

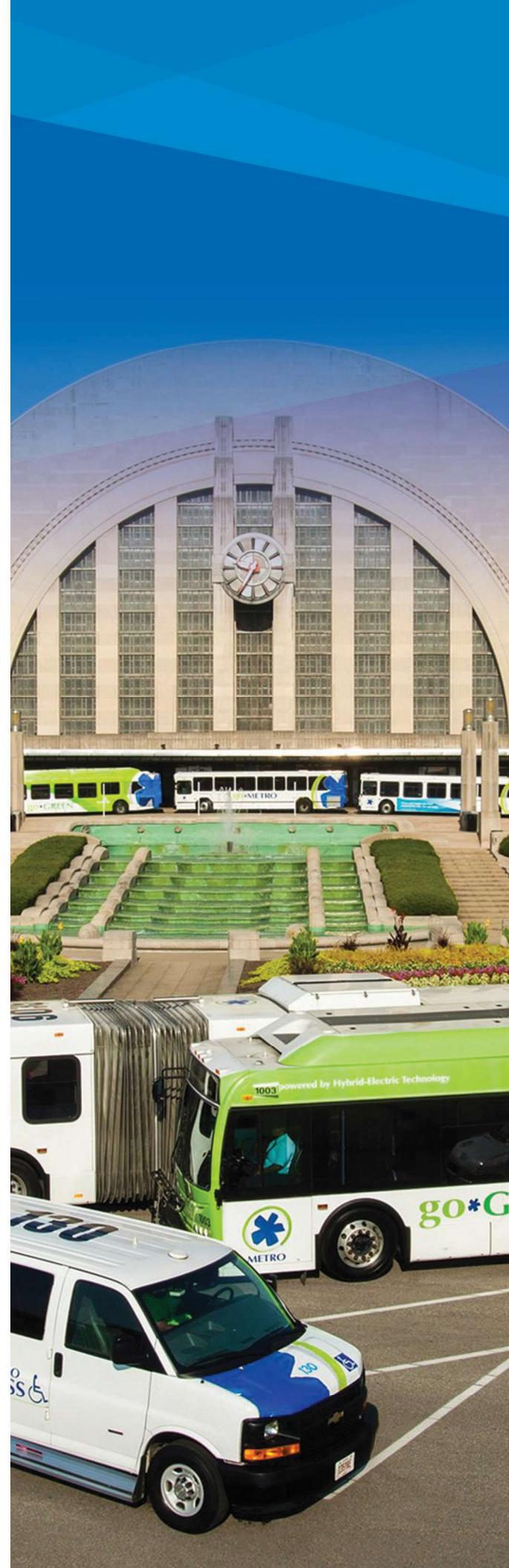


# Mobility On Demand Service Development and Recommendations

June 2022



Prepared by



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## 1.0 Introduction

The Southwest Ohio Regional Transit Authority (SORTA) recently completed a detailed and comprehensive strategic plan (Reinventing Metro), which guided phasing and recommendations for future transit improvements. One of the recommendations included the development of mobility-on-demand (MOD) services.

Thus, the purpose of this study is to identify and recommend areas within Hamilton County for the development and deployment of MOD services. MOD services may take several forms. In all cases, the MOD services respond to customer request, provide a shared-ride solution, and are designed and operated as a mobility-for-all service. This means the MOD service is equally available to the general public, as well as persons eligible for mobility services under the General Public Dial-a-Ride provisions of the Americans with Disabilities Act of 1990 (ADA).

MOD service is meant to serve localized mobility (e.g., home to grocery store) and to provide connections to the fixed route transit network for longer trips (e.g., home to mobility hub to catch fixed route bus downtown). MOD is designed to work in areas in which fixed route service may not be logically feasible because of street network constraints or lack of density, where customers have limited mobility access to bus stops, or where the necessary infrastructure is not available for safe or convenient access to bus stops.

The following section of this document detail the process, findings, and recommendations of the MOD study:

- Project Purpose, Goals, and Strategies
- Public Involvement
- Market and Gap Analysis
- Service Market Evaluation
- MOD Service Development

The study also includes an appendix which contains additional details on the following topics:

- Public Engagement Efforts
- Transit Service Performance Evaluation
- Service Area Screening Efforts
- Service Delivery Optimization Analysis Maps
- Mobility Needs Optimization Analysis Maps

## 2.0 Project Purpose, Goals, and Strategies

### Purpose

The purpose of this MOD study is to design on-demand mobility services that are accessible for all, provide localized mobility, and connect users to/from the fixed route network.

As a way to focus and guide the MOD service development and recommendations to meet specific mobility objectives, a set of goals and objectives were identified. The goals and objectives are consistent with those described in the Reinventing Metro strategic plan. In addition, goals and objectives were discussed with and set by SORTA staff, stakeholders, and the project team.

These goals and objectives were used to define MOD service zones and to develop the MOD service operational concepts.

### Goals and Objectives

The resulting goals and objectives focus on increasing access to mobility locally and regionally to improve individual and community wellbeing. The goals and objectives established for the MOD service are:

- Connect people and places
  - First/last-mile connections with the fixed route network
  - Deliver localized mobility
  - Offer access to the Greater Cincinnati region
  - Prioritize directness of travel
  - Connect jobs, housing, and major activity centers
- Drive economic growth
  - Facilitate access to employment
  - Reduce travel time to retail
  - Enable access to healthcare
  - Expand access to education
- Improve quality of life for individuals and communities
  - Eliminate transportation as a barrier
  - Expand access to mobility choices
  - Facilitate access to life services locally and via connection to the fixed route transit network

## Mobility Strategies

Service area delivery and strategies considered for this study were an integral part of identifying and defining the MOD zones. The overall definition and selection of the zones was primarily based on identifying areas with the following:

- A concentration of person with mobility needs,
- The coincidental absence of transit service within walking distance (less than ½-mile),
- Proximity (within 2-3 miles) of the Metro fixed route network, and
- Fulfillment of the mobility service goals and objectives.

The definitions helped determine the service strategies by zone, which will be discussed later in the report. The service delivery strategies considered for MOD service include:

- On demand *point-to-point shared-ride mobility* within a service zone which includes the provision of first mile/last-mile connections to the fixed network at designated mobility hubs,
- On demand *shared-ride first-mile and last-mile service* within a service zone that connects to the fixed transit network at designated mobility hubs,
- *Anchored on demand shared-ride point-to-point service* within a zone anchored at a retail hub with connection to the fixed network,
- *Flex service* in a defined service area that connects to the fixed network at a mobility hub, operates a semi-fixed route with fixed stops and serves off-route points by advance request,
- *Dynamic Flex service*, like the Flex service, but without fixed stops and the ability for the ride-hailing software to group riders at common pick-up and drop-off locations.

## 3.0 Public Involvement

This section summarizes the public involvement activities undertaken for the MOD study. The public involvement captured during the MOD study was an ongoing process that included continuous feedback and discussion. In order to properly engage with citizens in Hamilton County, a public involvement strategy was developed for this project that was successful in sharing project information as well as incorporating meaningful feedback into project decisions. Our goal was to provide an environment that promotes public feedback and input and encouraged dynamic two-way communication to help identify and promote the best on-demand service recommendations. We deployed a wide array of communication techniques, from traditional and grassroots, to more individualized methods, taking advantage of advancing technologies to gather input so members of the public can respond when it best fits their schedule.

The public engagement report describes a combination of virtual and in-person public involvement activities implemented to help all prospective riders and stakeholders understand and embrace the new on-demand services. The messages conveyed during these activities differed from traditional transit service changes because SORTA will be introducing new types of services. The authentic and compassionate voices of the team, equipped with in-depth knowledge of the transit services available in the Greater Cincinnati region, drove community involvement and understanding.

Residents, students, employees, transit riders, businesses, and community stakeholders were invited to outreach activities to help us understand the unique needs and characteristics of the transit community, stakeholders, businesses, and organizations that rely on transit, as well as those of the general public. The activities were selected to involve and engage underrepresented communities, including older adult populations, persons with disabilities, minorities, and low-income communities. Strategies to gather input from major employers, educational institutions, medical facilities, affordable housing advocates, and other communities of local significance are also included.

The activities were held virtually and in-person, in large group settings, personalized interviews, and through electronic surveys. These activities are further described in Appendix A. The Mobility On-Demand outreach activities were coordinated with the overall project schedule.



**Table 1: Summary of Outreach Activities**

Task Name	Between	
<b>Outreach Kickoff</b> (Virtual)	<b>Tuesday 9/7/21</b>	<b>Tuesday 9/7/21</b>
<b>Conduct Stakeholder Interviews</b> (Virtual) The Kroger Company Hamilton County Board of Developmental Disabilities Services Human Services Chamber of Hamilton County Southwest Ohio Council on Aging The Health Collaborative	<b>Monday 6/16/21</b>	<b>Friday 10/26/21</b>
<b>Internal Involvement</b> (In-Person) Access Bond Hill Queensgate Administrative Office	<b>Monday 10/11/21</b>	<b>Friday 10/17/21</b>
<b>Publish Surveys</b> (Online) Employee Survey County-wide Survey Zone Specific Surveys (6 zones)	<b>Monday 10/11/21</b>	<b>Friday 3/11/22</b>
<b>Facilitate Work Group Discussions</b> (In-Person)	<b>Thursday 10/26/21</b>	<b>Friday 10/17/21</b>
<b>Neighborhood Meetings</b> (In-Person) Avondale Library Blue Ash Library College Hill Branch Library Forest Park Senior Center Groesbeck Branch Library North Central Library SORTA Boardroom	<b>Monday 2/21/22</b>	<b>Friday 2/25/22</b>

## 4.0 Market and Gap Analysis

The market analysis and evaluation process used to identify and select the proposed MOD service zones is described in this section. The market analysis focused on mobility needs, as described by key socio-economic indicators, to highlight populations that are likely to benefit from mobility services in areas where fixed route service is not present or service levels are insufficient, or the service area density of demand and service area characteristics will not support traditional fixed route service.

Areas that show strong density of demand for transit should be served with fixed route transit. However, areas identified within Hamilton County where there is high mobility need but low density of demand are areas where MOD service may have potential as a service option. The socioeconomic and demographic characteristics examined include:

- Population
- Population Density
- Young Adults (age 15-24)
- Seniors (age 65 and over)
- Zero Vehicle Households
- Low Income Persons/Households in Poverty (Title VI)
- Limited English Proficiency (Title VI)
- Minority Populations (Title VI)
- Employment
- Employment Density
- Job Locations

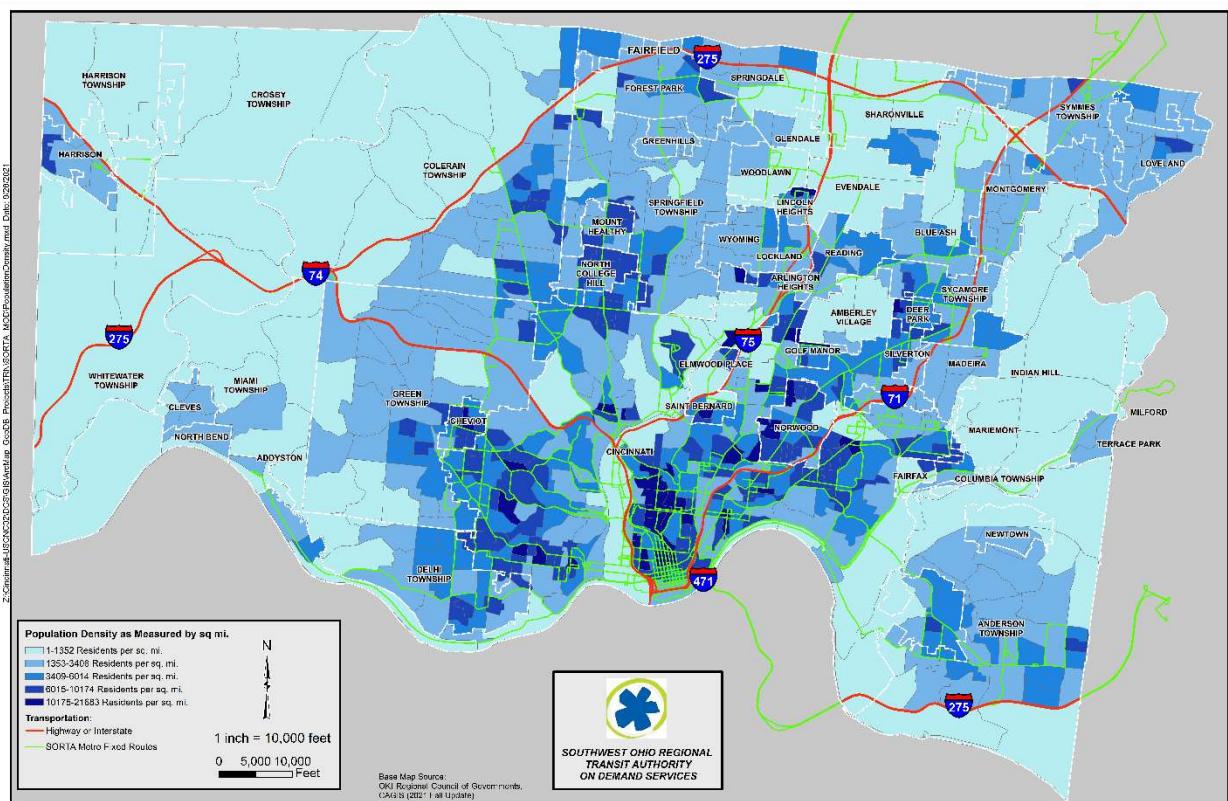
Minority, limited English proficiency, and low-income populations are required to be examined for Title VI service equity considerations. For this summary report, the focus of the market analysis is on the resulting relationship between our findings of the distribution and concentration of mobility need relative to the service catchment area of the existing Metro local transit services.

