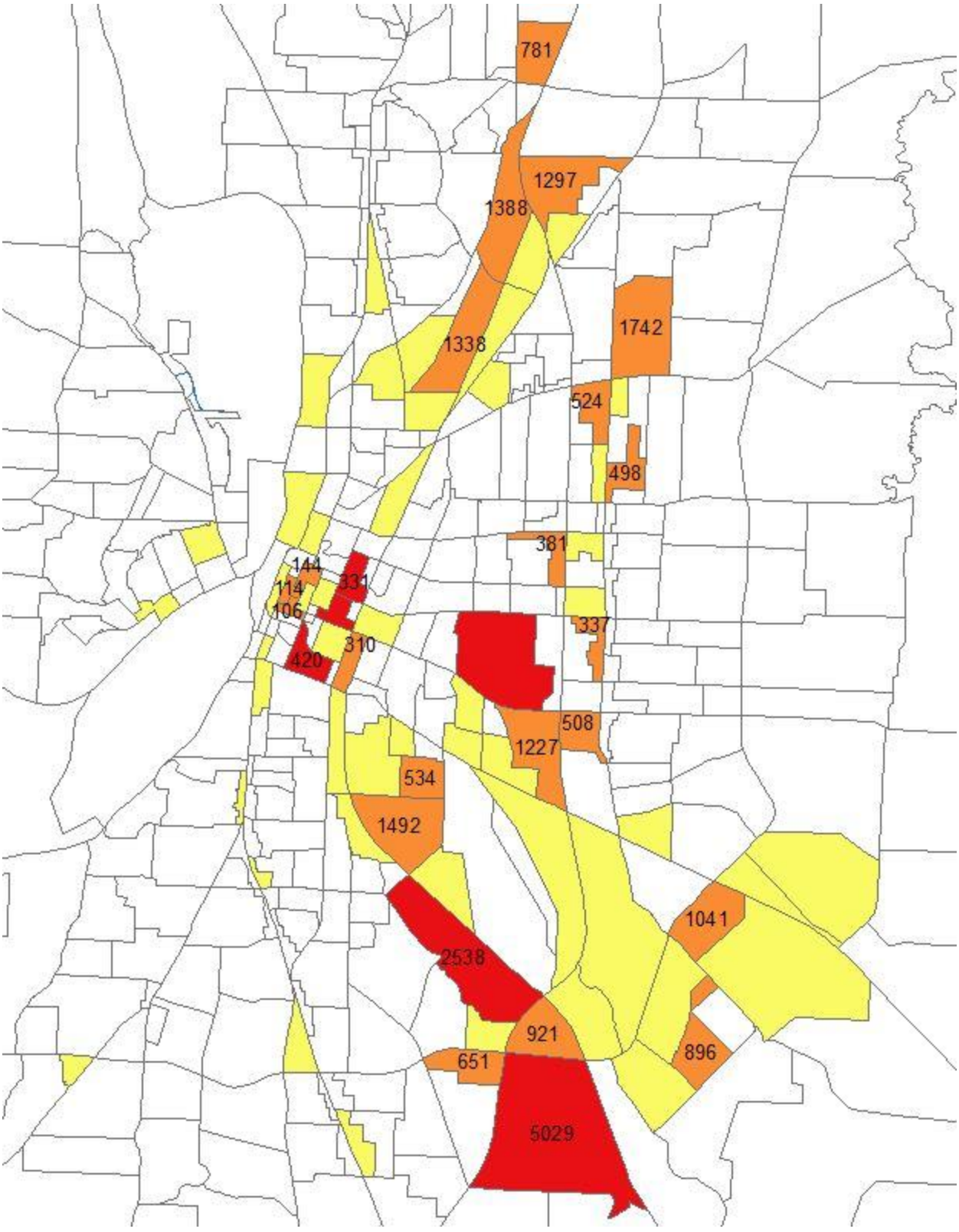
7. Using the same approach as Test 3 (i.e., increasing residential densities along transit lines) but modifying which TAZs are selected for the 24,500 single family households. Equal number of

