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1. INTRODUCTION

An important objective of Access Ohio 2040 is to ensure that the Ohio Department of Transportation (ODOT) has the resources to anticipate and respond to the congestion challenges that will arise as the state continues to grow and change in the coming decades. Congestion is a signal that the demand for transportation and the supply in a particular place and time are out of balance; it decreases productivity and causes frustration. It reduces air quality and can add to the risk of accidents and incidents. These impacts can have negative economic, social, and quality of life consequences and that is why ODOT and the State devote a great deal of time and resources designing and implementing ways to alleviate and manage congestion.

2. CONGESTION FORECASTING PROCESS

This technical memorandum profiles current and future congestion on Ohio’s state highway system, including the system as a whole, as well as several of its regions and roadway types. The source of this information is ODOT’s congestion management system (CMS), which uses traffic data and forecasting techniques to catalog existing traffic conditions and to identify potential future traffic issues. ODOT also uses the CMS to help create infrastructure improvements and policies to address congestion issues, and to understand the implications of growth in travel demand over time. The CMS process produces daily travel demand, congestion, and delay estimates for all roadways on Ohio’s statewide system. The CMS process produces traffic volume and congestion estimates for the current year, 3 years into the future and a long-range forecast for 2040.

2.1 Mobility and Congestion Terms

The transportation community uses a handful of terms to describe roadway travel and congestion conditions. Some of the most commonly used ones are:

1. **VMT (vehicle miles of travel):** VMT describes the level of travel demand on a highway system; growth in VMT indicates growth in travel demand. VMT is a weighted measure of travel, and it is calculated by multiplying the number of vehicles on a roadway segment by its length. To estimate VMT for an individual roadway element (such as the interstate system) or for individual areas (such as a county), the vehicle-miles for that element or area are simply added up.

2. **Congestion:** As noted, congestion describes the relationship between roadway supply and demand. When demand exceeds supply, traffic slows and sometime stops altogether. The volume (demand) to capacity (supply) ratio is a common measure of congestion for individual roadway segments.

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¹ This discussion includes all state roads, including Federal-aid routes and non Federal-aid routes that are state-maintained.
There are two types of roadway congestion. The routine congestion that occurs on a regular, predictable basis is the type of congestion that we describe and measure here. The type of congestion that is caused by accidents and incidents is unpredictable and is very difficult to forecast. For that reason, it’s not discussed here.

3. **Delay**: The amount of additional travel time needed to reach a destination, over and above the time needed when there is very light traffic and no congestion. Delay is measured in hours.

4. **Level of Service (LOS)**: A letter grade (from A to F) that describes traffic congestion conditions. Like school grades, “A” is excellent and “F” is failing. LOS A-C describes increasingly higher levels of vehicle density and increasingly greater restrictions in the ability to maneuver freely, but no delay. At LOS D there is little freedom to maneuver, and few additional vehicles can be added to the system without causing delays. LOS E describes unstable flow conditions, in which traffic slows and delays are evident, and sudden lane changes or braking maneuvers can cause undesirable ripple effects throughout the traffic stream. Lastly, LOS F describes a range of conditions, from stop and go, to gridlock.

Most DOTs strive to maintain a LOS D (acceptable) or better. Specifically, ODOT strives to maintain a LOS D or greater in urban areas and a LOS C or greater in rural areas. At LOS E, traffic starts to slow down.

### 2.2 Recent Trends in Demand for Highway Travel in Ohio

The number of vehicles on Ohio’s roadway system is driven by a few key factors: the number of households and workers, the number of businesses, general economic conditions, and consumer preferences. The growth in travel demand in Ohio has been generally consistent with national trends as a whole, but there are also some key differences.

Figure 1 shows the growth in travel demand on all roadways in Ohio and the U.S. between 2000 and 2011. The U.S. trend line (right-hand scale) shows that demand increased rapidly between 2000 and 2007. Since the 2008 recession, year-to-year demand has generally decreased and at 2011 fell below the levels recorded in 2004. Ohio (left-hand scale) has seen relatively flat demand over the 12-year period, and the effect of the recession is noticeable. Between 2000 and 2007, Ohio’s traffic grew at about 0.8 percent per year compared with 1.5 percent annually for the U.S. as a whole. In fact, VMT in Ohio began its decline in 2006, before the recession was officially announced, and continued to 2008, when it fell below 2003 levels. Since 2007, traffic in Ohio has grown very slightly, at 0.3 percent annually, while for the U.S. as a whole, traffic growth has decreased by 0.7 percent annually. By 2010, Ohio had surpassed 2004 levels of demand; VMT in 2011 marked the highest recorded level of demand in the state over the 12 year period.
2.3 Future Demand for Highway Travel in Ohio