The information presented in this section comes from data collected from OKI, the Cincinnati region's Metropolitan Transportation Planning Organization (MPO). The primary data source is the American Community Survey (ACS) 2016 through 2019. While some data modules from Census 2020 have been released, for this analysis a single data source was used to allow for data comparisons and cross-references as needed.

## Population Density

Transit thrives in areas that have a higher population density. Higher population density means that transit can effectively serve the population in the area with direct service. While on-demand services can, and do, thrive in lower population density areas, areas that have a high population density and lack transit service are markets where on-demand services are likely to be successful. In addition, areas that have a medium population density that can easily be fed into a fixed route transit service can also perform well. Map 1 presents the population density of Hamilton County by the same census block groups referenced in total population and total household figures. This figure shows that neighborhoods surrounding Downtown Cincinnati, the west side of Cincinnati, and along major corridors in the first ring of suburbs, radiating from Downtown Cincinnati, have the highest population density in Hamilton County. Other concentrations exist in the Mount Healthy and North College Hill areas. This is not surprising given the historic development patterns of these areas which were primarily developed during the 19<sup>th</sup> and early 20<sup>th</sup> century prior to widespread automobile use. Medium population density, where the transit network may not be effectively providing adequate coverage, also exists in portions of Anderson Township, Harrison, Delhi Township Springdale, Sharonville, Madeira, and Blue Ash.

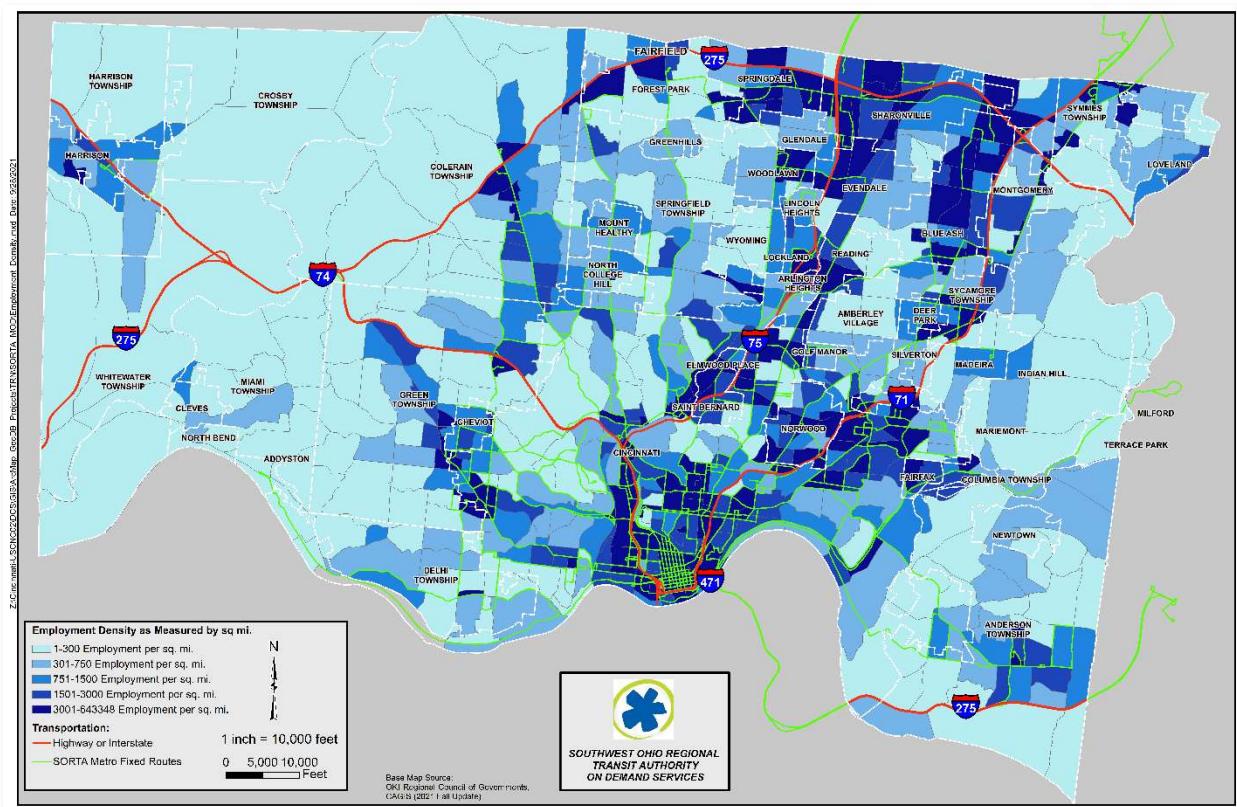
**Map 1: Population Density**



## Employment Density

Employment density is also considered an indicator of transit use as transit can serve dense employment clusters better than lower density of employment. The employment density map is presented on Map 2. What this figure shows is that the highest concentration of employment density is located along major interstates such as I-71, I-75, and I-275. Downtown Cincinnati, where several interstates converge, includes the highest concentration of employment density followed by the Uptown area surrounding the University of Cincinnati, which serves as the region's educational and healthcare hub. As you move away from Downtown Cincinnati, employment density does decrease, but where interstates converge the density is higher. Many of the radial corridors that do have high employment density are served by a fixed route service; however, as employment density moves further from a corridor, access to fixed route service becomes more difficult, creating an opportunity to connect these areas through a first mile/last mile service like MOD

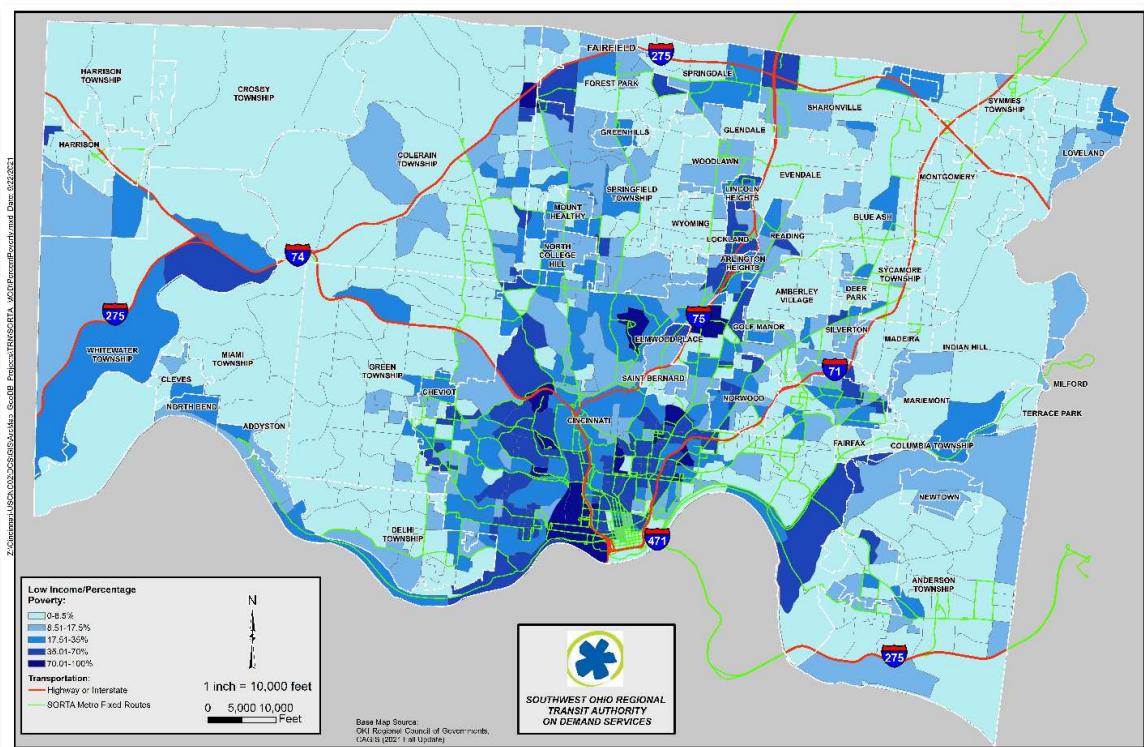
**Map 2: Employment Density**



## Low Income/Poverty

Income is another major indicator of transit demand, as many lower income citizens utilize the transit network for transportation in lieu of one or more privately owned vehicles. Lower income individuals tend to experience longer travel times and longer walk distances when using the transit network. Therefore, income is generally a very important indicator of transit demand, and based on land use and walking distance, an indicator that shows where on-demand service may improve the quality of transit access. Low income/poverty concentrations exist throughout Hamilton County. The map presented on Map 3 shows the concentrations of low-income residents on the west side of Cincinnati and nearby neighborhoods north of Downtown Cincinnati, as well as in the Avondale and Winton Hills areas. Additionally, there are concentrations in the northern parts of the county in the vicinity of Mount Healthy, Springdale, and Sharonville. Smaller concentrations of poverty exist in the Madisonville area, the East End of Cincinnati, Whitewater Township, and Delhi.

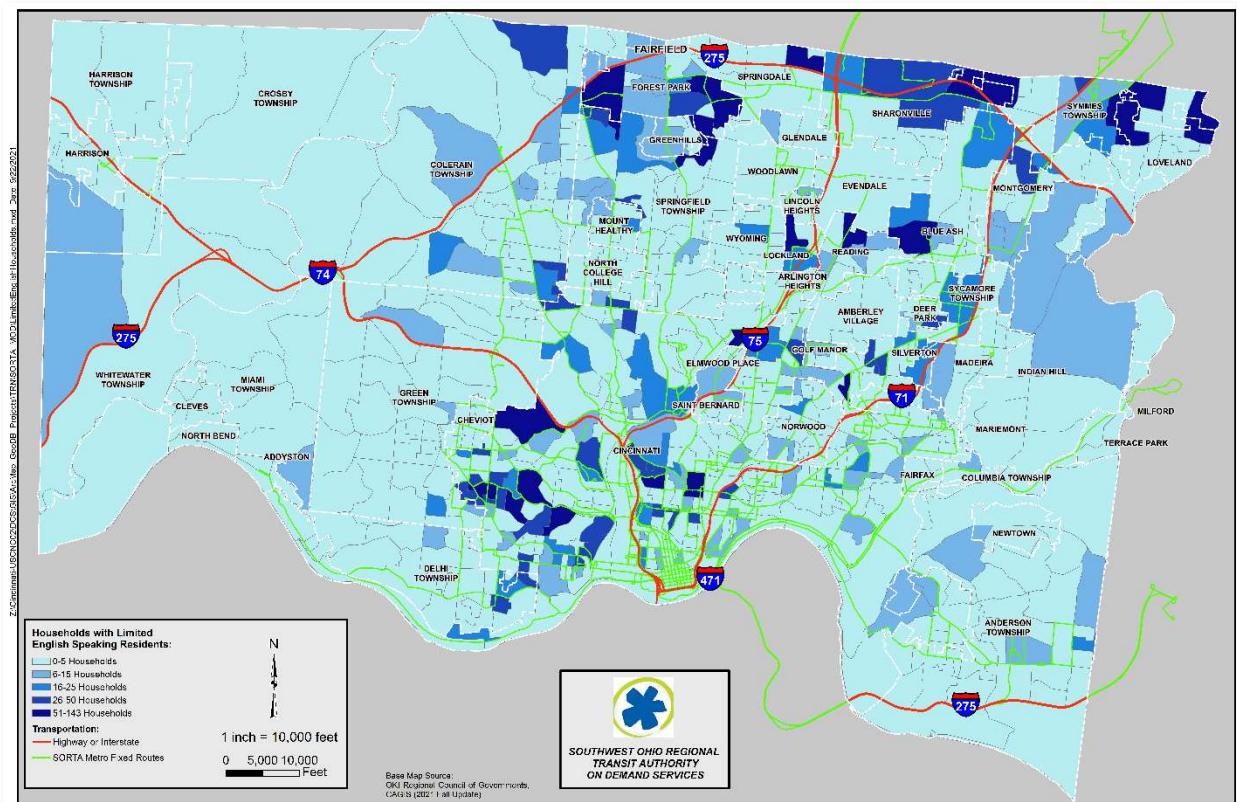
**Map 3: Low Income/Percent Poverty Population**



## **Limited English Proficiency**

Hamilton County has very few areas which have higher concentrations of residents with Limited English Proficiency (LEP), as shown in Map 4. LEP populations are reviewed because they are statistically correlate with low-income and minority status. The language barrier often limits ready access to transportation alternatives and an on-demand service may improve regional access for people who don't speak English proficiently. Also, in the Cincinnati area, LEP is seen as a Title VI indicator. Many of the areas that have higher concentrations of LEP populations are located in neighborhoods on the west side of Cincinnati and along the northern tier of the County. Other areas that have high concentrations of LEP populations are located as far east as Loveland and as far west as far west as Colerain Township. Monfort Heights, south area of Green Township, also shows a concentration of residents with LEP.