[2] In 2010 dollars

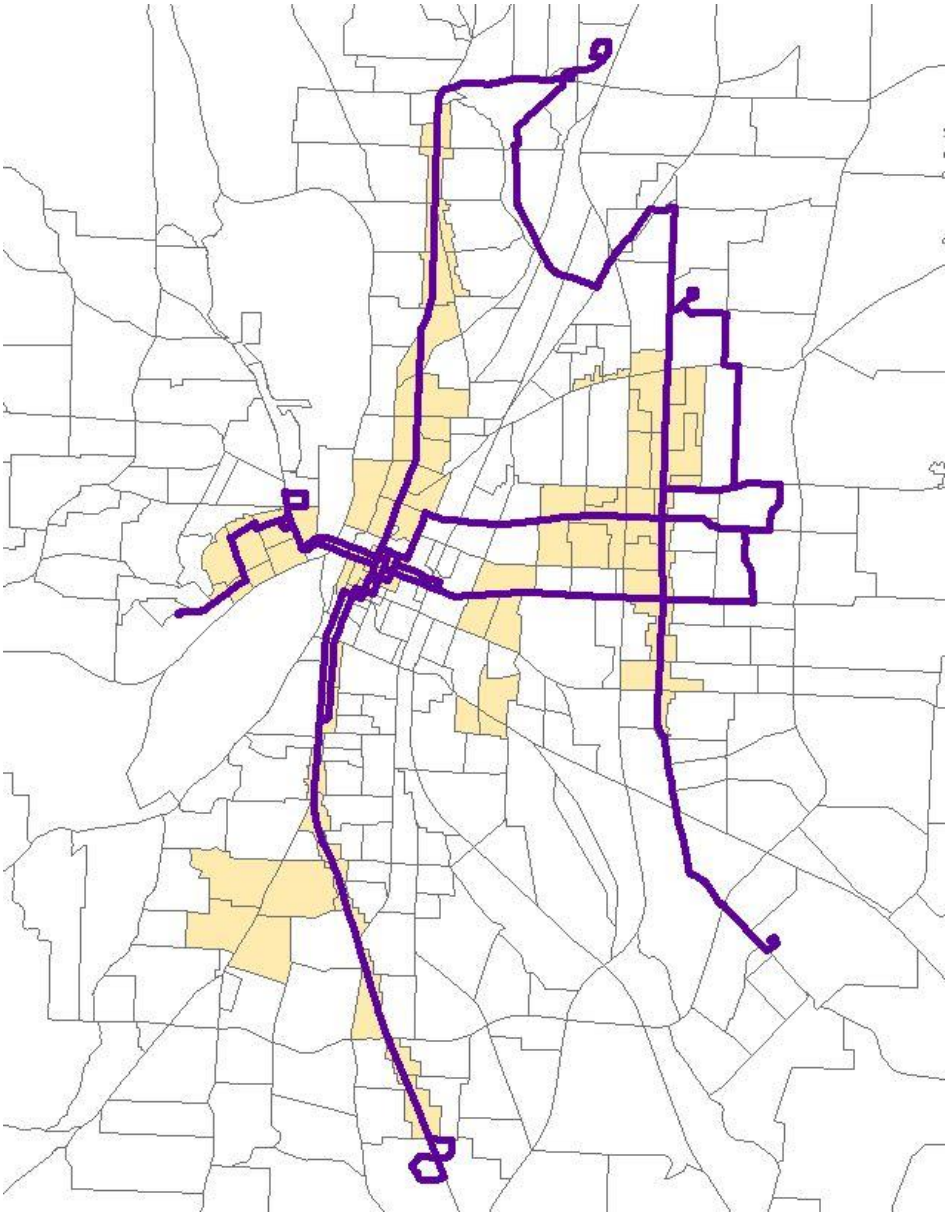
these households were placed in each selected TAZ, and multi-family households remained the same as the base case. See **Map 3**.