Growth in the demand for travel on Ohio’s roads is forecasted to increase slightly compared to trends since the 2008 recession, and the State’s interstate system will absorb most of that growth. According to the CMS, traffic on the interstate system will grow at an average annual rate of 0.8 percent, as compared to 0.5 to 0.6 percent for the arterial and the local/collection systems, respectively (see Figure 2). This implies that traffic, at least on the interstate system, will return to pre-recession levels of low to moderate growth. The higher level of growth in the interstate system reflects the role it plays in serving both intercity and national traffic, especially long-distance truck travel.
2.4 Growth in the Supply of Roadway Capacity

The supply of roadway capacity is often measured in terms of lane miles, which is simply the total length of a roadway system multiplied by the number of lanes, segment by segment. The growth in Ohio’s roadway system between 2012 and 2040 is derived from the state’s 4-year Transportation Improvement Program, which identifies a set of roadway improvements for which funding has been identified. While the projects may be initiated within the next four years, they may not be completed. There is a modest amount of roadway capacity growth that is in this pipeline, as shown in Figure 3 below; however, this growth does not include large capital improvement projects from ODOT’s Transportation Review Advisory Council program. The nine-member Transportation Review Advisory Council assists the DOT in developing a project selection process for the state’s largest investments.

Figure 3: Growth in Ohio State-maintained Roadway System Capacity from Ohio’s 4-Year Program

According to the improvements identified in the 4-year program, ODOT will proportionally direct more funding to its high-capacity system in the coming years. While the system as a whole is estimated to grow 1.6 percent, the interstate system is projected to grow 2.9 percent (in terms of lane miles of capacity), with arterial roadways and local/collector roads projected to grow 1.2 percent and 0.5 percent, respectively.

3. CHANGE IN CONGESTION AND DELAY

The forecasted growth in demand for travel in Ohio’s state roadway system will cause congestion and delay to increase by 2040. To gauge the likely growth of congestion between 2012 and 2040, the CMS process forecasts congestion trends assuming no growth in roadway (including the 4-year program), transit or rail capacity. This section presents the change in congestion and delay by measuring:

- The distribution of VMT by level of service
- Hours of delay
- Volume-to-Capacity ratio
3.1 VMT by Level of Service

Figure 4 presents the distribution of vehicle miles of travel by level of service category for two years, 2012 and 2040. LOS E to LOS F++ denotes the range of congested conditions, with LOS E corresponding to roadways experiencing some reduced speeds and LOS F++ meaning that there is far more traffic than can be served by the roadway, which results in traffic at a complete standstill for an extended period of time. As noted earlier, the Department has set LOS C as the threshold congestion standard for rural roads, and LOS D as the standard for roads in urban areas. As Figure 4 shows, travelers on the 2040 roadway system will experience significantly worse levels of service compared to 2012, with higher levels of LOS E, F, and F++ traffic conditions. Thirty-five percent of the 2040 network travel is forecasted to occur in LOS E or worse conditions, compared to 17 percent of 2012 network travel.

Figure 4: Estimated VMT by Level of Service on the Ohio State-maintained Roadway System, 2012 and 2040

3.2 Hours of Delay

Congestion causes delay, which has a direct effect on system efficiency, traveler frustration, and productivity. Congestion delay can be measured by the additional travel time needed to reach a destination, beyond the time it would take if there were no congestion.

Figure 5 presents a comparison of total vehicle hours of travel (VHT) on the state system for 2012 and 2040. The portions of the chart bars colored in red represent the congested component of statewide travel. The chart shows that, while modest increases in VHT are forecasted, the amount of travel that occurs in congested conditions will increase significantly. Total travel on the interstate system, as measured by VHT, is forecasted to increase by 5 percent between 2012 and 2040; however, congested travel is projected to increase by more than a factor of 4, to 13 percent of all travel. The arterial system will see more modest increases in congested VHT but higher growth in travel demand.
Between 2012 and 2040, VHT is predicted to increase by 19 percent, while the time spent in congestion on the arterial system will increase by a factor of 1.6, which represents 7 percent of arterial travel.