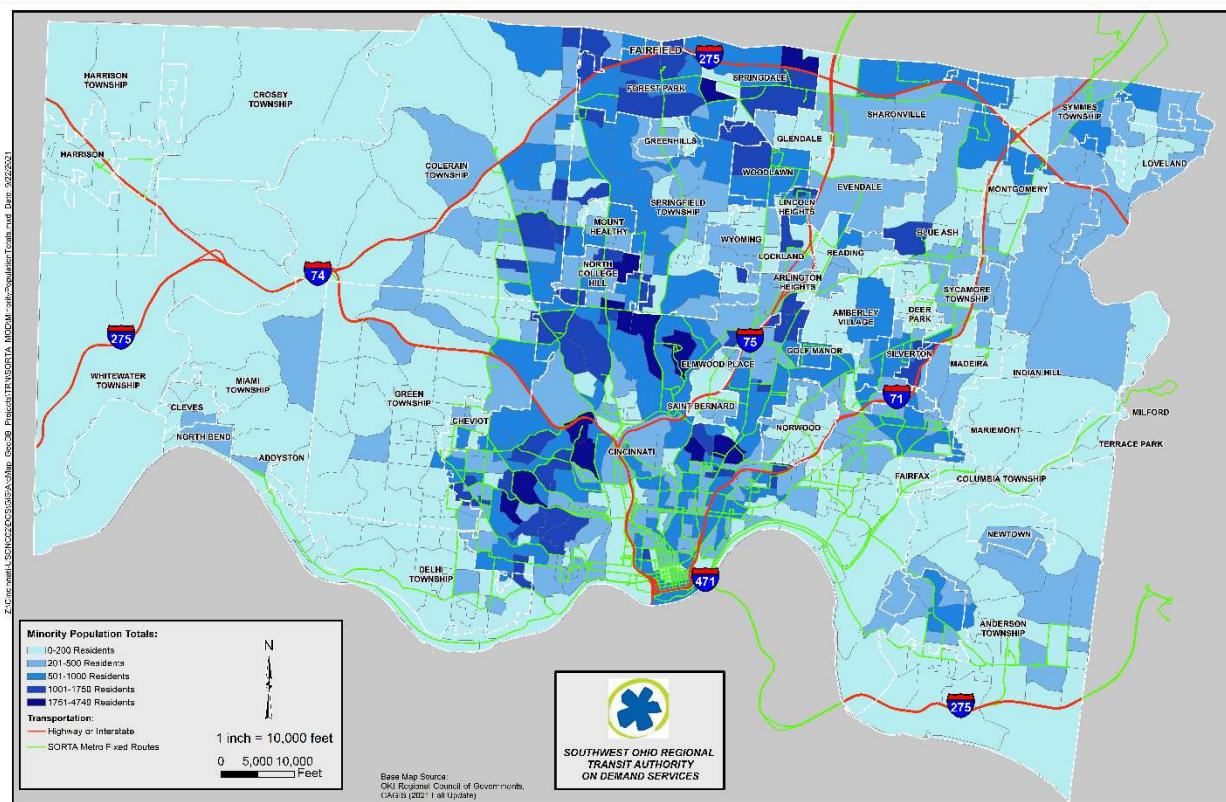
#### **Map 4: Limited English Proficiency**



## Minority/Non-White Population

While there are many other socio-demographic indicators that are more explanatory as to the reasons, this indicator is important not just because of the minority preponderance to transit, but it is also a major indicator for Title VI purposes. Map 5 shows that the greatest concentration of the minority/non-white population is concentrated in the central portion of the county stretching from the Ohio River downtown to the northern county line generally bounded by I-71 and I-74 on the east and west. These populations are generally concentrated in the urbanized portions of the county including includes areas within the City of Cincinnati, Silverton, Springdale. Forest Park, Mount Healthy, Lincoln Heights, and North College Hill.

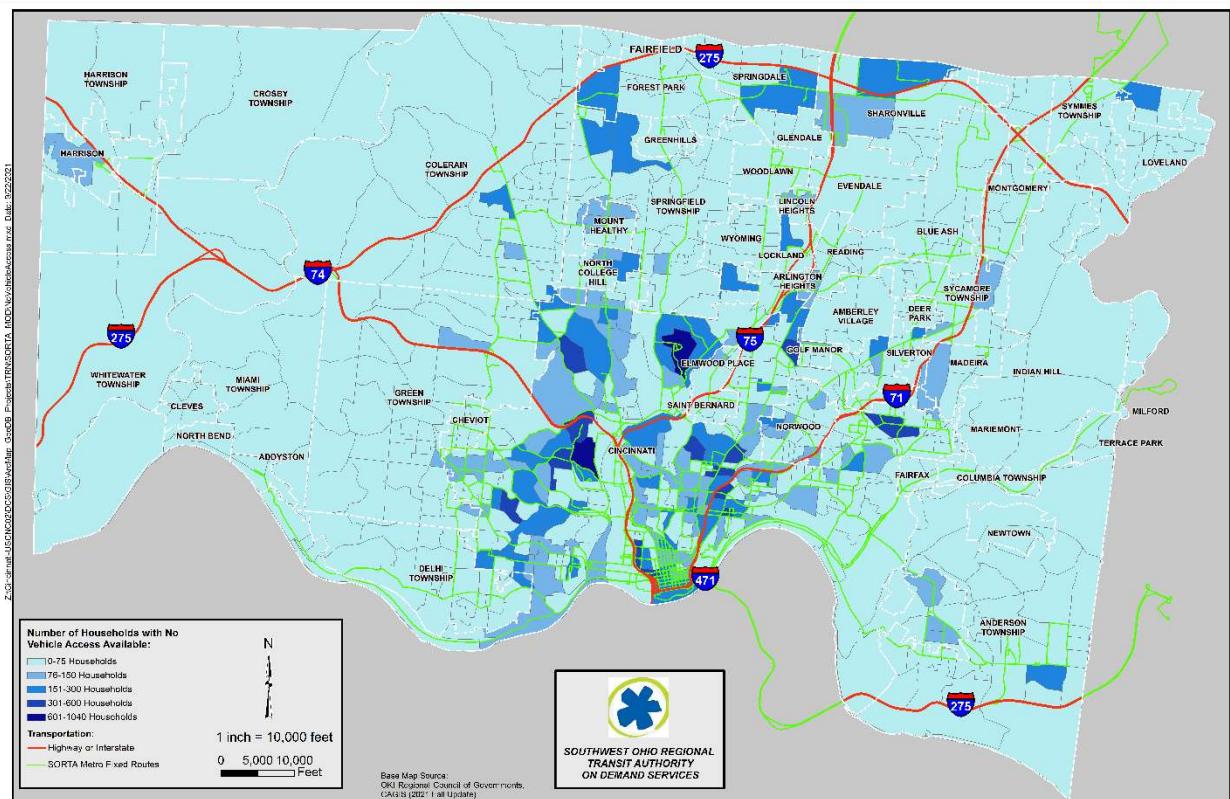
### **Map 5: Minority/Non-White Population**



## Zero-Car Households

Zero-car households are considered transit dependent given that the lack of access to a privately owned vehicle means that bus service is typically the primary transportation mode for many zero-car households. The zero-car household distribution throughout Hamilton County is presented on Map 6. This figure shows a preponderance of zero-car households in a number of places in the central corridor of Hamilton County including Downtown Cincinnati, Winton Hills, South Fairmount, Price Hill, Mt. Auburn, Avondale, College Hill, Madisonville, Springdale, and Sharonville.

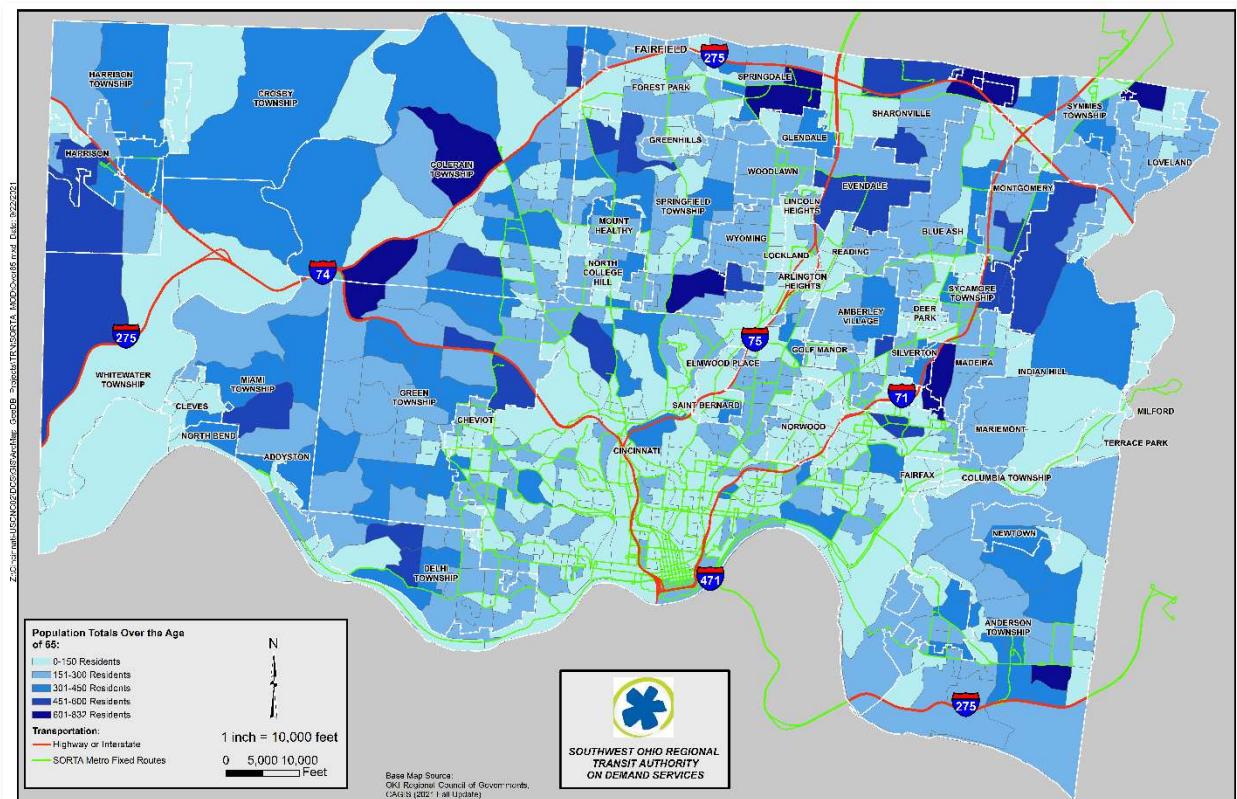
### Map 6: Zero-Car Households



## Older Adult Population (Over Age 65)

Older adults can be mobility limited due to physical or cognitive restrictions in operating an automobile; therefore, are a population that has a higher need to use transit. The older adult population is less concentrated within the City of Cincinnati and more concentrated in suburban and rural areas of Hamilton County. Communities that have higher concentrations of older adults include Madeira, Sycamore Township, Miami Township, Delhi, Colerain and Anderson Townships, Silverton, Evendale, Sharonville, and Springdale. These patterns are shown on Map 7.

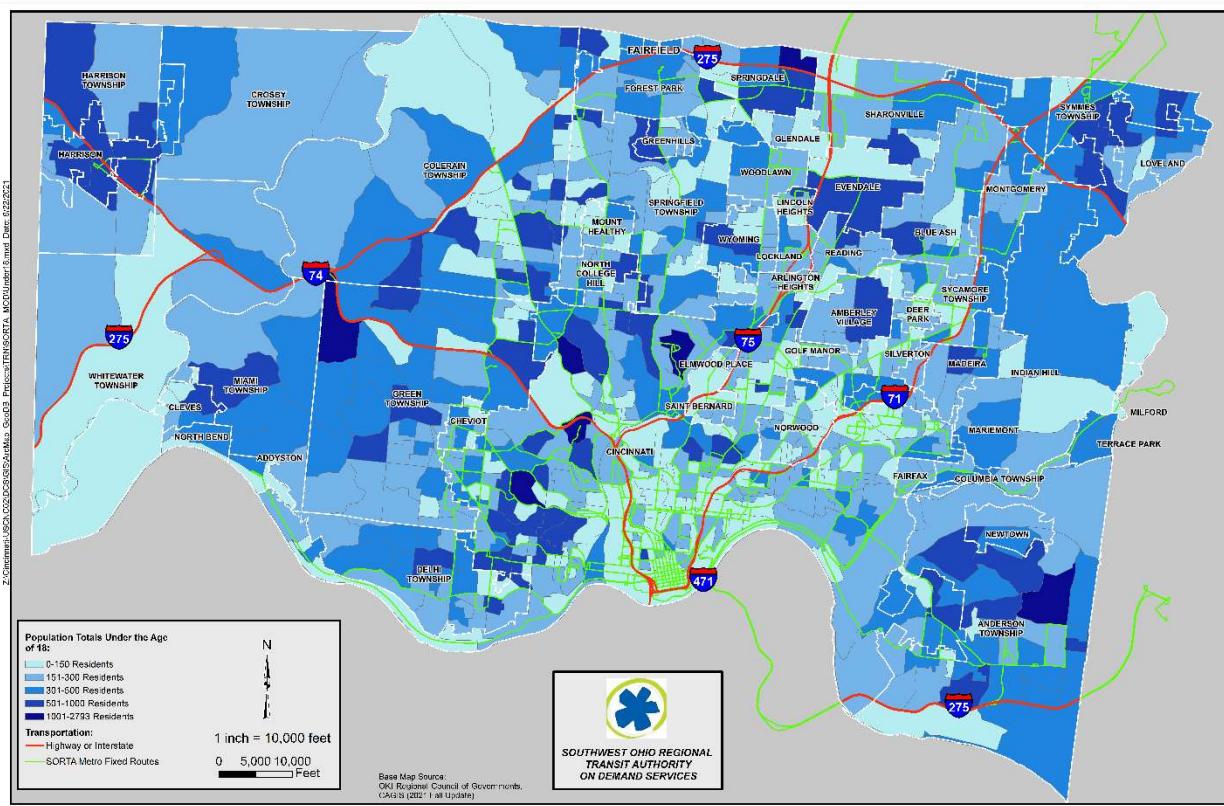
**Map 7: Older Adult (Ages 65 and above) Population**



## Youth Population (Age under 18)

Youth populations (under 18 years of age) are also more likely to be users of the transit network as it provides access to schools and non-school related activities. Map 8 presents the distribution of the youth population throughout Hamilton County. This map shows that the youth population is dispersed throughout the county and generally in suburban location. However, the greatest number of youth populations are not in areas near major business districts where residential land uses are less common. Some lower density areas also have very few people under 18 years of age. Concentrations of youth populations can be seen in various neighborhoods both within the City of Cincinnati and suburban locations throughout the county.