Map 1: Scenario 3 - Transit Routes and TAZs with new Households (as duplexes) added in proportion to existing Households



Map 2: Scenario 4 - TAZs with Highest Employment ***(new SF housing added to areas in red and orange only)***



Map 3: Scenario 7 - Transit Routes and TAZs with Growth in SF Households Distributed Equally in Highlighted TAZs

To summarize:

Test 3: Growth in SF households developed as duplexes and put in TAZs that are adjacent to 15-minute transit. Allocated in proportion to the number of households existing in thoseTAZ.

Test 4: Growth in SF households placed in TAZs with existing high employment (more mixed use).

Test 5: 2043 Base allocation, but all transit routes have 10-minute headways, with greater bus capacity.

Test 6: 15% less commute trips, 10% less shopping trips, 5% more home delivery trips.

Test 7: Growth in SF households equally allocated to selected TAZ that are adjacent to 15-minute transit (using a different set of TAZs for the location of households.)

Results

Table 1: Total Daily Trips (by Income Split)

Daily Trips	Low Income	Medium Income	High Income	TOTAL	Change from Base
Base	537,569	439,573	255,347	1,232,489	
Test 3	504,254	425,398	252,032	1,181,684	-4.1%
Test 4	541,214	435,178	254,662	1,231,054	-0.1%
Test 5	537,554	439,545	255,345	1,232,444	0.0%
Test 6	524,462	427,318	248,366	1,200,146	-2.6%
Test 7	529,788	436,296	256,763	1,222,847	-0.8%

Table 2: Mode Split Results

	Base	Test 3	Test 4	Test 5	Test 6	Test 7
Drive Alone	44.3%	43.9%	44.1%	43.9%	43.5%	43.5%
Drive w/Passenger	15.6%	15.0%	15.5%	15.4%	15.7%	15.2%
Bike	1.1%	1.2%	1.1%	1.1%	1.1%	1.1%
Bus	1.4%	1.8%	1.6%	1.9%	1.4%	1.7%
Park & Ride	0.1%	0.2%	0.1%	0.2%	0.1%	0.1%
Passenger Only	25.0%	25.1%	25.1%	25.0%	25.4%	24.8%
School Bus	2.9%	2.8%	2.9%	2.9%	3.0%	2.9%
Walk	9.6%	10.2%	9.6%	9.5%	9.8%	10.6%
TOTAL	100%	100%	100%	100%	100%	100%

Table 3: VMT/VHT/VHD Results (change from the Base scenario – includes both internal and external trips)

	Test 3	Test 4	Test 5	Test 6	Test 7
VMT	-4.7%	-3.3%	-0.4%	-3.0%	-4.3%
VHT	-17.6%	-7.0%	-1.4%	-12.6%	-15.4%
VHD	-23.4%	-4.0%	3.7%	-15.4%	-19.6%

Table 4: VMT/VHT/VHD Results (change from the Base scenario – Internal Trips Only)

	Test 3	Test 4	Test 5	Test 6	Test 7
VMT	-10.9%	-7.5%	-0.8%	-7.6%	-10.4%
VHT	-23.2%	-8.0%	-1.4%	-13.7%	-20.9%
VHD	-47.5%	-8.5%	-2.6%	-26.2%	-42.3%

Discussion of Results

The preceding tables (above) show the results of the sensitivity tests for the scenarios created.

