



# Environmental Justice Findings Technical Memo

September 12, 2013



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## 1. INTRODUCTION

This technical memorandum presents findings from an environmental justice (EJ) analysis of various 2040 transportation scenarios as part of the AO40 Plan. Three EJ populations were analyzed: an overall disadvantaged population comprised of anyone who is a minority or in poverty, the minority population individually, and the poverty population individually. The analysis was conducted at the traffic analysis zone (TAZ) level considering only areas outside of Ohio MPO (Metropolitan Planning Organization) jurisdictions. As part of their own planning processes, MPOs are responsible for conducting EJ analyses within their jurisdictions.

### Background and Methodology

As defined by the U.S. Environmental Protection Agency (EPA) Office of Environmental Justice, environmental justice is:

*“The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.”*

Analysis of environmental, economic, and social equity are required under various legislation, most notably including Title VI of the Civil Rights Act of 1964 and Executive Order 12898A issued in 1994 (updated in 2012). While such mandates determine when environmental justice analyses are required, states are afforded great flexibility in terms of how to evaluate “fairness.” A common approach includes identifying the affected population; estimating the nature and extent of the impacts; and assessing whether the impacts are equitable (NCHRP Report 532).

## 2. METHODOLOGY AND FINDINGS

To complete the AO40 EJ analysis, NCHRP Report 352 was followed in conjunction with guidance provided by ODOT. **Table 1** summarizes the approach used in this work for analyzing EJ populations by TAZ.

### 2.1 Identify EJ Populations

Three types of environmental justice populations were identified by TAZ. The disadvantaged population is defined as any person who is a minority or in poverty. In addition to this overall population, the minority population and poverty population were analyzed individually. TAZs with significant EJ populations were identified using the following thresholds:

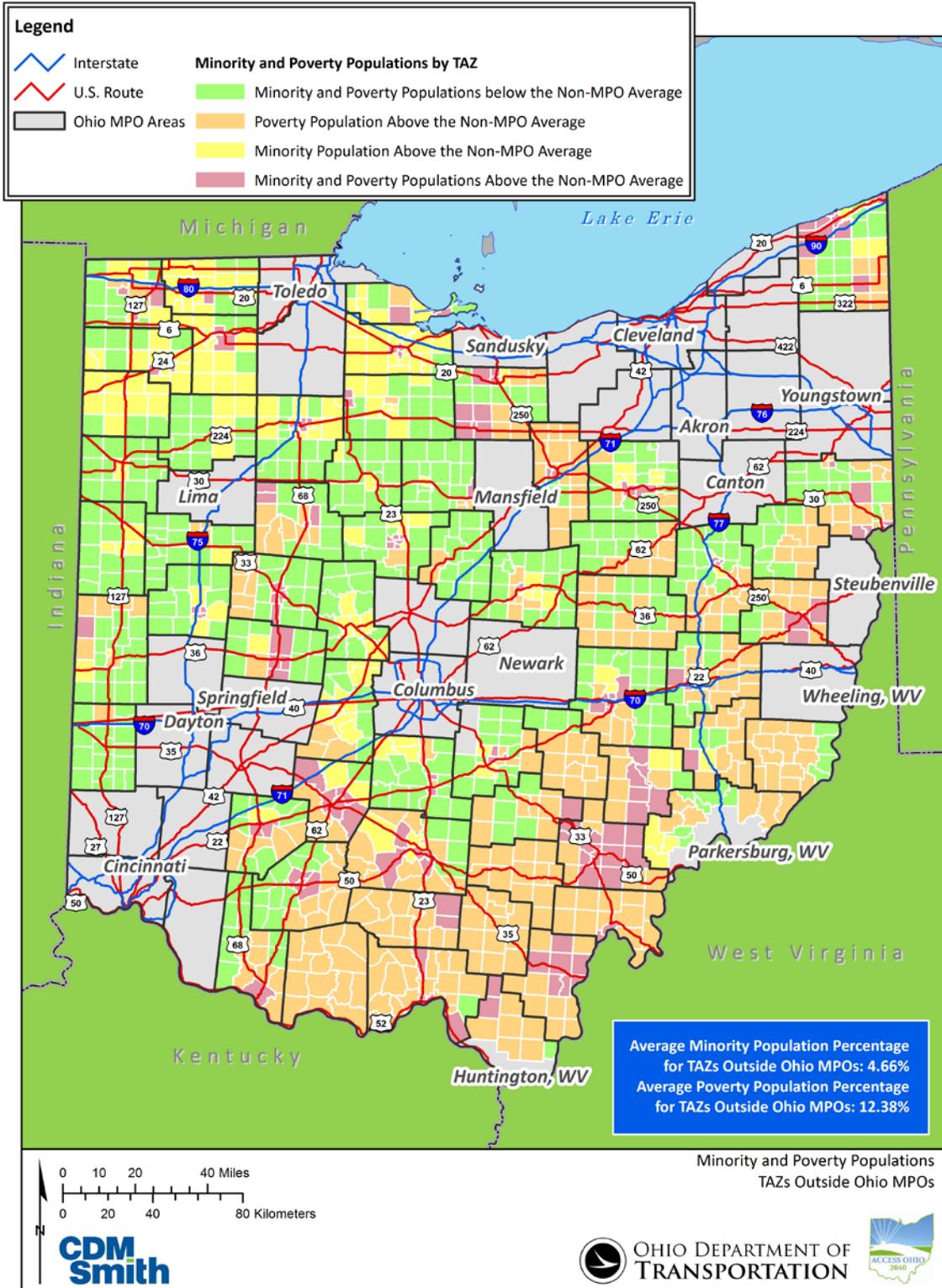
- Disadvantaged populations greater than non-MPO statewide average (16.4 percent)
- Minority populations greater than non-MPO statewide average (4.7 percent)
- Poverty populations greater than non-MPO statewide average (12.4 percent)

In identifying these populations in the 2040 analysis year, ODOT advised the use of current socio-economic ratios; that is, the percentage of a TAZ population that is at a minority and poverty-level was

held constant from 2010 to 2040. **Figure 1** geographically represents the various EJ and non-EJ populations using these thresholds.

**Table 1: AO40 Environmental Justice Methodology**

General Methodology	Approach
<p><b>Identify the affected population</b></p>	<p>Identify significant EJ populations using socioeconomic data. Three populations were identified:</p> <ul style="list-style-type: none"> <li>▪ Minority populations</li> <li>▪ Poverty populations</li> <li>▪ Disadvantaged populations (the overall population that is either a minority or in poverty)</li> </ul>
<p><b>Estimate the nature and extent of the impacts</b></p>	<p>Estimate accessibility using an ODOT developed post-processor tool that calculates an accessibility score. The score is based on employment and weighted by population. It takes into account the ability of people in a TAZ to travel to any other zone as a function of travel time and available modal options.</p>
<p><b>Assess whether the impacts are equitable</b></p>	<p>Compare access outputs for each TAZ across different scenarios with respect to:</p> <ul style="list-style-type: none"> <li>▪ Percent change in access</li> <li>▪ Pair-wise statistical hypothesis testing</li> <li>▪ Geographic overlay of impacts and EJ populations</li> </ul>



**Figure 1: Environmental Justice Populations**

Source: 2010 Decennial Census

Minority populations are most densely clustered in the northwestern portion of the state, while poverty populations are largely concentrated in the southeastern (Appalachian) portion of the state. Of the 1,147 non-MPO TAZs, 686 TAZs (60%) were found to contain either a minority, poverty, or disadvantaged population higher than the statewide non-MPO average (4.7% for minority populations, 12.4% for poverty populations, and 16.4% for disadvantaged populations) (Table 2).