**Map 8: Youth Population**



## Conclusion

The socio-demographic indicators indicated that the primary areas where transit demand is the highest are in areas where SORTA's fixed route transit service is already being provided (primarily within the City of Cincinnati and close in suburbs along major corridors). However, these indicators also point to areas that are currently underserved by transit, primarily along the northern tier of Hamilton County in suburban communities such as Blue Ash, Sharonville, and Springdale. Additionally, other areas that are noticeably underserved include Madisonville, Anderson Township, and Delhi. Neighborhoods on the west side of the city are served well with transit but still demonstrate a need for additional service. Also, some urbanized lower income neighborhoods, such as Avondale, have a centralized gap that is not being met by the current transit network. The areas

identified in this section have some level of unmet transit need that will benefit from an on-demand service.

## Gap Analysis

The gap analysis is an evaluation process that compares existing transit service coverage to potential mobility need using the Transit Orientation Index (TOI) analysis results for the SORTA service area. TOI is analysis used to identify areas in which a traditional transit market exists. To create a TOI, demographic ACS 2019 5-year estimates were compiled and categorized according to potential transit need based on the prevalence of specific demographic characteristics. The characteristics are compared to the general population characteristics to identify concentrations transit need.

The use of gap analysis has become a standard practice for assessing mobility need and determining the performance of public transit in meeting the mobility needs of the transit-disadvantaged populations within a service area.

Calculating the TOI based on the four socioeconomic characteristics at the Census block group level in Hamilton County, each block group was assigned a composite ranking from 1 to 4 (with 1 being very low mobility need and 4 being very high). The rankings demonstrate areas with a high proportion of the population that are more prone to need transit. Results of this analysis identified areas with populations that have a higher TOI and thus a higher propensity to need and to use transit.

The composite ranking for each census block group was assigned a level of transit orientation (“Very High,” “High,” “Medium,” and “Low”). Areas that ranked “Very High” reflect a very high transit orientation, i.e., a high proportion of transit-dependent population, and those ranked “Low” indicate much lower proportion of transit-dependent populations.

The gap analysis aims to identify geographical gaps in public transit where travel needs are medium to high, but services are non-existent (unserved) or insufficient (underserved). This is a twofold process that uses socioeconomic data and ArcGIS. The first step involves determining transit service subareas with high transit TOI scores, as mentioned above. The TOI score is then mapped to the SORTA service area, as shown in Map 9.

The second step uses geographic analyses to determine the extent of each route’s service reach by using ArcGIS buffers. Ultimately, the two outputs are overlaid with one another to identify general gaps in the SORTA transit service, and more specifically, high priority TOI areas that are served, unserved, or underserved. Note that areas beyond the route catchment area (the buffered area along the route) are considered to be unserved.

Areas with “very high” TOI gaps are located outside of the ¼-mile catchment area are located predominately east of I-75 just north of Downtown Cincinnati. The “high” pockets are dispersed throughout the service area but are mainly located north near I-275 and east near I-71. Areas with “medium” TOI gaps are located throughout the service area and have limited access to transit outside the ¼-mile threshold for walkability.

## Young Adult Population (Ages 15-24)

The young adult population represents those who are beginning to drive or have recently begin driving. In addition, this cohort also include college aged adults who have been driving for a number

of years. This population requires mobility options because some may still be dependent on other for mobility other than walking, bicycle, and transit. As those in the age cohort, they may lack mobility because they have not yet acquired a personal vehicle, or they cannot afford a personal vehicle. The distribution of the young adult population (15-24) in the study area is included in Map 9, gap analysis.

### **Automatic Passenger Count (APC) data**

APC data was included in the analyses from 2019 to illustrate the average daily boardings at the stop level along each route for local and express routes, respectively. This information displays where stops in the SORTA system have the lowest average daily ridership. This is an important metric to consider when reviewing neighborhoods and areas where on-demand services may be provided in the future. Map 10 shows the APC data for local routes in the service area from 2019. Map 11 shows the APC data for express routes in the service area from 2019.

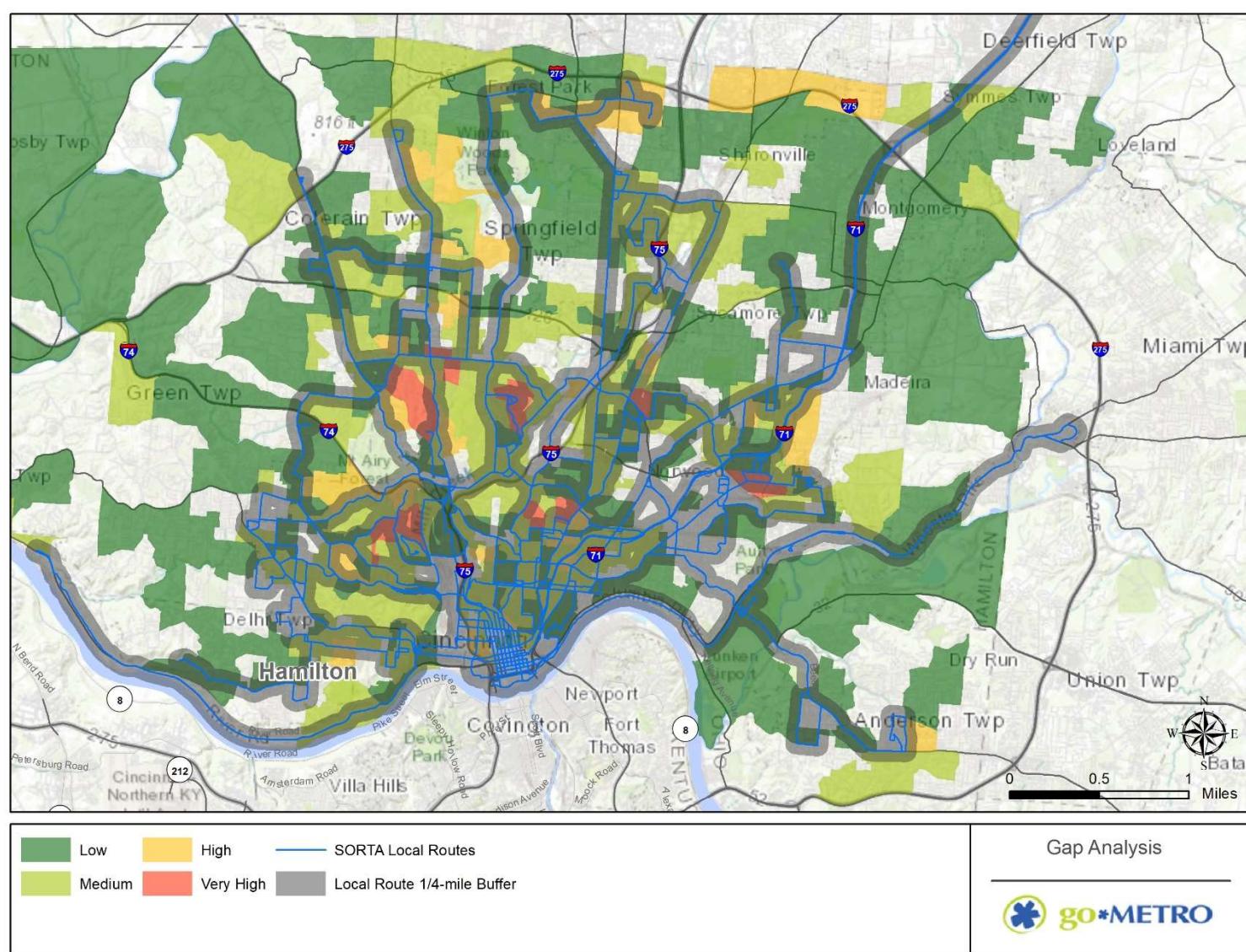
### **Access Paratransit Ridership**

A heat map analysis was generated to show where paratransit trips originate and end in the service area. Map 12 shows paratransit boarding locations. Most trips begin and end near Woodlawn and Glendale just south of I-275. Other areas that have a higher number of pick-ups and drop-offs are Blue Ash, Sycamore Township, and Norwood.

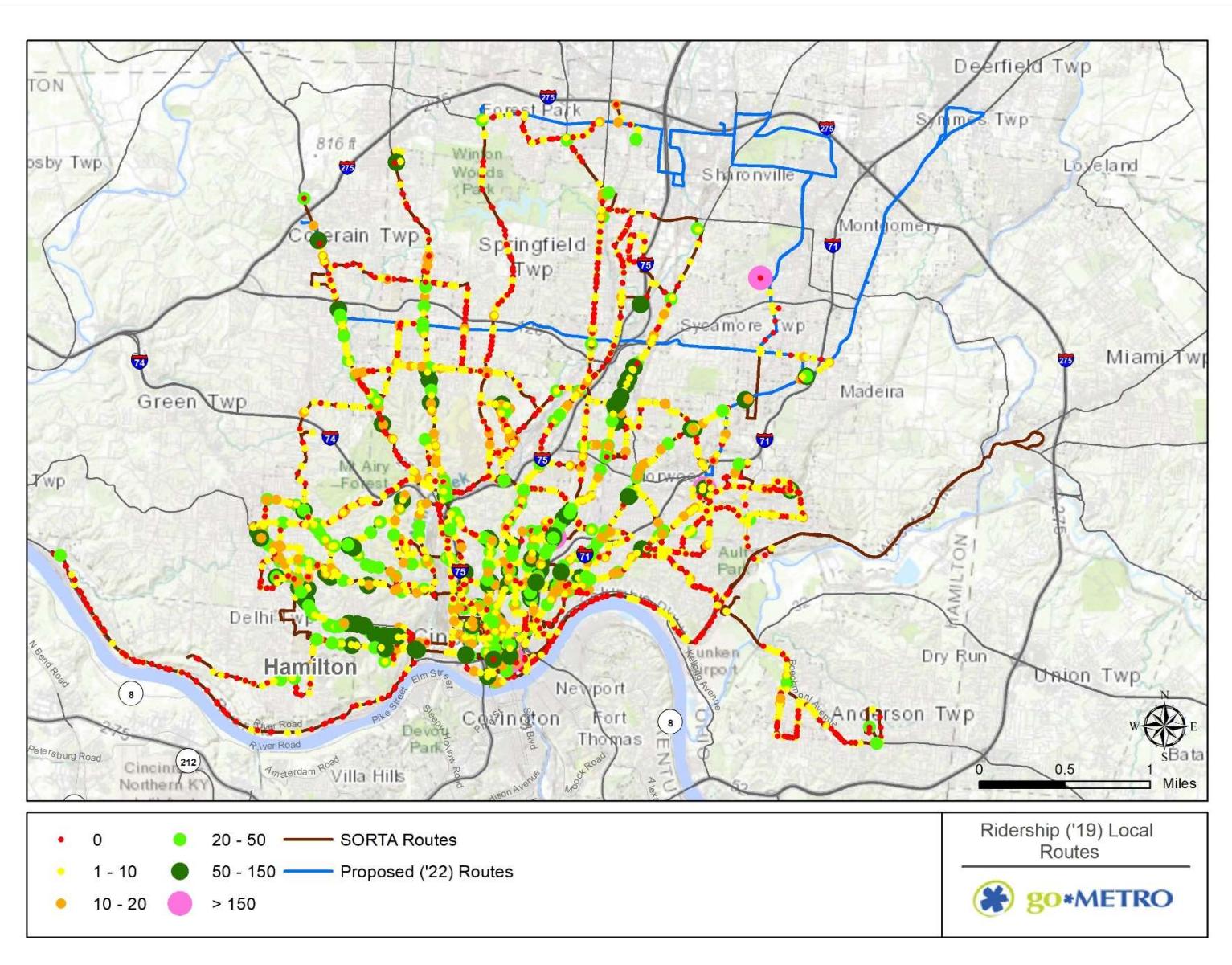
### **Transit Service Performance Indicators**

Transit service performance indicators were assessed to see how efficiently SORTA supplies fixed route and express transit service and how effectively those services meet the needs of the areas served. Performance indicators are included in Appendix B. These indicators help highlight the recent performance trajectory of the transit agency and can be useful for addressing negative trends before their impact to the agency becomes too burdensome.