Caveats: Before examining the results, three important caveats should be kept in mind:

1. Travel models attempt to capture a personal behavior (travel) that is quite complex. Each individual's determination of how much to travel, where to travel, and which mode to use are based on that individual's situation and needs. A travel model attempts to capture this behavior using algorithms that have limitations and that aggregate households into matrices of numbers.
2. That the increase in population, households and employment from 2019 to 2043 (about 85,000 persons or 31,800 households[3], and 36,000 jobs) that was altered for most of these scenarios is only a portion of the "baked-in" 2017 population, households and employment (about 261,000 persons or 98,800 households, and 115,000 jobs). Because the tests primarily vary the location and type of only the new households (i.e., growth from 2017 to 2043) there is only so much change that can be expected in the results.
3. As noted on page 1 of this memo and a critical point in this discussion, we initially reported the metrics for all trips, i.e. internal trips, external trips, and through trips. These are shown in Tables 1, 2, and 3. To better understand how the scenarios impacted internal trips, we created Table 4 to show the change VMT, VHD, VHT for internal trips, which are reported in the discussion below.

Results

- In **Test 3** and **Test 7**, housing and employment are more accessible to each other (due to being adjacent to 15-minute transit service) as well as physically closer. This increased the number of transit and walking trips. It also resulted in the largest decrease in the Vehicle Miles Traveled (VMT); a 10.9% and 10.4% decrease in internal VMT for Test 3 and Test 7, respectively.

[3] Of which, approximately 24,500 are forecast to be single-family households.

- **Test 4**, which placed new single-family households in existing employment areas, resulted in a tiny decrease in the number of trips and no change in mode splits. It did decrease internal VMT by 7.5 %.[4]

- **Test 5**, which increased transit frequencies only, increased the share of transit trips compared to the base (1.4% for the base, 1.9% for test 5).[5] However, internal VMT decreased only 0.8 percent.

- **Test 6** -- which made assumptions of continued work-at-home (therefore less commute trips), less shopping trips but more home-delivery trips -- reduced internal VMT by 7.5 percent but had very little effect on mode split.

Additional Considerations

When looking at the results, it is important to remember, that in real life, changes such as those tested are never made in isolation to other changes; denser housing would be placed near transit, efforts made to create shopping options nearby and perhaps parking controls would be put in place. The synergy of these efforts should be greater than any of the individual efforts. This will be explored in future work where two or more of the above scenarios are combined.

As mentioned above, the underlying equations used by the SKATS Travel Model are based on self-reported travel diaries from a sample of the population within Salem-Keizer-Turner. The last survey was conducted in 2010 and might not represent the attitudes of the traveling public today given changes that have happened. This can be fleshed out with two examples: Telework and Transit.

In 2010, telework was used by 1-2 percent of all workers, with some fields and some workers more likely to use this 'mode'. Growth in the use of telework had been slow and steady for decades. Newer technology allowed a better 'work from home' experience, but the main constraint was the existing work culture. During the COVID pandemic many of the objections from the work culture point-of-view were eclipsed by issues of safety. As a result, this percentage exploded while still being mostly limited to a handful of industries and types of workers. Whether this becomes the new norm and a permanent option for more workers remains to be seen. The current base 2043 model does not take into consideration a sizeable percent of workers working from home. The results from Test 6 show that removing workers from the need to travel does have an impact of the overall system. Future work be carried out to better understand who can use this option and at what level is reasonable[6].

During the period when the 2010 household travel survey was being conducted, the transit system in Salem-Keizer was in flux. The main transit center was being renovated to address structural issues with

[4] It is surprising that walking trips didn't increase in this test.

[5] Conceptually, greater transit ridership would likely be forecast if synergistic actions were taken to increase the coverage of the bus system, to decrease the travel time (by using green light extensions or dedicated lanes) and, for those traveling to the Capitol Mall area, to increase parking cost and reduce the supply.

[6] E-commerce use has also increased substantially during the pandemic. What that means for the future of shopping is another open question.

the buildings, resulting in moving the location several times and changing the amenities available. In addition, funding for operations was decreasing due to failures at the ballot box. Service was offered only during the work week. With the added revenue from employee taxes, in the last year or two this has changed: Cherriots started to provide service on Saturdays and for increased hours during the work week, and there are plans to introduce Sunday service once the pandemic is under control. By expanding the hours of service and the days of service, transit becomes a viable option for more people who travel outside of the traditional 9 A.M. to 5 P.M. Monday through Friday work period. Finally, more people have smartphones with data plans that allow them to be engaged or productive during periods of travel, something that was not always possible before[7]. Coupled with real-time arrival information this could encourage more people to try and use transit in the future.