**Table 2: TAZs by EJ Population**  
 Source: 2010 Decennial Census

	Number (percentage) of TAZs by EJ Population		
	Poverty	Non-Poverty	Total
<b>Minority</b>	157 (14%)	178(16%)	335 (29%)
<b>Non-Minority</b>	351 (31%)	461(40%)	812 (71%)
<b>Total</b>	508 (44%)	639 (56%)	1,147 (100%)

**2.2 Estimate Impacts**

Impacts to EJ populations were estimated by comparing accessibility scores generated by ODOT’s travel demand model post-processor (an automated tool that processes raw model results into more meaningful measures). This tool was used to calculate accessibility scores for the following scenarios:

- Base Year (2010)
- Future 2040 Existing and Committed Network (2040 E&C): This scenario includes programmed transportation improvement projects with population projections by TAZ for the year 2040. Programmed transportation improvement projects are those that have been approved and funded by ODOT for construction in the near-term.
- Future 2040 Build Network (2040 Build): This scenario includes programmed transportation improvement projects and ODOT Transportation Review Advisory Council (TRAC) projects with population projections by TAZ for the year 2040.

The post-processor tool computes an accessibility score using 16 employment categories as a function of travel time and available modes of transportation. Areas with more opportunities nearby, in terms of lower travel time and being readily accessible by transit and passenger vehicles, are given a higher score. For instance, a TAZ within 15 minutes of a shopping mall (high retail employment) on a regular bus route would rank higher than a similar one in which it would take 30 minutes to access and no transit option was available. These scores are then combined, based on types of employment, into five metrics:

- Accessibility to Jobs
- Accessibility to Goods and Services

- Accessibility to Health Care
- Accessibility to Schools
- Accessibility to Population.<sup>1</sup>

Each access metric is then weighted by the corresponding population subgroup. For example, the minority access score is the sum of the TAZ access score multiplied by the TAZ minority population divided by the TAZ total population. This process is then repeated to develop unique access scores for non-minority, poverty, non-poverty, disadvantaged, and non-disadvantaged populations in each TAZ. The raw accessibility scores are included at the end of this memorandum as **Appendix 1**.

## 2.3 Assess Equitability of Impacts

To evaluate the fair distribution of access, the following process was applied:

1. Evaluate percent changes in accessibility measures across EJ and non-EJ populations
2. Conduct statistical hypothesis testing of changes in access
3. Overlay changes in accessibility to EJ populations using Geographic Information Systems (GIS).

### 2.3.1 Percent Differences by EJ Population

Three sets of comparisons were tested:

1. Change in accessibility between the “2010 Base” and the “2040 E&C” scenarios
2. Change in accessibility between the “2010 Base” and the “2040 Build” scenarios
3. Change in accessibility between the “2040 E&C” and the “2040 Build” scenarios.

The growth, or decline, in each category is presented in **Table 3**. The following trends are observed:

- Relative to the “2010 Base” scenario, access is improved in the “2040 Build” with respect to jobs, goods and services, and health care; a loss of accessibility is observed with respect to schools and population.
- Relative to the 2040 E&C scenario, accessibility is expected to remain the same or increase for most metrics under the “2040 Build” scenario (The accessibility to health care for the minority has a 0.2% decrease).

Statewide, the total population (MPO + Non-MPO TAZs) is expected to increase from 11.6 million in 2010 to 12.7 million in 2040; the population for Non-MPO TAZs is expected to increase from 2.78 million in 2010 to 3.77 million in 2040. Of the 1,147 non-MPO zones, 42 percent are expected to experience a decrease in population.

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<sup>1</sup> “Access to population” is defined by ODOT as the accessibility of the EJ population to the larger population in the TAZ using available travel modes.

**Table 3: Percent Changes in Average Access for Non-MPO TAZs with a Significant EJ Population**

Source: ODOT Environmental Justice Evaluation Tool

Accessibility Measure	EJ Population	Percent Change		
		From “2010 Base” to “2040 E&C”	From “2010 Base” to “2040 Build”	From “2040 E&C” to “2040 Build”
<b>Access to Jobs</b>	Minority	22.5%	23.0%	0.4%
	Non-Minority	23.4%	24.1%	0.6%
	Poverty	25.1%	26.0%	0.7%
	Non-Poverty	25.8%	26.5%	0.6%
	Disadvantaged	24.5%	25.2%	0.6%
	Non-Disadvantaged	24.6%	25.3%	0.6%
<b>Access to Goods/Services</b>	Minority	11.9%	12.0%	0.0%
	Non-Minority	12.4%	12.7%	0.3%
	Poverty	13.6%	13.9%	0.3%
	Non-Poverty	13.9%	14.2%	0.2%
	Disadvantaged	13.1%	13.3%	0.2%
	Non-Disadvantaged	13.2%	13.4%	0.2%
<b>Access to Health Care</b>	Minority	46.9%	46.6%	-0.2%
	Non-Minority	47.3%	47.3%	0.0%
	Poverty	49.9%	50.0%	0.1%
	Non-Poverty	50.6%	50.7%	0.0%
	Disadvantaged	49.5%	49.5%	0.0%
	Non-Disadvantaged	49.6%	49.6%	0.0%
<b>Access to Schools</b>	Minority	-18.0%	-13.9%	5.1%
	Non-Minority	-16.8%	-12.5%	5.2%
	Poverty	-16.5%	-11.9%	5.5%
	Non-Poverty	-17.1%	-12.5%	5.5%
	Disadvantaged	-17.8%	-13.3%	5.5%
	Non-Disadvantaged	-17.8%	-13.2%	5.5%
<b>Access to Population</b>	Minority	-4.5%	-3.7%	0.8%
	Non-Minority	-4.5%	-3.5%	1.1%
	Poverty	-4.2%	-3.3%	1.0%
	Non-Poverty	-3.9%	-3.1%	0.9%
	Disadvantaged	-4.4%	-3.6%	0.9%
	Non-Disadvantaged	-4.4%	-3.6%	0.9%

### 2.3.2 Statistical Hypothesis Testing

Hypothesis testing was conducted to determine whether the access-related improvements are equitably distributed among EJ and Non-EJ TAZs. For this analysis, two sets of hypothesis tests were conducted to:

- Assess changes in equity between 2010 and 2040 by comparing average changes in accessibility between the 2010 and the 2040 Build scenarios across EJ and non-EJ populations;
- Assess changes in equity between the TRAC projects and the E&C projects by comparing average changes in accessibility between the 2040 Build scenario and the 2040 E&C scenario across EJ and non-EJ populations.

Statistical evidence, by way of the t-statistic, was applied to assess the level of confidence that the average change in accessibility scores varies significantly between the EJ and non-EJ populations. Mathematically stated, the null hypothesis for each of these tests is that the average change in the accessibility score is equal between EJ and non-EJ populations. Therefore by rejecting this null hypothesis with over 95 percent confidence, disproportionate impacts can be identified.

As discussed in the following sections, no statistical evidence was found to suggest inequities in future access-related improvements.

#### *Equity of 2010-2040 Improvements*

A simple comparison of percent growth in access between the 2010 and 2040 Build scenarios, shows that:

- Minority EJ TAZs have a *lower* average percent change in access for all metrics excluding schools
- Poverty EJ TAZs have a *higher* average percent change in access for all metrics
- Disadvantaged EJ TAZs have a *higher* average percent change in access for all metrics excluding population.

To assess whether these differences are significant, similar hypothesis testing was conducted. As shown in **Table 4**, no statistical evidence was obtained to suggest non-EJ populations are disproportionately favored.