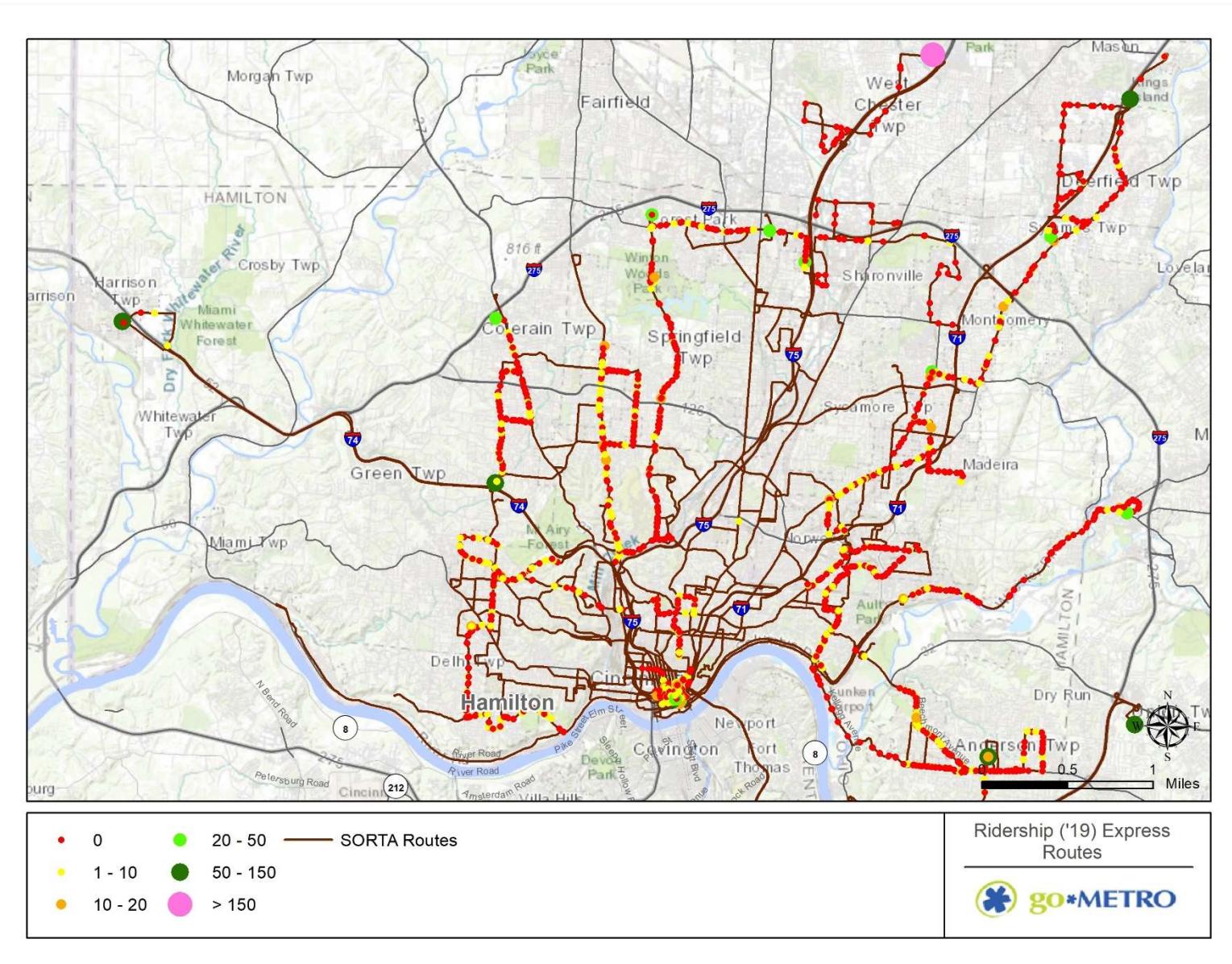
Map 9: Gap Analysis



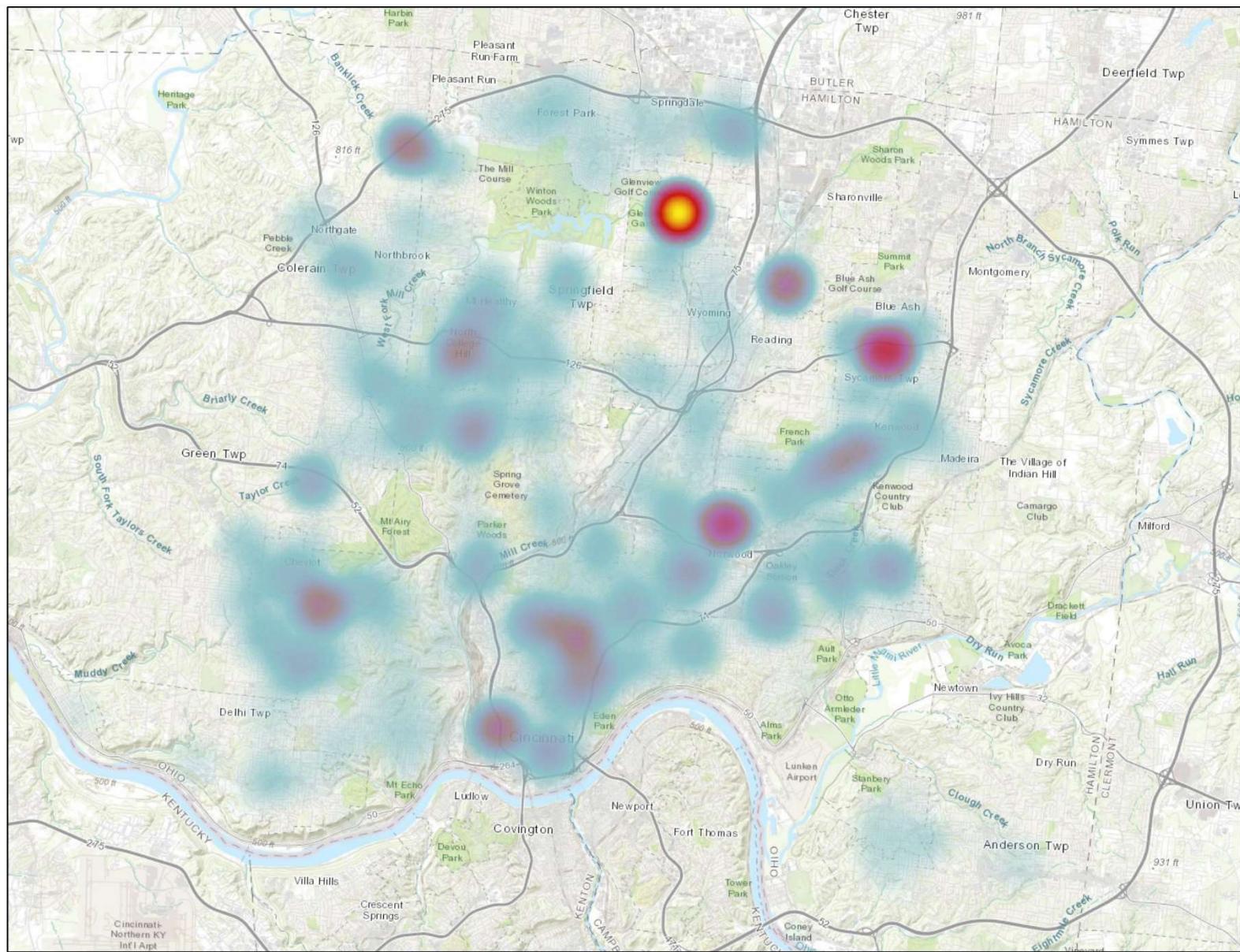
Map 10: APC Local Routes



Map 11: APC Express Routes



Map 12: Paratransit Pick-up Locations



## 5.0 Service Market Evaluation

Reinventing Metro identified certain areas of Hamilton County for potential on-demand services. The locations listed in this section are primarily suburban areas in the northern portion of the county where fixed route buses are not efficiently served, as they are less dense with both residences and businesses set back from the roadway.

The design of each on-demand zone allows for streamlining fixed-route services to ensure that they operate along an optimized routing to improve service reliability and on-time performance, reduce travel times and revenue hours, and make the route function more as a trunkline service rather than a collector service. These refinements improve the attractiveness of fixed-route service for riders by offering a more direct and shorter ride. This also makes the transit network more efficient to operate, which allows SORTA the opportunity to invest saved revenue hours into increased service frequencies. The objective is to create a better-functioning and more attractive mobility network for SORTA, current riders, and potential new riders by overlaying and integrating a network of on-demand services connected to the regional fixed-route network at a series of mobility hubs.

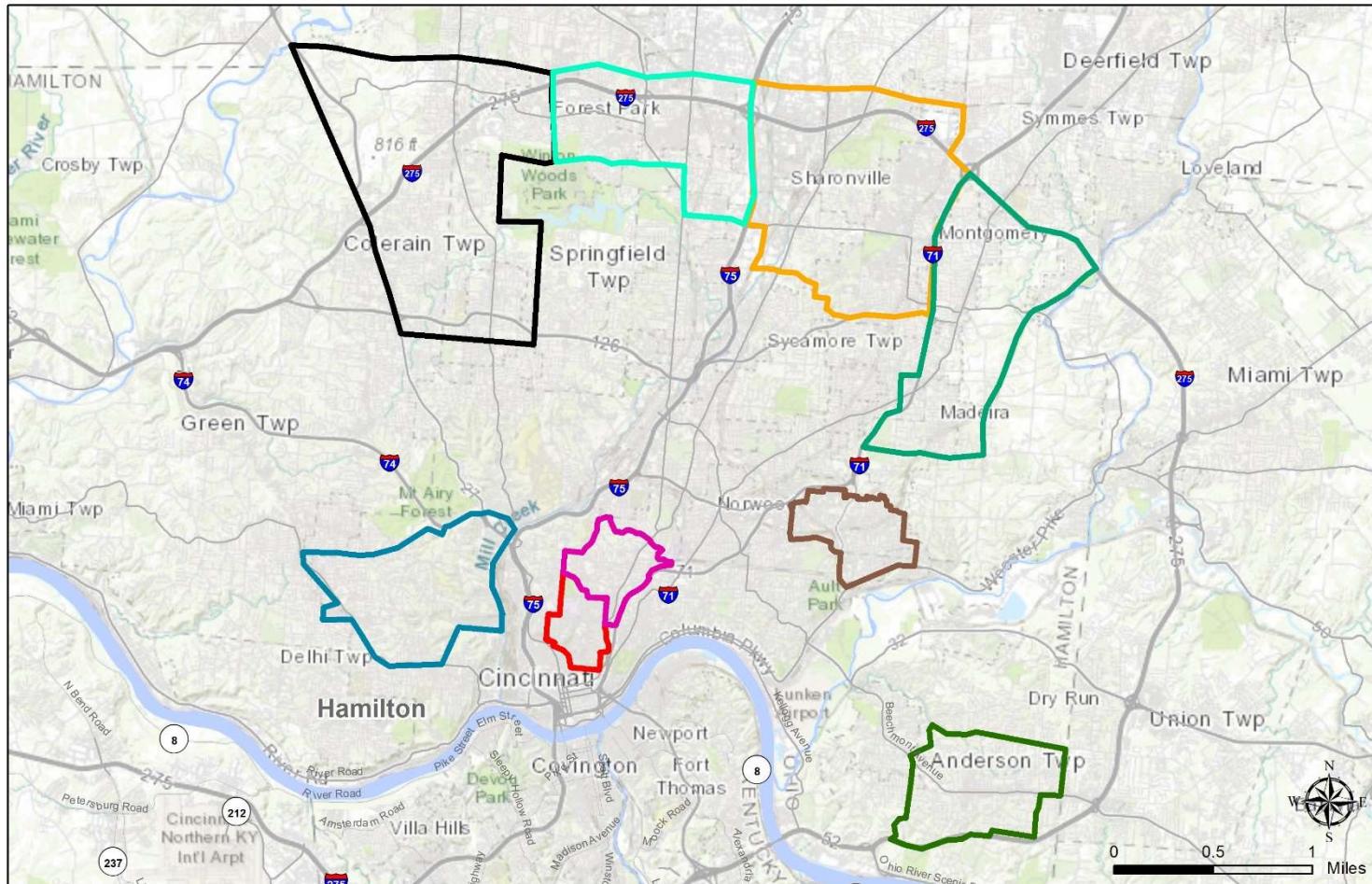
### Service Area Identification

An initial set of nine areas were examined and screened based on a set of evaluation criteria. These criteria include population, percent minority, percent persons aged 65 and older, percent of persons aged 15-24, percent of low-income persons. These need-based indicators were used to calculate a mobility need index. This is the same index used in the mobility gap analysis. The need index was then factored based on the percentage of the service area within the service catchment of the existing Metro local transit routes. The results were used to rank each area and refine the areas to be considered further as candidates for MOD service areas. Table 2 presents the mobility gap rankings. Map 13 presents the initial areas examined.