**Figure 5: Daily Vehicle Hours of Travel and Delay on Interstate and Arterial Components of Ohio State-maintained Roadway System, 2012 and 2040**

3.3 Volume-to-Capacity Ratio

Every roadway segment has a unique set of characteristics that influences how many vehicles it can accommodate in a given period of time. These characteristics include the number of lanes, lane width, number of intersections and driveways, as well as the mix of trucks and autos in the traffic stream. For Access Ohio 2040, segment (non-intersection) congestion and delay above a volume-to-capacity (V/C) ratio of 1.0 is considered congested. A V/C ratio of 1.0 is the point at which the number of vehicles exceeds what the roadway can accommodate.

A relatively small portion of the state roadway system accounts for the roadway delay and congestion that travelers encounter. **Table 1** shows the distribution of the state roadway system mileage by volume-to-capacity ratio. In 2012, 163 miles of roadway experienced recurring congestion (as defined by a volume-to-capacity ratio exceeding 1.0). By 2040, that number is forecasted to increase to 560 miles, and much of that increase will occur on the State’s highest capacity component, the interstate system.

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2 The Department’s volume to capacity threshold for congestion is 0.9 for the entire state except for Cincinnati, Columbus and Cleveland, where it is 1.0.
Table 1: Ohio State-maintained System Roadway Mileage, by Volume-to-Capacity Ratio, 2012 and 2040

<table>
<thead>
<tr>
<th>V/C Ratio</th>
<th>2012</th>
<th>2040</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mileage</td>
<td>Percentage</td>
</tr>
<tr>
<td>0.00-0.50</td>
<td>17121.8</td>
<td>89.2%</td>
</tr>
<tr>
<td>0.50-0.75</td>
<td>1431.0</td>
<td>7.5%</td>
</tr>
<tr>
<td>0.75-0.90</td>
<td>310.5</td>
<td>1.6%</td>
</tr>
<tr>
<td>0.90-1.0</td>
<td>158.7</td>
<td>0.8%</td>
</tr>
<tr>
<td>1.00-1.10</td>
<td>51.4</td>
<td>0.3%</td>
</tr>
<tr>
<td>1.10-1.20</td>
<td>40.4</td>
<td>0.2%</td>
</tr>
<tr>
<td>1.20-1.30</td>
<td>49.0</td>
<td>0.3%</td>
</tr>
<tr>
<td>1.30-1.40</td>
<td>22.4</td>
<td>0.1%</td>
</tr>
<tr>
<td>1.40-1.50</td>
<td>0.0</td>
<td>0.0%</td>
</tr>
<tr>
<td>&gt;1.50</td>
<td>0.0</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

3.4 Congestion Locations

For the most part, congestion on state routes is limited to the urbanized areas. However, according to the CMS forecasts (which assume no highway capacity additions and reflect modest, though continued growth in population and employment), congestion will increase in the locations experiencing delay today, and grow outward to additional areas further away from the core of the urbanized areas. These forecasts can be interpreted as an indication of the congestion-related mobility needs that are likely to require management through some combination of traffic operations, roadway or multimodal capacity, or travel demand management investments in the future.

Figure 6 shows the current (2012) average peak hour congestion levels around the state. Congested roadway segments (those showing an LOS of E or worse for urban areas or D or worse for rural areas) are concentrated in the major urbanized areas of Toledo, Akron, Cleveland, Columbus, Cincinnati, and Dayton. For the most part, congestion is concentrated along the interstate segments in and around these developed areas. Columbus and Cincinnati experience the most extensive levels of congestion, corresponding to the peak transportation demands generated from everyday commuting.

Figure 7 presents the state system 2040 forecast traffic conditions. It shows congestion intensifying and extending outwards beyond urbanized area boundaries. Segments of the beltway around Columbus and the interstate system in Cincinnati at the border with Kentucky are forecasted to experience very high levels of congestion. Rural and suburban areas, outside of the interstate system that serves the State’s urbanized areas, are predicted to experience congestion as well. For example, the forecasts indicate that regular traffic bottlenecks are likely to occur on I-75 in the Toledo area, and I-71 between Columbus and Cleveland.