**Table 4: Statistical Tests of Percent Change in Access between 2010 and 2040 Build Scenarios for Non-MPO TAZs**

*Source: ODOT Environmental Justice Evaluation Tool*

Accessibility Measure	Population Comparison		Test Statistic	Confidence that EJ Population has Significantly Lower Access
<b>Access to Jobs</b>	Minority	EJ vs. Non-EJ	-0.08	53.11%
	Poverty	EJ vs. Non-EJ	0.13	44.73%
	Disadvantaged	EJ vs. Non-EJ	0.07	47.23%
<b>Access to Goods/Services</b>	Minority	EJ vs. Non-EJ	-0.05	52.04%
	Poverty	EJ vs. Non-EJ	0.17	43.14%
	Disadvantaged	EJ vs. Non-EJ	0.13	44.91%
<b>Access to Health Care</b>	Minority	EJ vs. Non-EJ	-0.19	57.53%
	Poverty	EJ vs. Non-EJ	0.26	39.61%
	Disadvantaged	EJ vs. Non-EJ	0.18	42.72%
<b>Access to Schools</b>	Minority	EJ vs. Non-EJ	0.05	47.86%
	Poverty	EJ vs. Non-EJ	0.22	41.23%
	Disadvantaged	EJ vs. Non-EJ	0.19	42.47%
<b>Access to Population</b>	Minority	EJ vs. Non-EJ	-0.11	54.47%
	Poverty	EJ vs. Non-EJ	0.02	49.10%
	Disadvantaged	EJ vs. Non-EJ	-0.03	51.23%

*Null hypothesis: Average (mean) percent change in accessibility scores between the 2010 and 2040 Build scenarios for EJ and non-EJ populations are equal*

*The test statistic is used to identify the confidence level associated with rejecting the null hypothesis; at confidence levels above 95%, statistical evidence would suggest an inequity in access improvements between EJ and non-EJ populations exists.*

\*Positive test-statistics occur when the EJ population has a larger percent change in the average access score than that of the Non-EJ population. As such, it is less likely that the EJ population is adversely affected, but the possibility still exists (however at low confidence) given the variability in the data.

*Equity of 2040 TRAC Projects*

In comparing the percent growth in access between the 2040 E&C and 2040 Build scenarios, it was found that all EJ TAZs have a higher access growth rate relative to Non-EJ TAZs excluding minority population access to school. To assess whether these differences are significant, a final set of hypotheses were tested to compare the percent growth between the 2040 E&C and 2040 Build scenarios. No statistical evidence was obtained to suggest non-EJ populations are disproportionately favored (**Table 5**).

**Table 5: Statistical Tests of Percent Change in Access between 2040 E&C and 2040 Build Scenarios for Non-MPO TAZs**

*Source: ODOT Environmental Justice Evaluation Tool*

Accessibility Measure	Population Comparison		Test Statistic	Confidence that EJ Population has Significantly Lower Access
<b>Access to Jobs</b>	Minority	EJ vs. Non-EJ	0.09	46.55%
	Poverty	EJ vs. Non-EJ	0.15	43.91%
	Disadvantaged	EJ vs. Non-EJ	0.19	42.56%
<b>Access to Goods/Services</b>	Minority	EJ vs. Non-EJ	0.10	46.08%
	Poverty	EJ vs. Non-EJ	0.12	45.19%
	Disadvantaged	EJ vs. Non-EJ	0.17	43.32%
<b>Access to Health Care</b>	Minority	EJ vs. Non-EJ	0.07	47.21%
	Poverty	EJ vs. Non-EJ	0.13	44.73%
	Disadvantaged	EJ vs. Non-EJ	0.16	43.54%
<b>Access to Schools</b>	Minority	EJ vs. Non-EJ	-0.03	51.37%
	Poverty	EJ vs. Non-EJ	0.11	45.46%
	Disadvantaged	EJ vs. Non-EJ	0.12	45.05%
<b>Access to Population</b>	Minority	EJ vs. Non-EJ	0.19	42.33%
	Poverty	EJ vs. Non-EJ	0.28	38.96%
	Disadvantaged	EJ vs. Non-EJ	0.30	38.23%

*Null hypothesis: Average (mean) percent change in accessibility scores between the 2040 E&C and 2040 Build scenarios for EJ and non-EJ populations are equal*

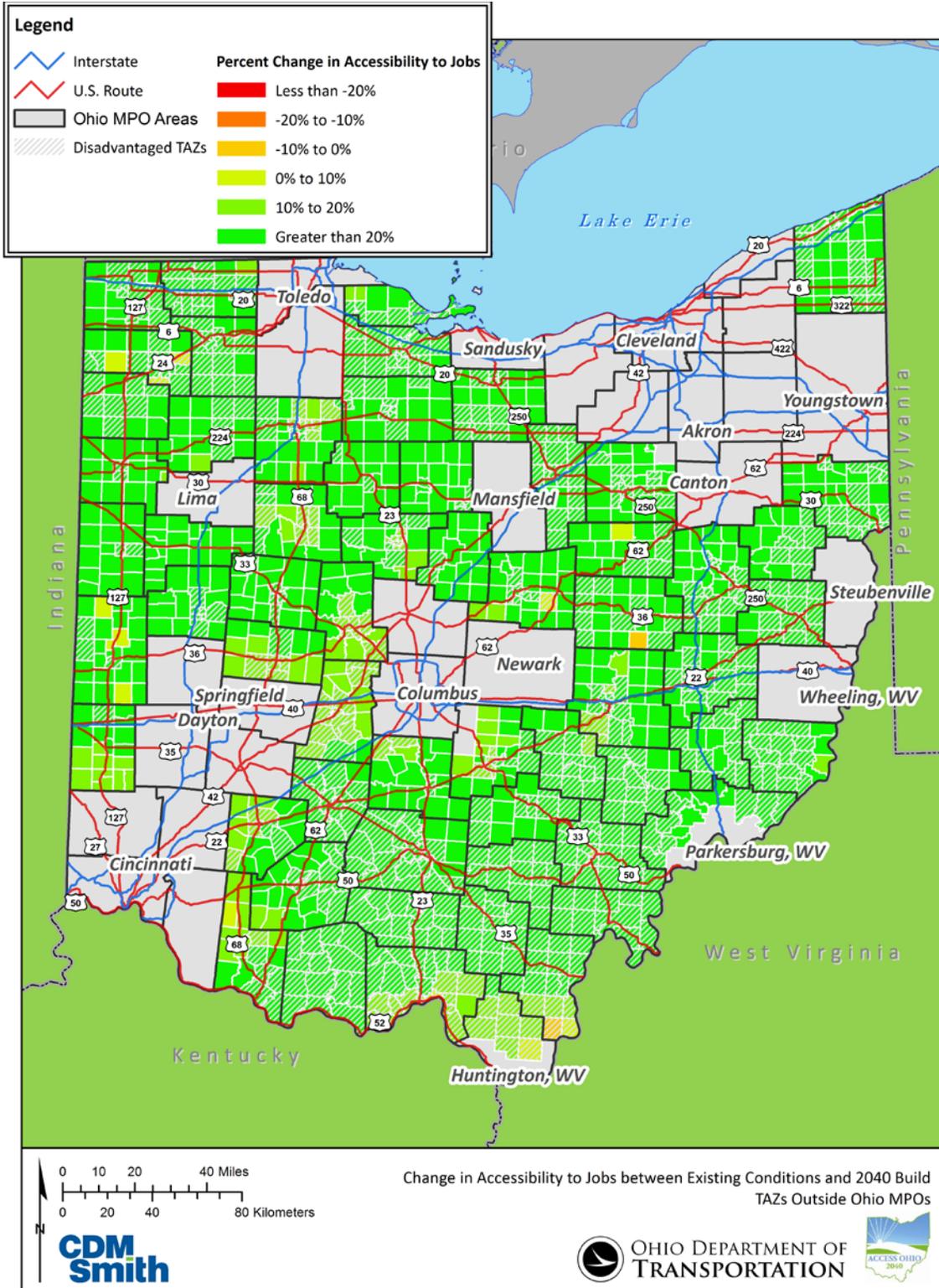
*The test statistic is used to identify the confidence level associated with rejecting the null hypothesis; at confidence levels above 95%, statistical evidence would suggest an inequity in access improvements between EJ and non-EJ populations exists.*

\*Positive test-statistics occur when the EJ population has a larger percent change in the average access score than that of the Non-EJ population. As such, it is less likely that the EJ population is adversely affected, but the possibility still exists (however at low confidence) given the variability in the data.