**Table 2: Service Area and Mobility Needs – Initial Screening**

Service Area	Pop.	Minority	Snr. (65+)	15-24	Low Income	Need Index	Local Transit	Transit Score	Rank
College Hill/Mt Healthy /Pleasant Run	61,741	54%	16%	11%	15%	0.95	21%	0.75	6
Springdale/Sharonville	22,844	64%	19%	12%	16%	1.10	36%	0.71	1
Blue Ash/Sharonville	25,618	24%	20%	10%	8%	0.62	11%	0.55	2
Madeira/Montgomery	24,749	17%	21%	9%	3%	0.49	15%	0.42	3
Anderson Township	21,981	9%	18%	10%	5%	0.42	23%	0.33	5
Westside	47,516	69%	9%	13%	34%	1.25	85%	0.19	8
Avondale/Uptown	15,245	79%	11%	17%	47%	1.53	92%	0.12	9
Madisonville	14,009	38%	14%	10%	15%	0.77	87%	0.10	7
Clifton Heights/CUF	18,426	37%	5%	63%	45%	1.51	100%	0.00	4

Map 1: Initial Neighborhood Zones



 Anderson Township  
 Avondale  
 Blue Ash/Sharonville East  
 Clifton Heights

 Westside/English Roll Hill  
 Madeira/Montgomery  
 Madisonville

 North College Hill/Mt Healthy/Pleasant Run  
 Springdale/Sharonville West

Initial Neighborhood Zones

 go\*METRO

The project team met with stakeholders and the public to gather feedback about the MOD concept and asked for input about areas to be considered for MOD service. Based on feedback from stakeholders and the public, the project team refined the service areas to incorporate public comment collected from October 11, 2021, to October 15, 2021. Following these initial set of public outreach efforts, the service areas were further refined and evaluated as shown in Table 3. Appendix A provides details on the public outreach activities and Appendix C provides additional details on the service area evaluation and screening process.

Table 4 presents the screening results. Most noteworthy in these results is the elimination of areas primarily due to either high existing transit service coverage or lower mobility need relative to the other areas being considered. A good example of this includes Clifton Heights, Avondale, Uptown. These areas have high mobility need and high transit coverage. However, the transit service structure within these areas requires a more complex solution than solely the application of MOD. Areas such as Anderson Township, and Montgomery-Loveland have relatively low mobility need, low existing transit and paratransit ridership, and lower latent demand compared to the other areas.

**Table 3: Service Area and Mobility Needs Evaluation**

Neighborhood	Need Index <sup>1</sup>	Local Access <sup>2</sup>	Job Access <sup>3</sup>	Paratransit Boardings <sup>4</sup>	Local Boardings <sup>5</sup>	Need Scoring <sup>6</sup>	Need Gap Rank <sup>7</sup>
Avondale/Evanston/Uptown/Walnut Hills	1.40	94.5%	1	78.96	8,316	6.10	0.34
Westwood	1.22	84.0%	1	52.68	4,238	4.84	0.77
Winton Hills	1.01	71.2%	1	27.71	1,530	3.52	1.01
Montfort Heights/Mt. Healthy/Northgate	0.93	55.2%	1	92.56	1,923	4.93	2.21
Springdale/Glendale/W. Sharon Woods	1.06	47.6%		76.26	358	4.59	2.41
Pleasant Run	1.00	17.7%		25.50	285	2.51	2.06
Madisonville	0.95	79.9%		38.48	1,075	2.95	0.59
Blue Ash/Evendale	0.54	37.1%		48.64	551	2.54	1.60
Sharon Woods/Highpoint	0.65	38.5%		0.00	0	1.65	1.01
Montgomery/Loveland	0.51	17.8%		0.00	0	1.51	1.24
Anderson Township	0.40	15.7%		2.45	76	1.40	1.18

<sup>1</sup>Sum of (each need factor\*population)/population

<sup>2</sup>Percent of service area within 1/4-mile fixed route transit buffer (local).

<sup>3</sup>Areas with high Job Access assistance zip codes.

<sup>4</sup>Paratransit boardings (average weekday)

<sup>5</sup>Local transit boardings (average daily)

<sup>6</sup>Need scoring (add Need Index + Job Access + paratransit), Need Index greater than 1 is weighted 1.5.

<sup>7</sup>Need Gap Rank (Need Scoring less Local Transit Access)

**Table 4: Service Area and Mobility Needs Screening**

Neighborhood	Proposed Status	Comments
Avondale/Evanston/Uptown/Walnut Hills	REMOVE	<b>High need index</b> , high transit, complex mobility
Westwood	REMOVE	<b>High need index</b> , high transit
Winton Hills	KEEP	<b>High need index</b> , high transit, low paratransit, job access
Montfort Heights/Mt. Healthy/Northgate	KEEP	Medium need index, medium transit, high paratransit, job access
Springdale/Glendale/W. Sharon Woods	KEEP	<b>High need index</b> , medium transit, high paratransit
Pleasant Run	KEEP	<b>High need index</b> , low transit, low paratransit
Madisonville	REMOVE	Medium need index, high transit
Blue Ash/Evendale	KEEP	Low need index, medium transit, medium paratransit
Sharon Woods/Highpoint	REMOVE	Medium need index, medium transit
Montgomery/Loveland	REMOVE	Low need index, low transit, low paratransit
Anderson Township	REMOVE	Low need index, low transit, low paratransit

Following the initial screening efforts, the project team combined the resulting areas into larger zones to improve operations and eliminate service gaps between zones that would hamper MOD service delivery. Based on these further evaluations and findings from the public outreach, the project team created six (6) larger zones to capture areas with a higher transit need that are currently underserved by transit or are difficult to serve with fixed route transit. The service areas were carefully examined to avoid cannibalizing fixed route transit. If an area was well served by existing fixed route transit, the area was likely not included for further consideration. However, if an area had higher job access or a higher transit need gap, they were considered for further evaluation and potential refinement. The six neighborhood zones include multiple neighborhoods that combined, equate to approximately 65 square miles and a population of over 187,000. The resulting candidate MOD zones are listed below and displayed on Map 14.

- Zone A - Blue Ash/ Evendale
- Zone B - Montfort Heights / North College / Finneytown
- Zone C - Northgate / Mt. Healthy
- Zone D - Pleasant Run North
- Zone E - Springdale / Glendale / Sharonville
- Zone F - Winton / Bond Hill / Roselawn

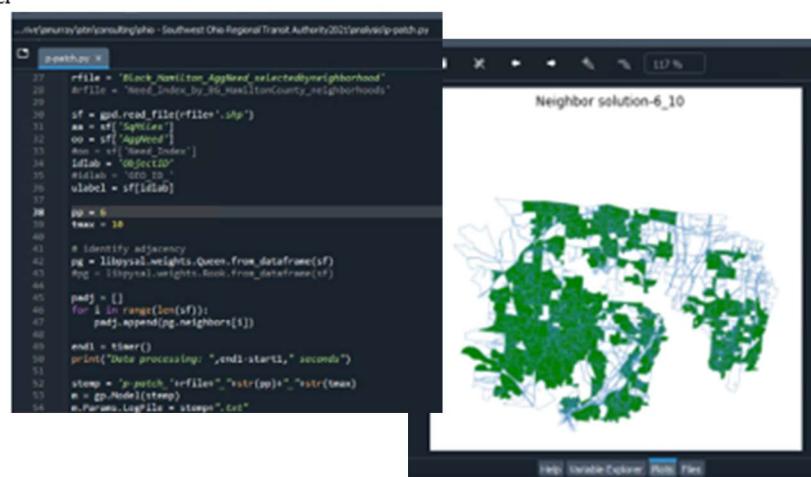
## Service Area Spatial Optimization

The project team made further refinements to the larger six MOD zones from the previous analysis through the use of spatial optimization and initial MOD service planning. The intent of the spatial optimization modeling was to use advanced mathematical analytics to help identify the optimal service area and mobility solution for each zone.

The spatial optimization model examined Census block level data to identify, concentrate, and connect Census blocks with high mobility need. The intent of the model was to create contiguous groupings of Census blocks with high mobility needs by optimizing block groupings based on variables of either 4, 5, or 6 zones and the allowable size of the zones (5, 6, 7, 8, 9, or 10 square miles). The optimization equation and a sample output of the model is illustrated below. Appendix E provides maps for the zonal optimization analysis results for service area.

Neighborhood identification spatial optimization model

$$\begin{aligned}
 & \text{Maximize} && \sum_i \beta_i X_i \\
 & \text{Subject to} && \sum_i V_i = p \\
 & && \sum_{j \in \Phi_i} Y_{ij} - \sum_{j \in \Phi_i} Y_{ji} \geq \alpha_i X_i - \tau V_i \quad \forall i \\
 & && \sum_{j \in \Phi_i} Y_{ij} \leq \tau X_i \quad \forall i \\
 & && V_i \leq X_i \quad \forall i \\
 & && X_i \in \{0,1\} \quad \forall i \\
 & && V_i \in \{0,1\} \quad \forall i \\
 & && Y_{ij} \geq 0 \quad \forall i,j
 \end{aligned}$$



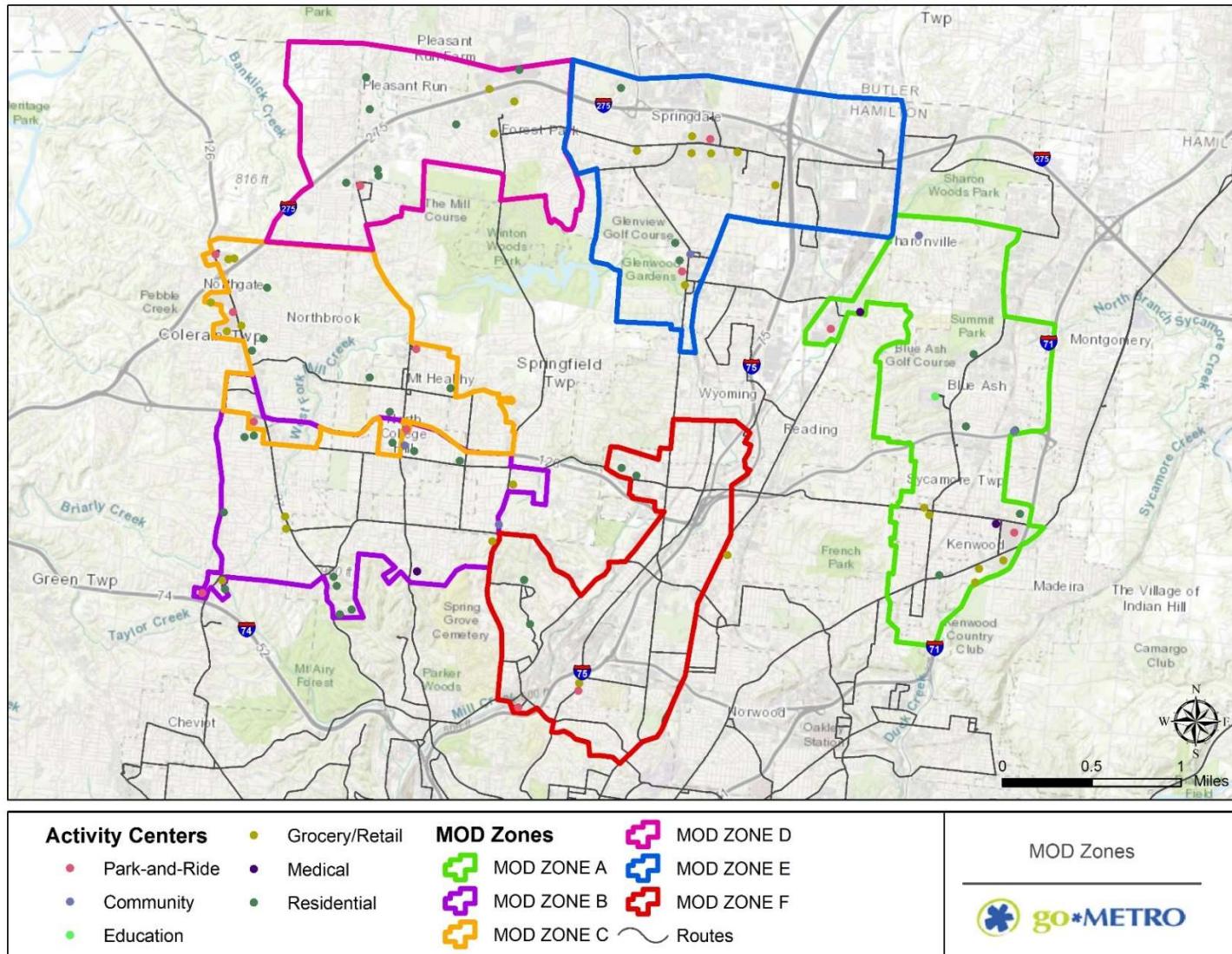
The optimization model captures identified transit need by Census block within the candidate MOD zones as well as the Census blocks directly outside the candidate MOD zones. This analysis identified the high aggregated need blocks derived from minority population, older adult (65+) population, younger adult (15-24) population, zero vehicle households, and households in poverty. Aggregate mobility need was identified in blocks based on these population and household characteristics and measured as a percentage of need compared to the total population and households within each Census block. Any Census blocks beyond the zone were apportioned to the area within the zone. This was also the process for any Census blocks that were split by the zone boundary.

Recognizing that the analysis of mobility need is based on the person and therefore reflects residential locations and not trip generators such as work, school, shopping, healthcare which create the need for trip-making, the project team made further refinements to the zones to ensure zones included residential based need and trip generators. Therefore, the final recommended MOD zones reflect multi-family housing complexes, grocery stores, retail centers, healthcare, educational, employment, and mobility hubs.