With these caveats in mind, the results presented should be considered a 'floor' to the amount of change that may take place.

Other factors that have not been tested include:

- **Parking cost**: The short-term and long-term cost of parking is often discussed as a way to encourage people to adjust either the mode they use or their destination. Currently the only areas with parking controls exist are within Salem downtown and the Capitol Mall area. Parking cost information is used in the Destination Choice model. Testing by other agencies has shown that parking controls need to be systematic and region-wide to have the most effect. When limited to a small area and in a region with other areas with no parking controls, in general people will travel to those parts of the region without the parking controls.

- **Fleet considerations**: When considering metrics beyond VMT, VHT and VHD, such as vehicular emissions, it is important to have information on what the composition of the fleet of vehicles in use in the region will be in the horizon year. Until recently the assumption in air quality modeling has been that the fleet will be powered by petroleum products (i.e., gasoline and diesel) and the only difference between today and twenty years in the future could be attributed to changes in the Corporate Average Fuel Economy (café) standard[8]. However, with the rapidly decreasing cost in batteries and the increasing range and options available to consumers, it is reasonable to forecast that future fleets will include a growing percent of electric-powered vehicles. To the extent that Electric Vehicles become a sizeable fraction of the vehicle fleet in the region, this decouples the current assumption that VMT and emissions are linked[9]. The current model does not include information on the vehicles being used, and thus cannot estimate vehicular emissions; a separate program (such as ODOT's VisionEval) would be required.

- **Operating Costs**: One common question is how the model takes into consideration fuel prices and the general cost of operating a vehicle. Within the model there is an assumed operating cost based on information from AAA for the year of the latest household survey. Currently this value is around $0.12 per mile. It is assumed to stay constant over the 20 years that is being

[7] SAMTD is in the process of equipping all their buses with Wi-Fi.
[8] Granted increases in the CAFÉ standard have stalled under the Trump Administration.
[9] It is to be determined what percent of the vehicle fleet needs to be EVs to have a noticeable impact.

modeled. While the actual cost of gasoline or diesel may increase over 20 years, as the price increases people will be motivated to replace their vehicles with ones that have better fuel economy (with or without the CAFÉ standards)[10]. Thus, the operating cost will stay roughly constant over time. However, this does not take into consideration discontinuous changes in operating costs that are possible with EVs (and which are seen to a lesser degree in PHEV 'hybrids'). The current cost to operate an EV is much less than a petroleum fueled vehicle, often half as much. As more people purchase EVs this will encourage manufacturers to offer more models, reduce the purchase price due to manufacturing at scale, and likely improve the range (which will make the vehicles attractive to more people continuing the cycle). How this influences the behavior of people in regards to how much they travel remains to be seen. The two obvious possibilities are that they either drive the same amount and keep the savings for other uses, or they increase the amount they drive to spend the same amount as they would if they were not using an EV.

- Side note 1: It is this cost savings that are one of the motivations for fleet operators (delivery services, taxi/TNC operators, etc.) to transition to EVs. They reduce their operating costs, plus the maintenance of EVs is lower due to less moving parts. It is likely that these fleet operators will be using fully EV fleets years before the general public has completely switched over.
- Side note 2: EVs also have a distinct advantage over petroleum fueled vehicles in that the owner can install solar panels (or wind turbines etc.) and produce the needed electricity at home. Further reducing the operating costs.

[10] And it is not guaranteed that the price of fuel will consistently increase over 20 years. As was the case from 2000 to 2020, there will be fluctuation in the price of fuel. In the case of the period from 2011 to 2021, the price started at ~$3.10 per gallon (regular gas) and ended at ~$2.50 per gallon, with a high of ~$4.25 in 2012 and a low of $1.82 in 2016 (see www.gasbuddy.com/charts).