### 2.3.3 GIS Mapping of Access

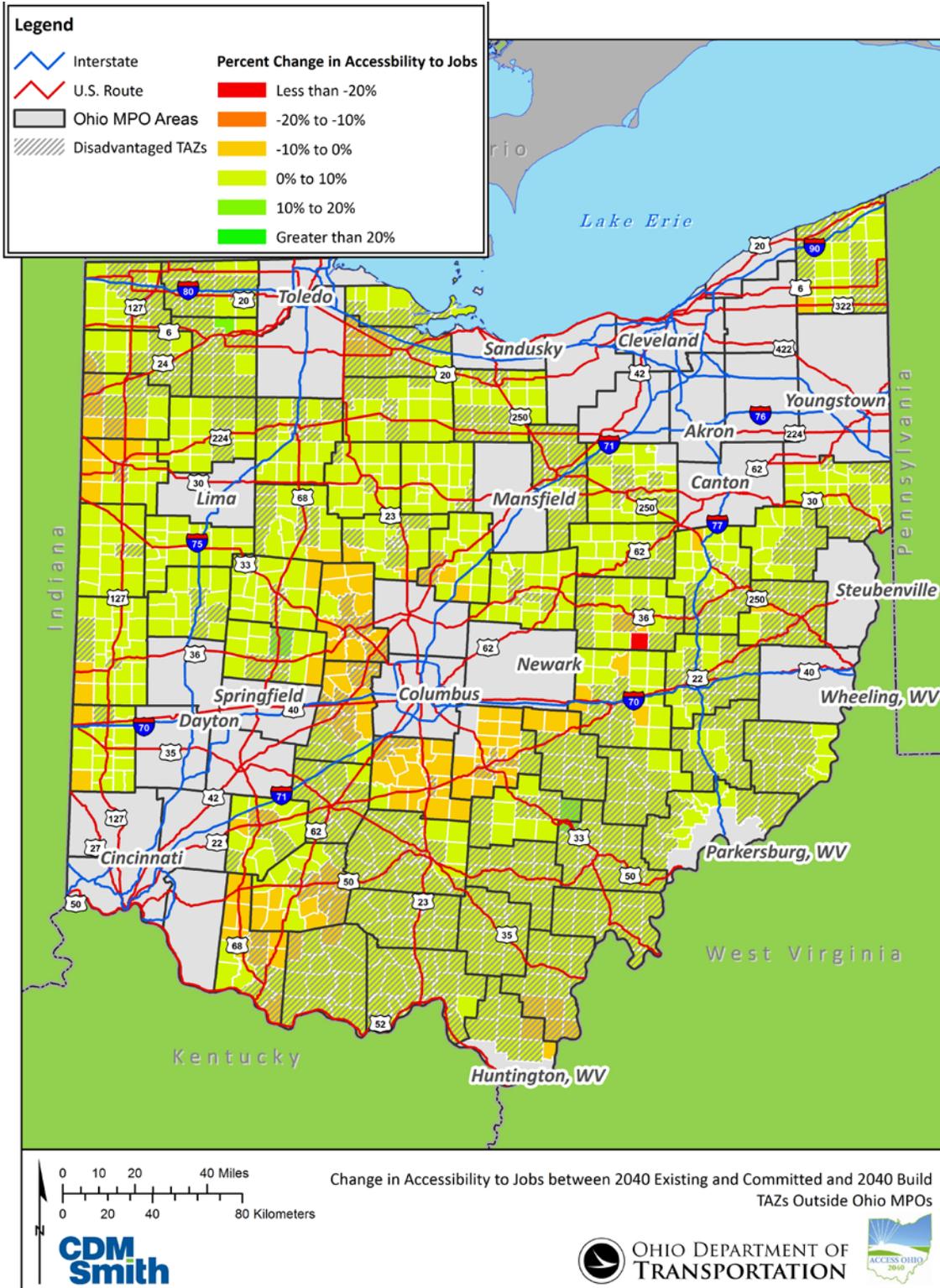
Geographic analysis was conducted to ensure that benefits were equitably distributed throughout the state. This was done by overlaying the percent growth in access against target zones. Target zones were selected based on the existence of minority, poverty, and/or disadvantaged population proportions that exceed statewide non-MPO mean levels. **Figures 2 to 11** illustrate the percent change in the accessibility scores for each accessibility measure between the 2010 and 2040 Build scenarios and between the 2040 Build and 2040 E&C scenarios.

In comparing the changes in job access, it can be seen that there is a general increase in access relative to 2010, but more stagnant growth relative to the 2040 E&C scenario. No significant concentrations of less access are apparent upon visual inspection nor for other access metrics.



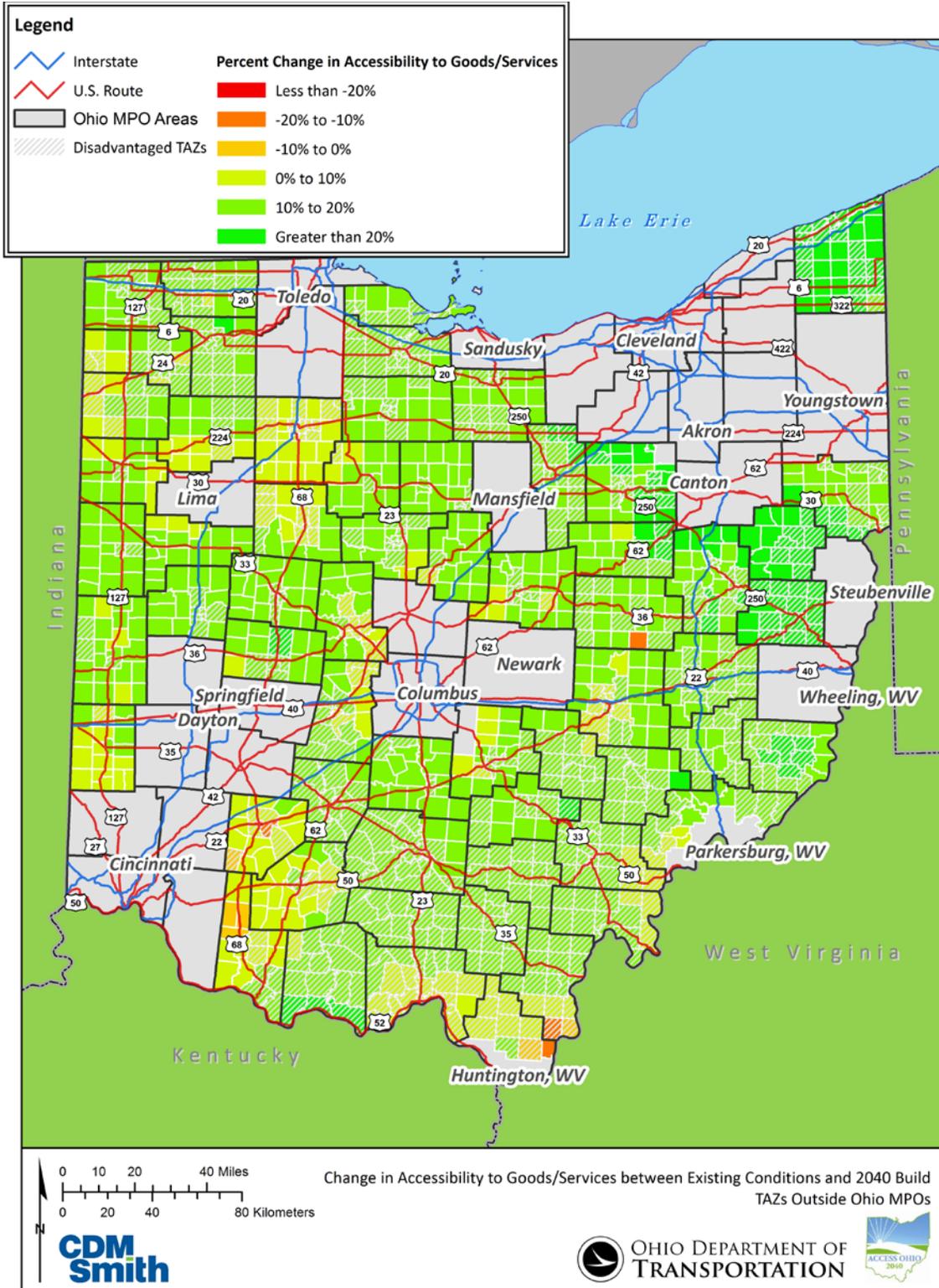
**Figure 2: Ohio Non-MPO Percent Change in Job Access (2010 vs. 2040 Build)**