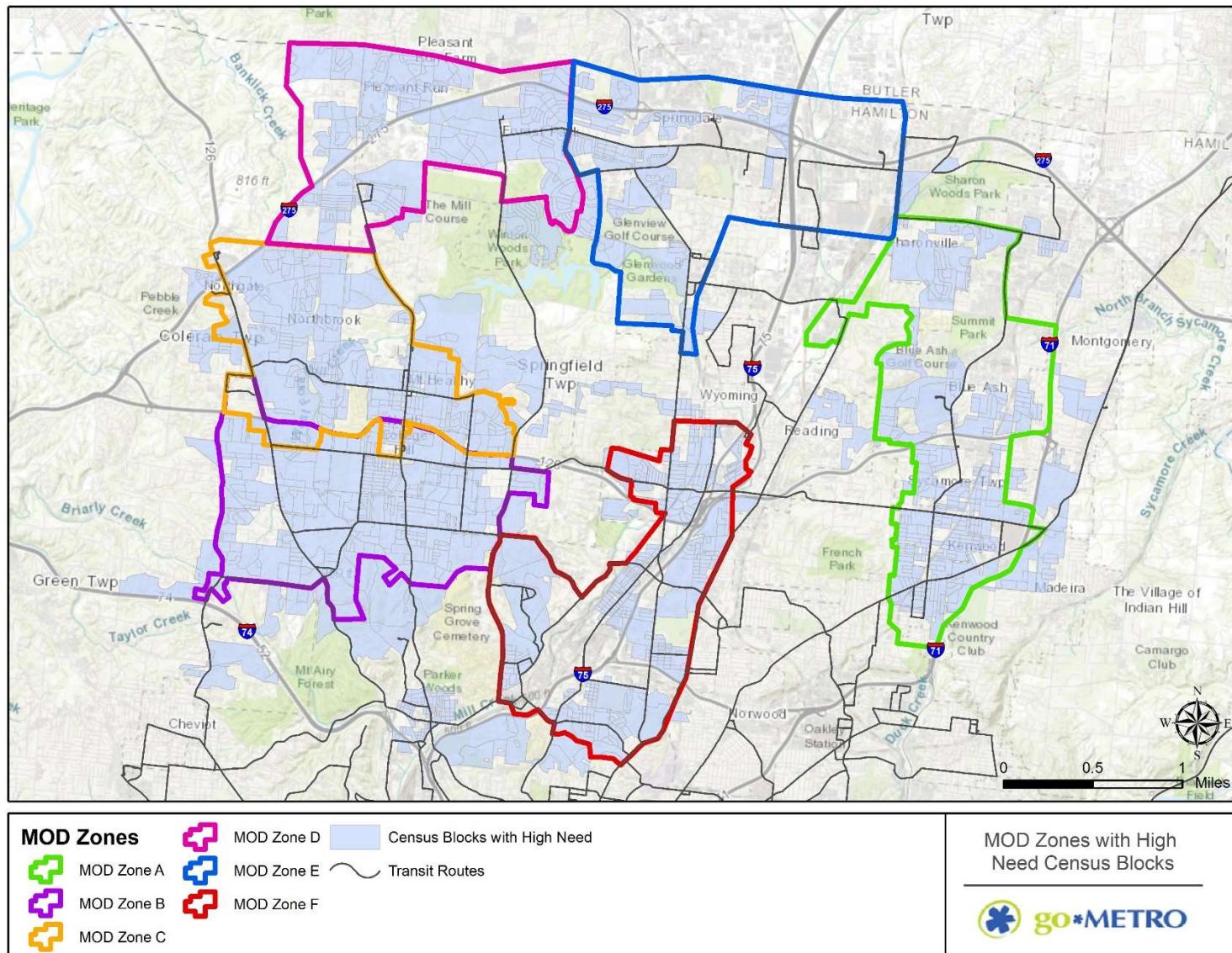
The zones also reflect consideration of land use and street networks. The boundaries of the zones tend to follow major arterial road networks so as not to exclude portions of neighborhoods which prevent riders from accessing service. Further, zone creation included MOD service concept development and operational considerations – point-to-point MOD, Flex, Dynamic Flex – with the type of service delivery strategy within each zone depending on geography, land use, street network, demand, peak volumes. These considerations are addressed in the next section.

Map 15 presents an example of the optimized model for six zones with an average area of eight (8) square miles with the shaded areas reflecting the contiguous groupings of higher mobility need Census blocks. Maps for each zone are in Appendix E.

Map 14: Recommended MOD Zones



Map 15: Spatial Optimization of MOD Zones



## 6.0 MOD Service Development

The selection of MOD zones and MOD service design considered the relationship between the proposed MOD service, the existing fixed route network, and the potential for access to mobility to be expanded and improved for persons within each MOD zone, locally as well as connections to regional destinations. This consideration factored into the evaluation of candidate MOD zones. The objective being to identify opportunities to refine and streamline fixed routes, where needed, to operate along an optimized routing to improve service reliability, on-time performance, reduce travel times, revenue hours, and make the route function more as a trunkline service rather than a collector service. These refinements improve the attractiveness of fixed-route service for riders by offering a more direct and shorter ride. This also makes the transit network more efficient to operate and may allow saved service revenue hours to be reinvested to improve service frequencies. The objective is to create a better-functioning and more attractive mobility network for current riders and new riders by overlaying and integrating MOD services to the regional fixed-route network at key mobility hubs.

### Service Models

The project team examined and evaluated the following MOD service models. Each is described and identified as whether it is recommended for Metro for the initial pilot services.

- *Flex service*, also known as point-deviation service, is a quasi-fixed stop and fixed schedule service. While a traditional fixed route bus service operates along a fixed route and a fixed schedule, Flex service operates from stop to stop in sequence with the stops being more dispersed and with the bus operation permitting the vehicle to deviate or flex into adjacent neighborhoods (within a designated buffer) to pick up or drop off passengers. These off-route events must be requested by the rider in advance of boarding the vehicle. Off-route pickups and drop-offs cannot be accommodated without advance request and still maintain the Flex service schedule, especially during peak periods vehicle capacity. Riders who board and alight the Flex service at fixed stops do not need to request a ride in advance. However, at key transfer locations, the lack of knowledge of how many passengers are waiting to board the Flex service will create overcrowding conditions during peak periods and will require additional vehicles to avoid turning away passengers. Flex services were originally created before the advent of the smart phone to introduce transit services that covered broader service areas than fixed route was able to, especially in locations with lower density of demand. Based on these operating considerations, and the results of the spatial optimization modeling, the Flex service model is *not recommended* for Metro.
- *First-mile/last-mile MOD service*, provides point-to-point on demand shared-ride service within a designated service zone. All trips must be requested (immediate or scheduled for a future time). However, under this service model, travel requests are limited to trips to and from a fixed route (connection at a mobility hub). For example, this model would provide a trip between home and the closest mobility hub or from a retail center to the closest mobility hub, but it would not serve a trip between home and the retail center, even if the two locations are within the same MOD zone. Because this limitation on travel effectively excludes the most of reasons a person is likely to need to travel, and the results of the spatial optimization modeling, this service model is *not recommended*.

- *Anchored MOD* service provides shared-ride point-to-point service within a zone anchored at a retail hub with connection to the fixed network. The service model collocates two important functions – the mobility hub (where one can connect to the fixed transit network) and the retail center (where one can access and conduct many essential life functions). The service model operates within a designated zone and responds to trip requests. However, this model does not accommodate travel to other locations within the zone. With this limitation on likely needs to travel and based on the results of the spatial optimization modeling, this service model is *not recommended*.
- *Point-to-point MOD* service is designed to serve localized mobility (e.g., home to grocery store) and to provide connections to the fixed route transit network for longer trips (e.g., home to mobility hub to catch fixed route bus downtown). It is designed to work in areas in which fixed route service may not be logically feasible because of street network constraints or lack of density, where customers have limited mobility access to bus stops, or where the necessary infrastructure is not available for safe or convenient access to bus stops. The service is designed to operate point-to-point within a designated service zone in response to customer requests (immediate or scheduled for a future time). This service is designed to operate as a service for all within the zone and thereby, serve a greater share of the mobility market including young adults, choice riders, seniors, as well as supplement or replace growing demand for complementary paratransit services in certain areas. Because all trips served must be requested, the software managing the service is able to optimize the assignment of the riders to a vehicle and optimize the sequence of rider pickups and drop offs. As such, this point-to-point service provides operators with exact information about capacity requirements (number of vehicles and when and where service is required). Due to this precise level of service demand information, a more precise and cost-effective level of service supply can be provided – more service at peak times, less during lower demand times. The point-to-point MOD service model is *recommended* as the base service for all zones based on the operational considerations listed and from the results of the spatial optimization modeling.
- *Dynamic Flex service*, this service model is like the Flex service model, but it overcomes the key shortcomings of the Flex model. The Dynamic Flex service model does not use fixed bus stops and therefore does require every trip to be requested by the rider. This operational change facilitates the collection of better demand and service supply information and thus yields more reliable and predictable service. With this information, the ride-hailing software and service optimization algorithms enable to the system to group riders at common pick-up and drop-off locations. This minimizes vehicle travel and the number of stops necessary to pickup and drop-off riders. This service model is *recommended* to be utilized during peak travel times to facilitate more efficient operations by accommodating greater demand and directionality in travel patterns. The Dynamic Flex service model provides a more robust operational solution during peak periods and is supported by through the optimization model.

## Service Optimization

As noted in the previous section, to help confirm and improve the service strategies contemplated for each zone, spatial optimization modeling was conducted. The optimization model focused on optimal allocation of resources within each zone to cover travel needs. Travel needs were defined by the aggregate mobility need index associated with each Census block coupled with likely destinations within each zone as represented by existing bus stops, designated mobility hubs, and designated retail/commercial centers. The spatial optimization model seeks to find optimal mobility solutions for the blocks in each MOD zone through changes to the following variables:

- Service Focal Points – service focal points are selected from the set of bus stops, mobility hubs, and retail/commercial centers within each zone and the variable limit is set to either 2 or 3 focal points.
- Travel Distance – this is the maximum allowable distance from a focal point that the vehicle is permitted to travel with the variable limits are set to either 2 miles, 2.5 miles, or 3 miles.
- Coverage Percentage – this is the percentage of the MOD zone that is required to be covered when seeking a solution based on the other variables. The coverage percentage variables were 90%, 95%, or 100%. The coverage percent should be thought of both in terms of geography as well as in terms of the period for which the solution is being sought.

These variables operate in conjunction to identify an ideal or optimal solution. These variables have direct implication on resources required to provide the service, the distribution of service to demand, and the quality and reliability of the service. For example, scenarios with 3 focal points were generally found to also result in the requirement of more resources (vehicles and revenue hours) and an imbalance in the workload and distribution of vehicles and trips. Operationally, this will likely result in some vehicles being too busy or travelling too far and others with too much idle time.

Another example to consider is the concept of the coverage percentage. To require 100% of the demand and service area to be covered all times means a greater need for vehicles and incurs more revenue hours. Demand fluctuates predictably within certain periods that include spikes in demand and longer periods when demand is moderate or low. MOD is designed to respond to these predictable and less predictable fluctuations. Considering the temporal element of the coverage percentage, a rider may request a ride and rather than the request being denied, the software solution may be postponed a few minutes until it is assigned to a vehicle. In this case, say the coverage percentage is set to 90%, this means that 90 trips out of 100 would get an immediate acceptance (we are on the way) and 10 would get a response with a pickup time a few minutes later (we will get you in 15 minutes). This concept is familiar if one has used a ride-hailing service like Lyft or Uber.

The spatial optimization model was run for each MOD zone and the optimal results are provided on Table 5 along with a map of the MOD zones to provide context. The green areas represent Census blocks covered by the solution. The blue dots represent the retail centers or mobility hubs (in many cases they are both) around which the MOD service will be focused. Also provided are the results for each zone - the locations of the focal points, the coverage percentage, the permitted service distance from the focal points, workload (mobility need population), and average travel distance per trip. The mathematical equation and sample model code from one of the runs are provided in Table 6.