The growth in congestion statewide between 2012 and 2040 is shown in Figure 8. There are very few locations that show the same or lower congestion levels in 2012 as compared to 2040, so the 2040 map (Figure 7) and the difference map (Figure 8) are virtually identical.
Table 2 presents the distribution of current and future VMT by Level of Service for 4 major urbanized areas in the state. For these areas (Cincinnati-Dayton, Cleveland-Akron, Columbus and Toledo) congested travel, especially travel at LOS F or worse, is forecast to more than double by 2040.

### Table 2: VMT by Level of Service 2012 and 2040 (Thousands of Daily VMT)

<table>
<thead>
<tr>
<th>LOSA-D</th>
<th>2012</th>
<th>2040</th>
<th>2012</th>
<th>2040</th>
<th>2012</th>
<th>2040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cincinnati-Dayton</td>
<td>1,715</td>
<td>1,233</td>
<td>2,352</td>
<td>2,126</td>
<td>795</td>
<td>569</td>
</tr>
<tr>
<td>Cleveland-Akron</td>
<td>575</td>
<td>676</td>
<td>731</td>
<td>774</td>
<td>501</td>
<td>367</td>
</tr>
<tr>
<td>Columbus</td>
<td>95</td>
<td>396</td>
<td>76</td>
<td>286</td>
<td>214</td>
<td>235</td>
</tr>
<tr>
<td>Toledo</td>
<td>458</td>
<td>1,227</td>
<td>138</td>
<td>566</td>
<td>397</td>
<td>1,279</td>
</tr>
</tbody>
</table>

| Percentage VMT Increase LOS F-LOS F++ | 194% | 301% | 155% | 221% |

Figures 9-16 present congestion locations on roadway segments in the Ohio’s largest urbanized areas, including Cincinnati/Dayton, Cleveland/Akron, Columbus and Toledo. Within these areas, the observation that congestion will increase and expand outwards towards suburban areas, and that congestion will be most prevalent on the state’s interstate system becomes more apparent. An overview of more specific findings by area is presented below.

**Cincinnati/Dayton (Figures 9-10):** By 2040, the principal areas in which congested travel is expected to grow include:

- I-275, west of I-75 and east of I-71
- I-75 through Middletown and from Dayton to Cincinnati, North of I-275
- I-70 in North Dayton, from SR49 to east of Dayton
- I-675, between I-70 and SR35
- Portions of SR73, east of Middletown
- I-74, south of I-275.

**Cleveland/Akron (Figures 11-12):** By 2040, the principal areas in which congested travel is expected to grow include:

- I-90, east of SR91, Northeast Cleveland;
- I-480, from I-71 to I-271;
- I-271, from I-77, to I-480 (Akron to Cleveland), and
- I-77, south of I-76.
Columbus (Figures 13-14): By 2040, some of the areas in which congested travel is expected to grow include:

- I-270, west, north and east quadrants;
- I-71, at I-270, north of SR37 and south of SR33;
- I-70 at I-270 and east of I-270;
- SR161 east and west of I-270;
- SR33, downtown and south of I-270, and
- I-670, east of I-71.

Toledo (Figures 15-16): By 2040, some of the areas in which congested travel is expected to grow include:

- I-75, north of SR120;
- I-75, from SR6 to I-475, and
- I-475, from I-75 to north of I-80.

4. CONCLUSION

ODOT monitors forecasts and reports congestion levels on its state highway system through CMS. The CMS indicates that, with some important exceptions, there will be sufficient capacity to accommodate the modest growth in traffic expected to occur on most of the state’s roadway system. However, travelers on the State’s interstate system in and around many urbanized areas are likely to experience more intense congestion on currently-congested roadway segments as well as additional congestion in areas that are free-flowing today.

ODOT will continue to manage congestion issues through its programs and policies. These include its 4-year transportation improvement program, the Department’s safety programs and its Transportation Review Advisory Council project selection process. It will also continue to manage peak demands on its system by measures such as:

- Investing in Intelligent Transportation Services;
- Supporting transit services and other modal options, and
- Coordinating with its municipal partners to balance land use development with the Department’s requirement to maintain mobility and access for intercity travel.

Access Ohio 2040 (ODOT’s Statewide Transportation Plan) will guide decisions concerning the actions and policies needed to augment capacity and manage demand that will unfold on a year-to-year basis.
Figure 6: 2012 Highway Level of Service on Ohio’s Statewide System
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Figure 8: Difference in Highway Level of Service (2012-2040)
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