Source: ODOT Environmental Justice Evaluation Tool



**Figure 3: Ohio Non-MPO Percent Change in Job Access (2040 E&C vs. 2040 Build)**

Source: ODOT Environmental Justice Evaluation Tool



**Figure 4: Ohio Non-MPO Percent Change in Goods/Services Access (2010 vs. 2040 Build)**

Source: ODOT Environmental Justice Evaluation Tool

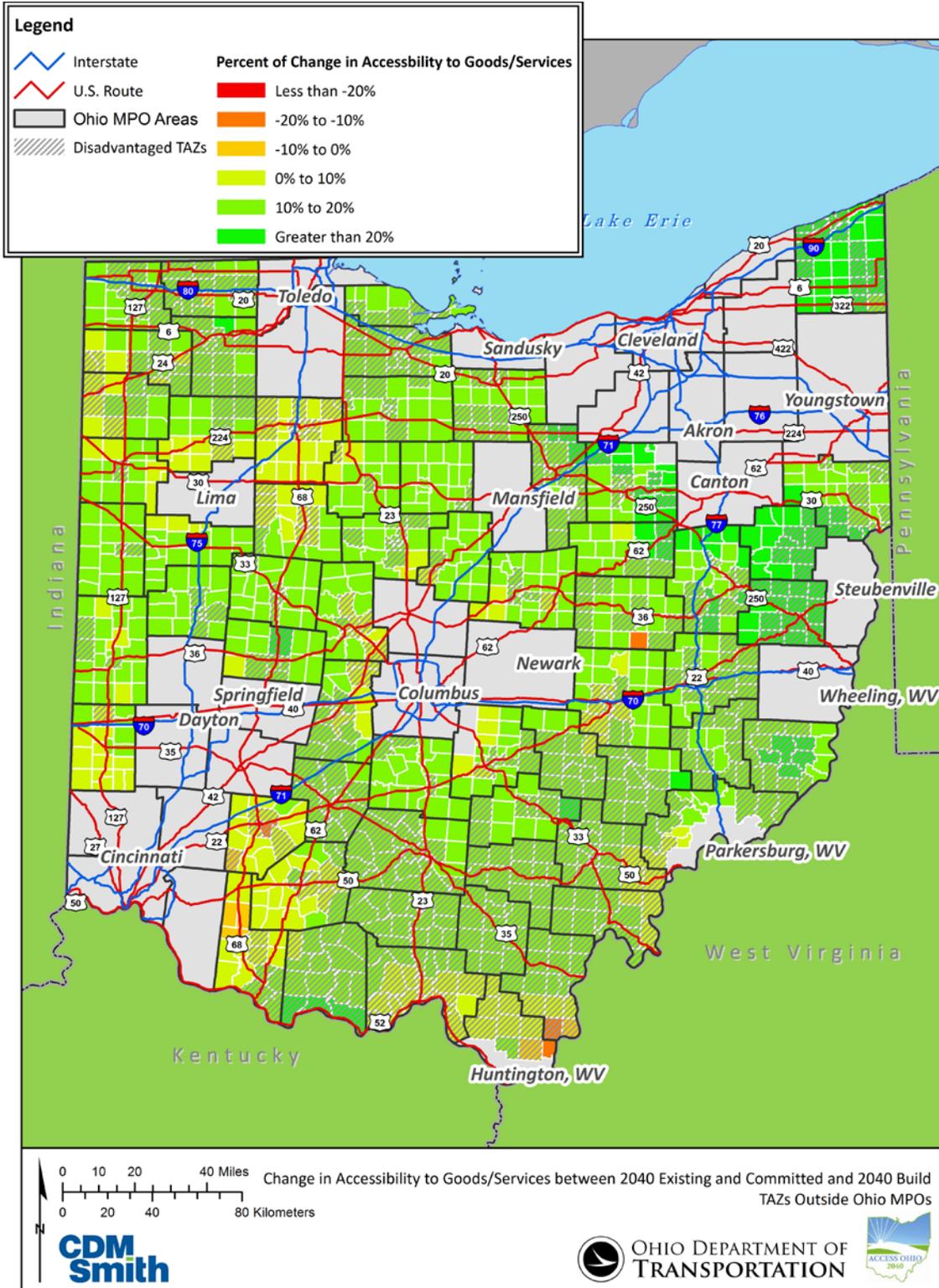
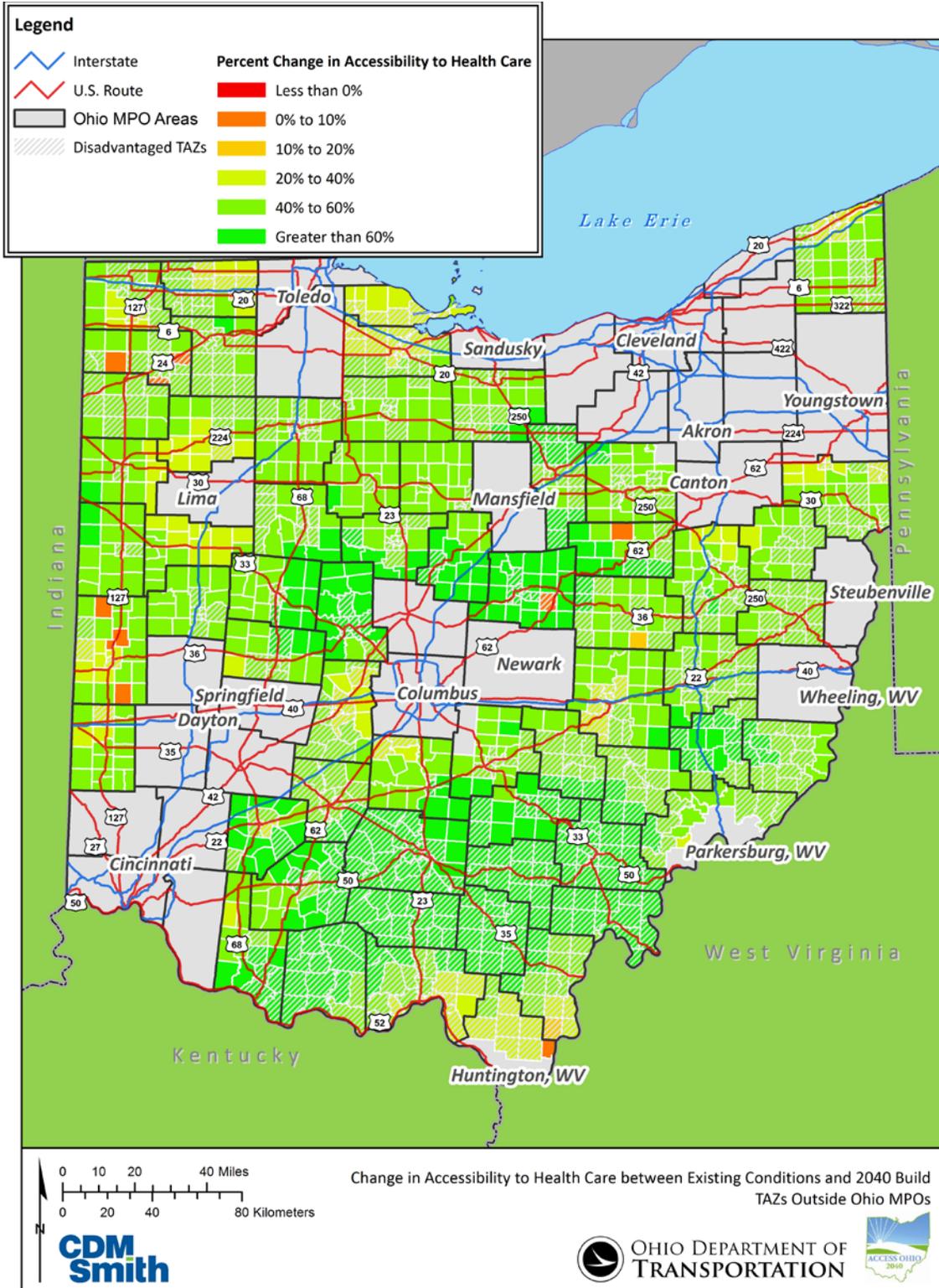


Figure 5: Ohio Non-MPO Percent Change in Goods/Services Access (2040 E&C vs. 2040 Build)

Source: ODOT Environmental Justice Evaluation Tool



**Figure 6: Ohio Non-MPO Percent Change in Health Care Access (2010 vs. 2040 Build)**

Source: ODOT Environmental Justice Evaluation Tool

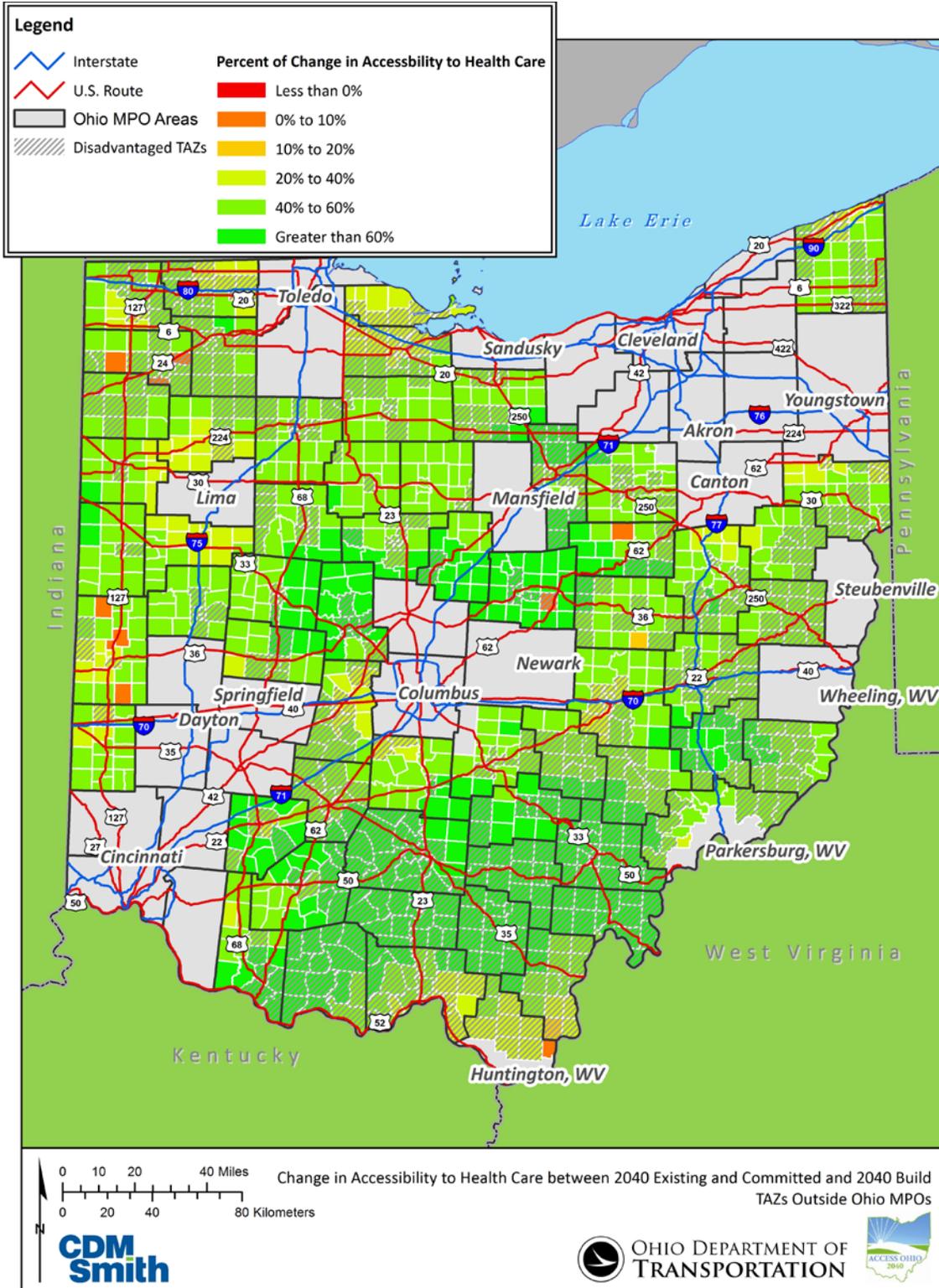
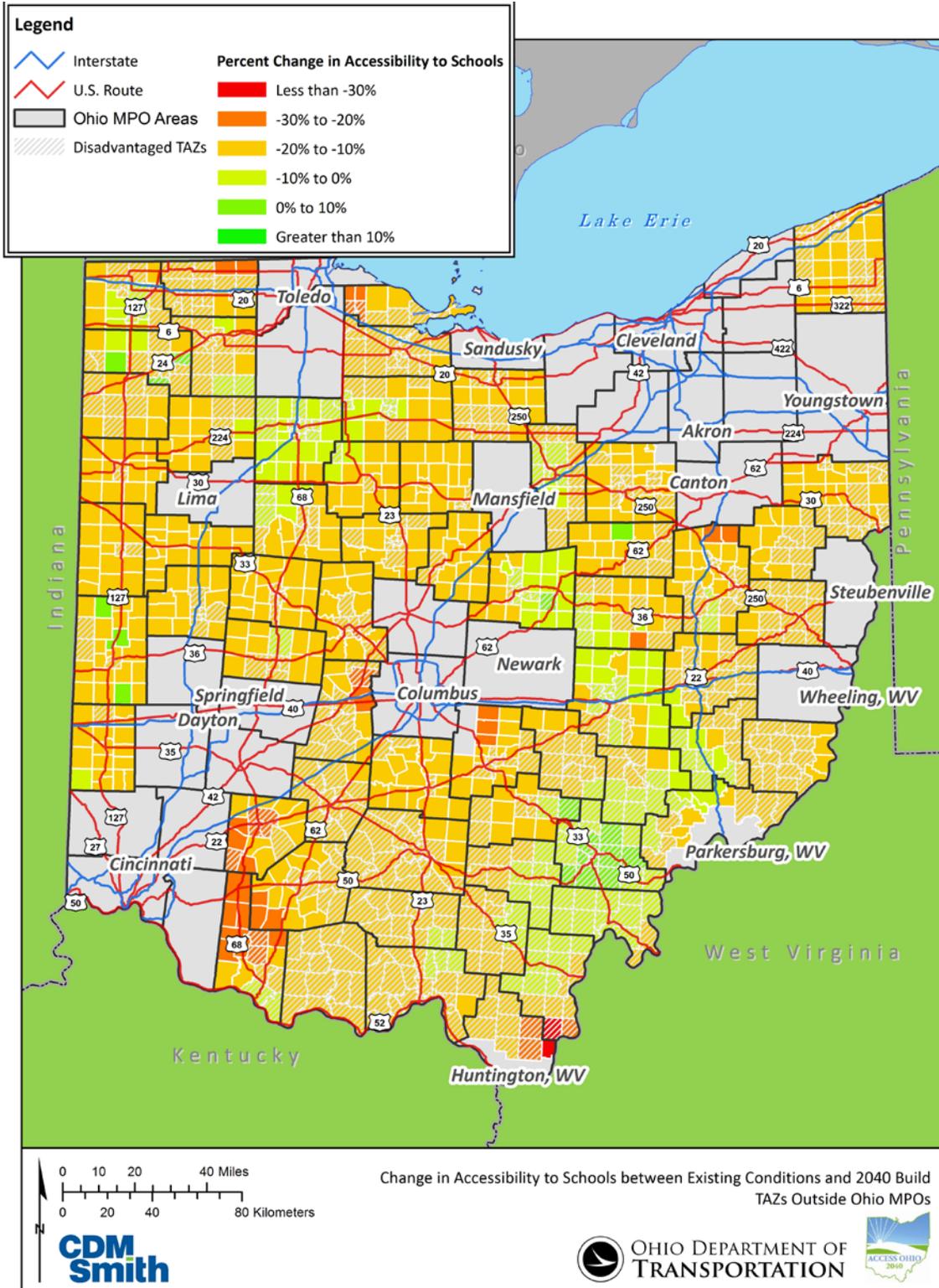


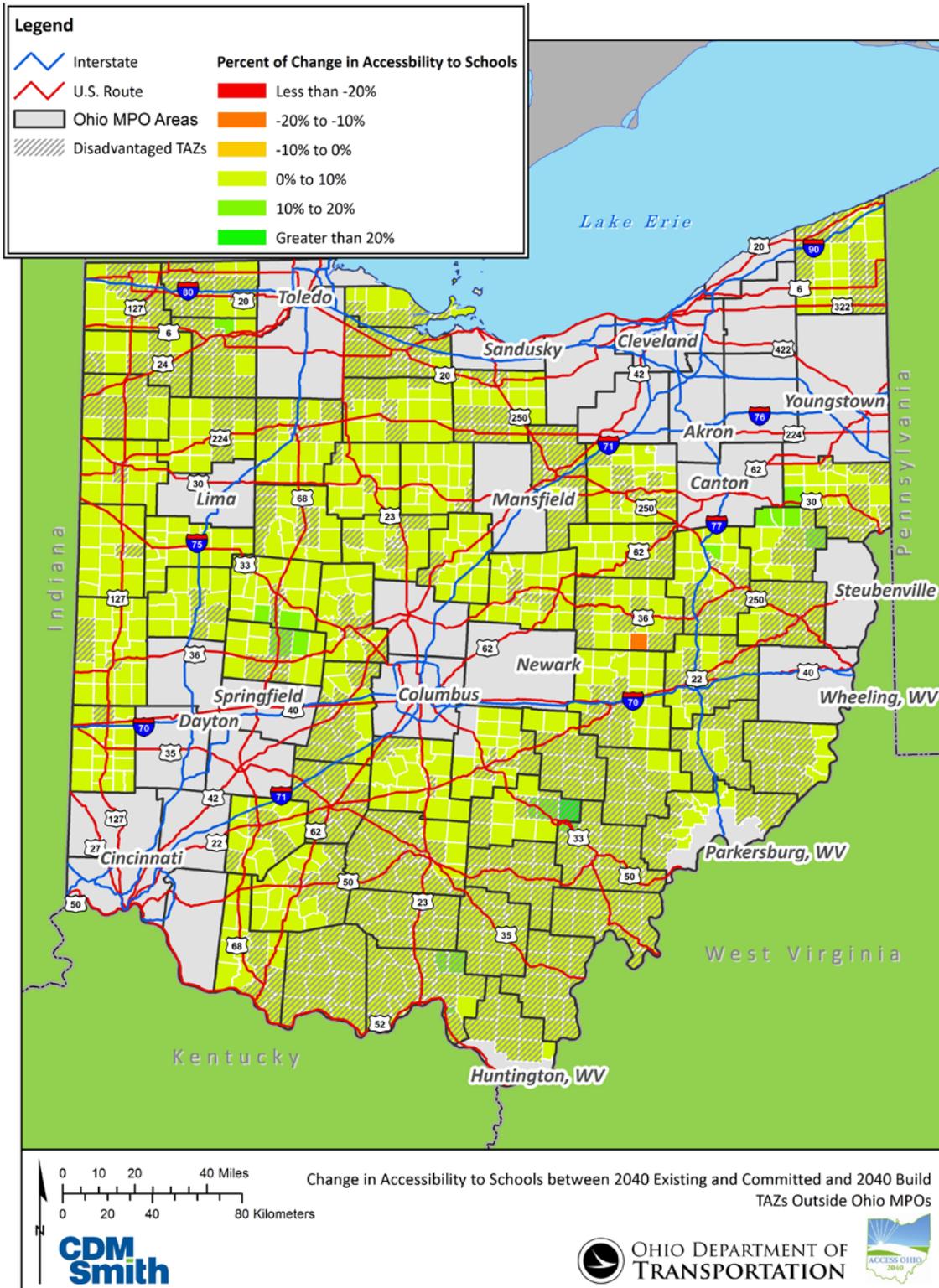
Figure 7: Ohio Non-MPO Percent Change in Health Care Access (2040 E&C vs. 2040 Build)

Source: ODOT Environmental Justice Evaluation Tool



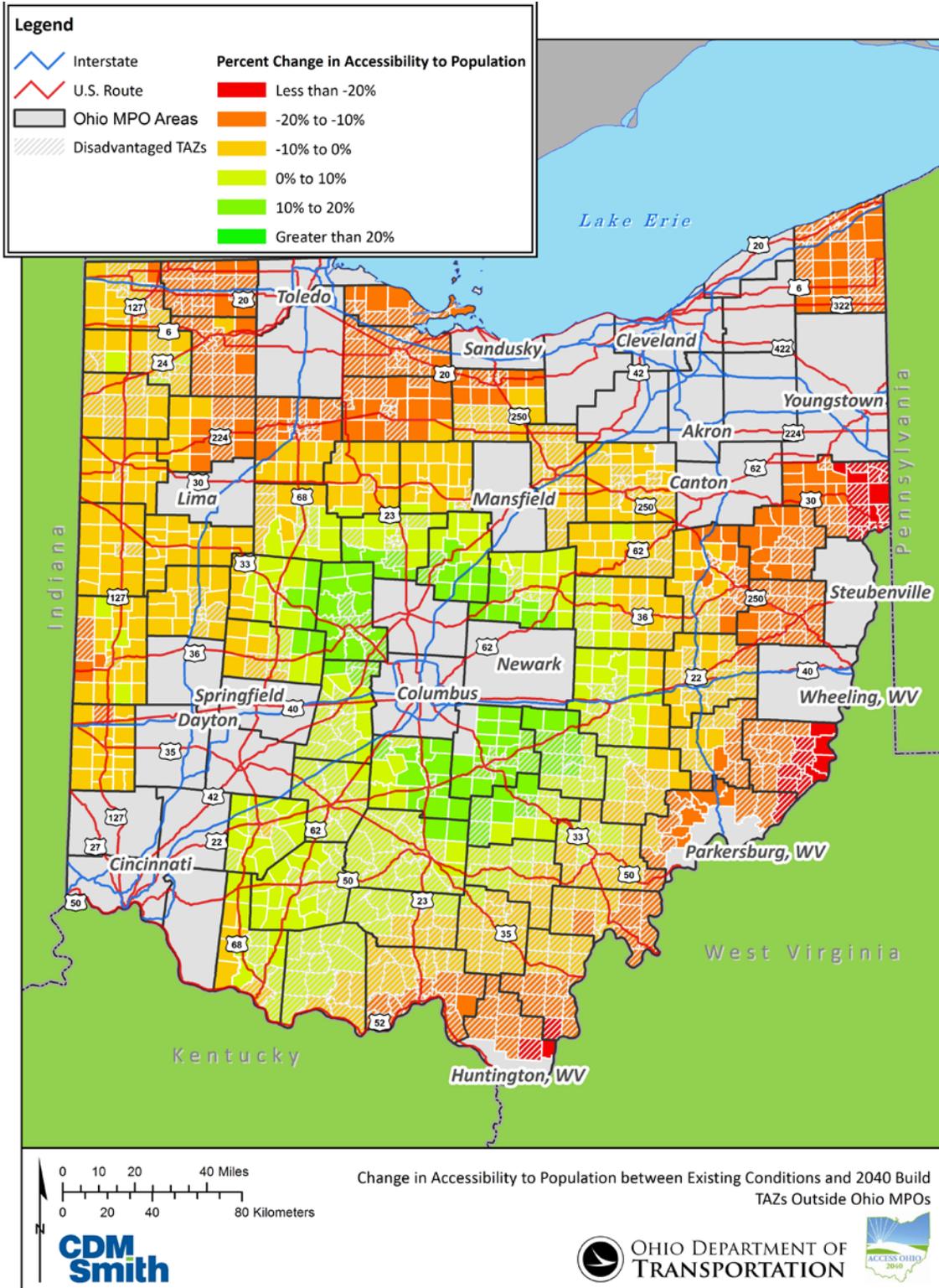
**Figure 8: Ohio Non-MPO Percent Change in Schools Access (2010 vs. 2040 Build)**

Source: ODOT Environmental Justice Evaluation Tool



**Figure 9: Ohio Non-MPO Percent Change in Schools Access (2040 E&C vs. 2040 Build)**

Source: ODOT Environmental Justice Evaluation Tool



**Figure 10: Ohio Non-MPO Percent Change in Population Access (2010 vs. 2040 Build)**

Source: ODOT Environmental Justice Evaluation Tool

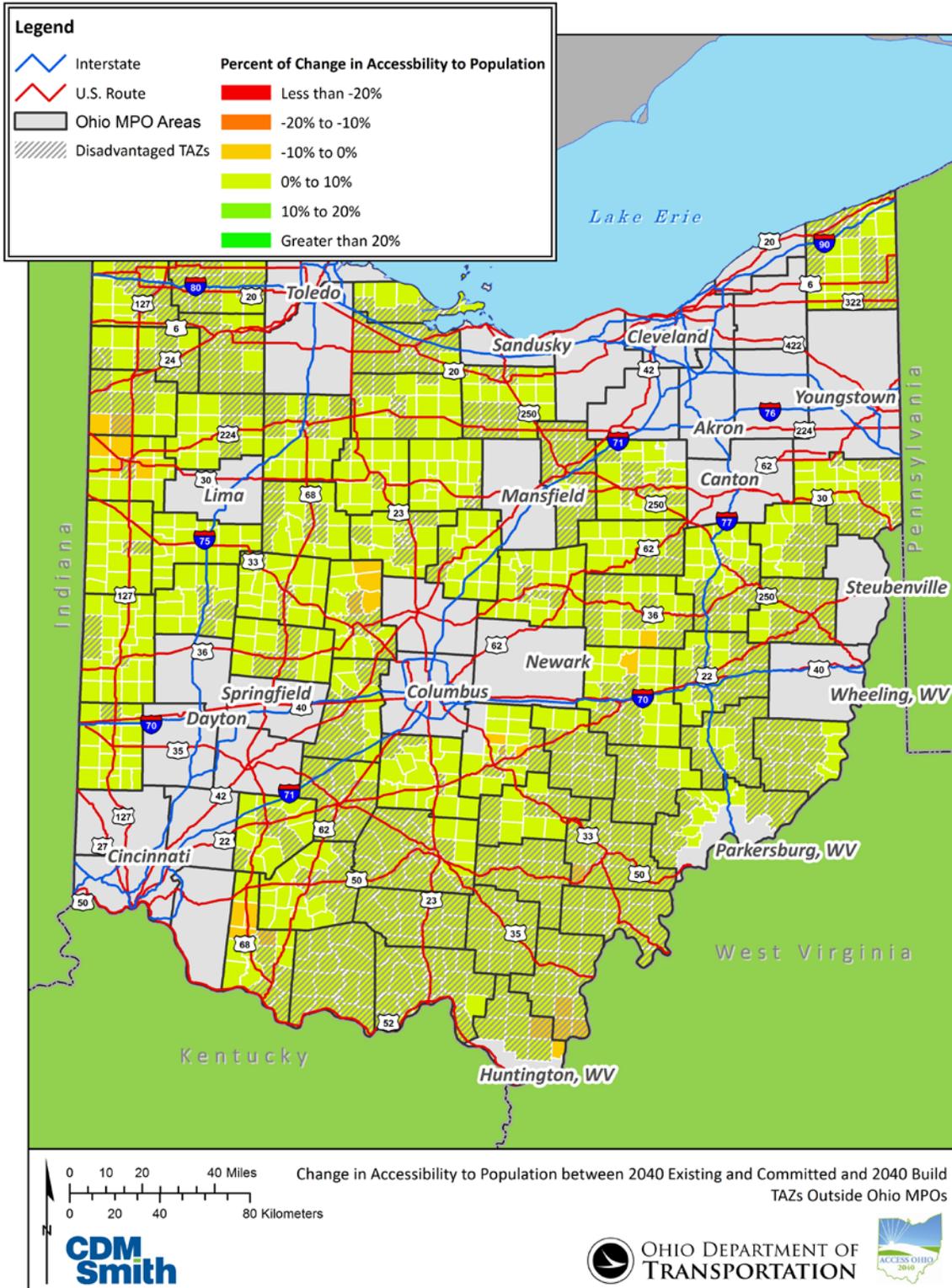


Figure 11: Ohio Non-MPO Percent Change in Population Access (2040 E&C vs. 2040 Build)

Source: ODOT Environmental Justice Evaluation Tool

### 3. SUMMARY OF FINDINGS

Percent differences, statistical hypothesis testing, and GIS overlays were conducted to compare the growth in accessibility between EJ and non-EJ populations across the 2010 and 2040 Build scenarios and the 2040 E&C and 2040 Build scenarios. No statistical or visual evidence was found to suggest a significant difference in changes in access between the EJ and non-EJ populations. Therefore, there is insufficient evidence to suggest EJ populations are adversely affected by the 2040 Build scenario.

More specifically, the analysis conducted reveals the following:

- In the non-MPO areas of Ohio, 60% of TAZs have either a minority, poverty, or disadvantaged population higher than the statewide non-MPO average (4.7% for minority populations, 12.4% for poverty populations, and 16.4% for disadvantaged populations).
- In the non-MPO TAZs, 44% of the TAZs have poverty rates above the statewide non-MPO average and 29% of the TAZs have a higher proportion of minority populations than the statewide non-MPO average.
- While EJ populations occur throughout the state, TAZs with significant minority populations were most densely concentrated in the northwestern portion of the state.
- TAZs with significant poverty populations were most densely present in the southeastern (Appalachian) portion of the state.
- In comparing the 2010 and 2040 Build scenarios, it was found that access is expected to increase at a faster rate for EJ populations for all metrics excluding schools and population.
- In comparing the 2040 E&C and 2040 Build scenarios, it was found that EJ population access is expected to increase at a faster rate for all metrics (excluding minority access to health care).
- In the few cases where the percent change in access for the EJ populations was lower than the non-EJ populations, statistical testing and visual inspection indicated that these differences are not significant.

## 4. APPENDIX

Attachment 1: Raw accessibility scores from ODOT Post Processor Tool (**Table A-1**)

**Table A-1: ODOT Post-Processor Tool Outputs – Average Accessibility Score (in thousands) by Non-MPO TAZ**

*Source: ODOT Environmental Justice Evaluation Tool*

Accessibility Measure	Scenario	Minority	Non-Minority	Poverty	Non-Poverty	Disadvantaged	Non-Disadvantaged
Access to Jobs	2010	356	713	1,026	5,982	5,625	5,312
	2040 E&C	439	886	1,272	7,421	6,973	6,588
	2040 Build	441	891	1,278	7,452	7,002	6,615
Access to Goods/Services	2010	162	322	465	2,701	2,541	2,399
	2040 E&C	182	363	524	3,041	2,860	2,700
	2040 Build	183	364	524	3,042	2,861	2,701
Access to Health Care	2010	46	98	138	779	728	688
	2040 E&C	68	146	206	1,163	1,085	1,026
	2040 Build	68	146	205	1,161	1,083	1,024
Access to Schools	2010	29	59	85	486	456	430
	2040 E&C	24	49	70	394	369	348
	2040 Build	25	51	73	415	389	367
Access to Population	2010	8,718	20,282	27,941	168,222	156,658	148,998
	2040 E&C	8,394	19,519	26,903	162,449	151,324	143,940
	2040 Build	8,456	19,675	27,111	163,554	152,335	144,899

\*Due to the weighting technique applied in the post-processing tool, the totals between EJ classifications will vary based on population size (that is, Minority + Non-Minority access ≠ Poverty + Non-Poverty access ≠ Disadvantaged + Non-Disadvantaged access).

\*\*The post-processor computes an accessibility score for all non-MPO TAZs regardless of there being significant concentrations of an EJ population. For the analysis presented herein, the groupings of ‘minority’ and ‘poverty’ refer solely to those non-MPO TAZs with higher than average concentrations.