**Table 5: Spatially Optimized MOD Service Model Results**

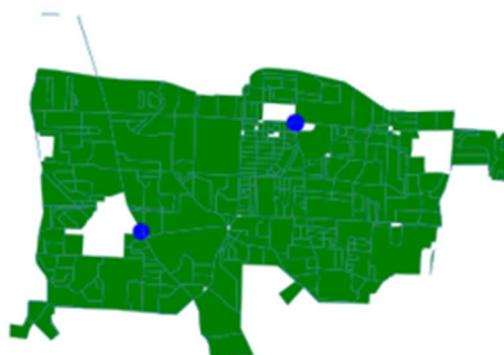
**Zone A - Blue Ash**

Two Focal Points  
 Kenwood  
 Plainfield Kroger/Target  
 Distance: 3 miles  
 Coverage: 95%  
 Workload: 18.8k popul.  
 Avg. Trip: 1.05 miles



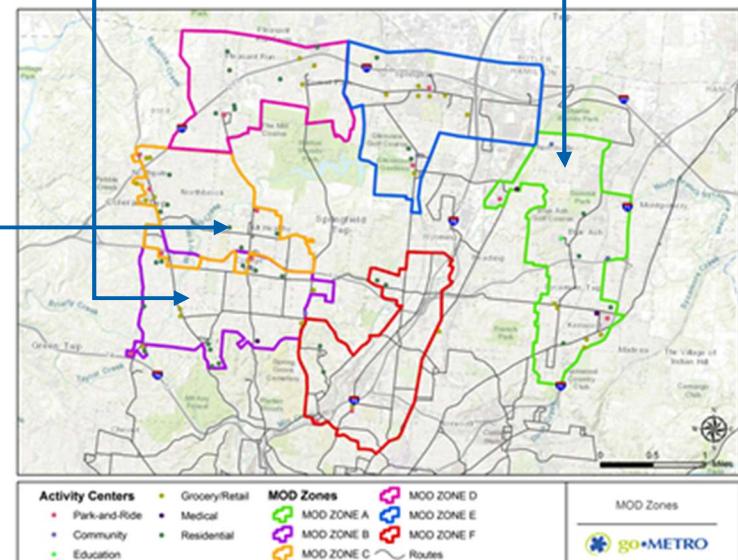
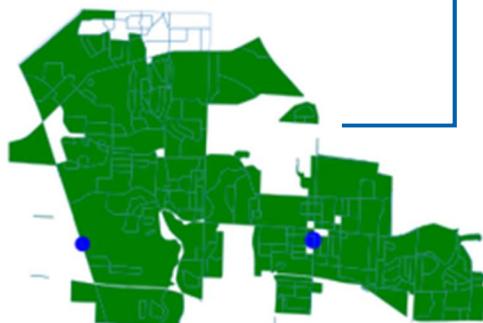
**Zone B - Montfort/N College Hill**

Two Focal Points  
 N College Hill  
 Colerain/Kipling  
 Distance: 3 miles  
 Coverage: 100%  
 Workload: 52.6k popul.  
 Avg. Trip: 1.08 miles



**Zone C - Northgate/Mt Healthy**

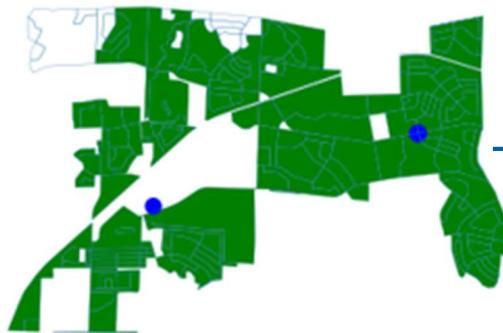
Two Focal Points  
 Grosbeck Target  
 N College Hill Kroger  
 Distance: 2 miles  
 Coverage: 95%  
 Workload: 35.1k popul.  
 Avg. Trip: 0.86 miles



**Table 5: Spatially Optimized MOD Service Model Results (continued)**

**Zone D – Pleasant Run**

Two Focal Points  
 Seven Hill Center  
 Winton Rd Walmart  
 Distance: 2 miles  
 Coverage: 95%  
 Workload: 30.0k popul.  
 Avg. Trip: 0.88 miles



**Zone E – Springdale/Sharonville**

Two Focal Points  
 Glenwood Kroger  
 Springdale/Kemper  
 Distance: 3 miles  
 Coverage: 95%  
 Workload: 16.9k popul.  
 Avg. Trip: 0.84 miles



**Zone F – Bond Hill/Roselawn**

Two focal points  
 St Bernard  
 Roselawn  
 Distance: 3 miles  
 Coverage: 95%  
 Workload: 38.1k popul.  
 Avg. Trip: 1.15 miles

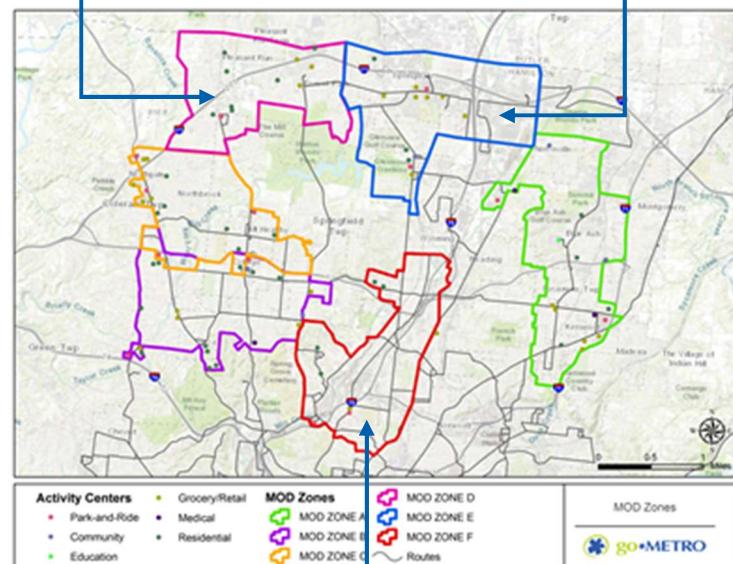
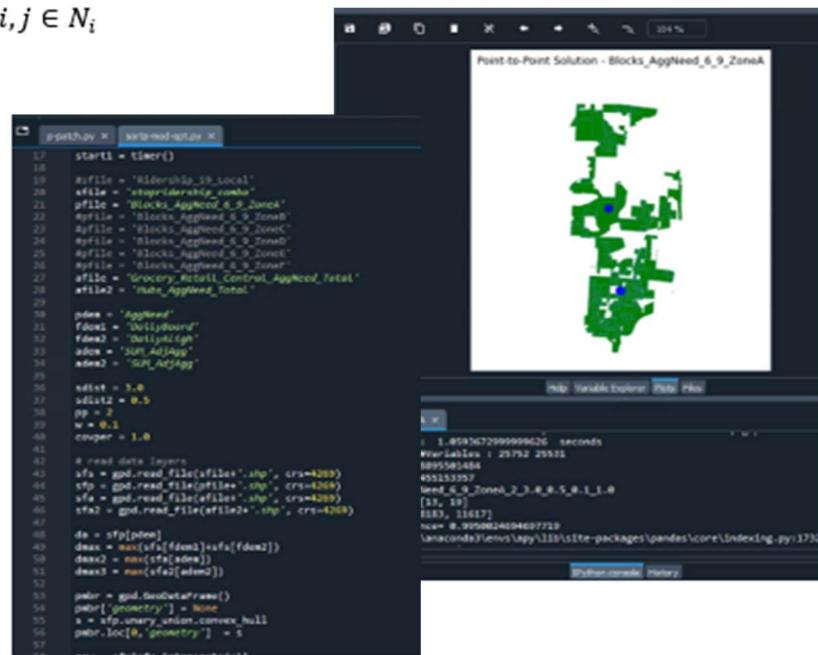


Table 6: Optimization Analysis Equation and Sample Code

Point-to-Point spatial optimization model

$$\begin{aligned}
 \text{Minimize} \quad & \sum_i \sum_{j \in N_i} \alpha_i d_{ij} Z_{ij} \\
 \text{Maximize} \quad & \sum_j \beta_j X_j \\
 \text{Subject to} \quad & \sum_{j \in N_i} Z_{ij} \leq 1 \quad \forall i \\
 & Z_{ij} \leq X_j \quad \forall i, j \in N_i \\
 & \sum_j X_j = p \\
 & \sum_i \sum_{j \in N_i} \alpha_i Z_{ij} \geq \lambda \sum_i \alpha_i \\
 & X_j = \{0,1\} \quad \forall j \\
 & Z_{ij} = \{0,1\} \quad \forall i, j \in N_i
 \end{aligned}$$



## Software-as-a-Service (SaaS) Requirements

MOD services operate best when coupled with a software-as-a-service (SaaS) platform that provides the key functional capabilities required to support the operation. The functional capabilities identified as required for the Metro MOD services are presented below. These functions will be accessed through the SaaS platform by using a mobile application, a web portal, or calling the Metro call center and speaking with a CSR.

- *Ride Hailing* – customer requests a ride by responding to a series of prompts about their travel, the system provides date, time, location of pick-up, and date, time, location of drop-off, and transfer connection information (if applicable).
- *Payment* – facilitates payment via app (MOD fares should be same as fixed route and all valid passes apply), requires on-board reader for app-based payment. A cash fare/transfer drop box may be needed on the vehicle if the existing Metro cash fare payment app or a similar app is not available.
- *On-board tablet* – used by the operator to view next event (pickup or drop-off information, including transfer information – where, when, which route - if applicable), acknowledge completion of each event, and process/record fare payment associated with each event. The tablet will provide directions from event to event. The tablet facilitates communications to/from operator to the dispatch function.
- *Data Collection/Reporting* – the SaaS platform will continuously collect all data needed to complete and generate NTD reports and other KPIs used by Metro.
- *Operations and Optimization* – the SaaS platform will assign rider trip request to a vehicle and optimize sequencing of pickups and drop-offs. The SaaS platform will determine trip details for each request, including a transfer if applicable. It will assign a requested ride to fixed route if the trip can be made (origin to destination) by fixed route unless the fixed route travel time is greater than XX times the travel time of the trip if served point-to-point or point-to-hub within the MOD zone (including wait times) as calculated based on the Travel Time Factor. The fixed route Travel Time Factor (XX) is equal to two (2) times the travel time by MOD if the travel time by MOD is less than 10 minutes. The fixed route Travel Time Factor (XX) is equal to one and a half (1.5) times the travel by MOD if the travel time by MOD is greater than 10 minutes.
- *Dynamic Flex Service* – during times of peak travel demand, particularly when there is a majority skewed directionality of travel, the SaaS platform will tune service parameters to optimize loadings (vehicle utilization) and direct riders to predetermined pop-up bus stops to facilitate fewer pickups and drop-offs and a more direct routing to the common destination (mobility hub).
- *Real-time service information* – the SaaS platform will maintain continuous service information and vehicle location information generally available to the public. In addition, for registered riders, the SaaS platform will provide personalized account and service information, vehicle location, trip request confirmation, trip status, trip fare, payment confirmation, connecting time, location, and transfer information.

A separate technical requirements document was prepared for SORTA to support the procurement of the requisite cloud-based SaaS platform capabilities.

## Service Plan and Operating Requirements

The project team developed a service plan operating requirements for the MOD services for each MOD zone evaluated. The service plan quantifies the number of vehicles required for peak service times as well as for lower demand times (midday and post evening peak). The service plan assumes operations Sunday through Saturday with an operating span of 6AM to 8PM weekdays and Saturdays and an operating span from 7AM to 8PM Sundays. The service plan assumes 255 weekdays, 52 Saturdays, 52 Sundays, and no service on six holidays.

Calculating the number of vehicles and resulting revenue hours for each zone involved identifying a range of service supply needed to serve estimated demand in the morning peak, the afternoon peak, and during midday/late hours. Table 7 presents per-hour and annual ridership estimates.

**Table 7: MOD Ridership Demand**

Candidate MOD Zones	AM Peak Trips/Hour	Mid/Late Trips/Hour	PM Peak Trips/Hour	Annual Ridership
Zone A - Blue Ash/Evendale	35	10	30	83,971
Zone B - Monfort Heights/Finneytown	19	5	16	45,323
Zone C - Northgate/Mt Healthy	30	9	26	72,636
Zone D - Pleasant Run North	10	3	9	23,925
Zone E - Springdale/Sharonville	22	6	19	53,129
Zone F - Winton/Bond Hill/Roselawn	29	8	25	70,097
	144	41	126	349,081

The service demand estimates are based on serving a relevant percentage of 2019 average weekday fixed route ridership within each MOD zone. It also includes serving fifty percent of the existing Access paratransit weekday boardings within each MOD zone. In addition, experience with MOD services have shown an induced trip-making impact since the service is convenient and responsive to the rider. As such, for service design purposes, our experience is to include an MOD induced ridership factor of 1.25 applied to the fixed route and paratransit ridership base. These weekday ridership estimates are then apportioned to a per hour demand for the AM peak, the PM peak, and midday/late periods. This provides a range for sizing operations to service peaks and low demand periods.

Based on the per hour demand estimates, the operating plan was developed based on requirements to meet minimum and peak demand over the course of the service day. Vehicles requirements for AM peak, PM peak, and off-peak are multiplied by the period span to calculate daily revenue hours. Annual revenue hours are calculated by multiplying by the corresponding number of operating days. Table 4-3 presents the operating requirements for each MOD zone assuming a range of low productivity service and higher productivity service.

The peak vehicle requirement for all six MOD zones ranges between 24 and 33 with the off-peak vehicle requirement estimated to be 12. The annual revenue hours for all six MOD zones ranges between 82,900 and 99,900. The annual operating cost for the MOD service, based on the Metro Access paratransit marginal hourly cost rate of \$55.00, ranges between \$4.5 million and \$5.5 million.

The MOD operating costs can be off-set by reductions in fixed route services and shifting ADA paratransit customers who are able to navigate their travel to use the MOD service (curb-to-curb). An advantage of doing this is that ADA customers would not need to book a trip 24-hours in advance and the fare on MOD will likely be less than on Access. No assumptions were made in terms of modifications to fixed route. However, the assumption was made that twenty-five percent of ADA trips within each MOD zone would be served by MOD. Based on this assumption and using the 2020 NTD per trip cost of \$69.89 for Access trips, an estimated \$1.88 million in Access operating costs could be mitigated. This would yield a net annual operating cost for MOD service in all six MOD zones of between \$2.7 million and \$3.6 million. No fares were calculated or applied for planning purposes.

**Table 8: Operating Requirements Range**

MOD Operating Requirements	Veh AM Pk	Veh Mid/Late	Veh PM Pk	Annual Rev Hrs	Annual Oper Cost	Net Annual Oper Costs
Zone A - Blue Ash/Evendale - Low Prod	7.0	3.0	6.0	22,590	\$1,242,441	\$849,069
Zone A - Blue Ash/Evendale - High Prod	5.0	3.0	5.0	19,488	\$1,071,850	\$678,479
Zone B - Monfort Hts/Finneytown - Low Prod	4.0	2.0	4.0	14,339	\$788,629	\$374,596
Zone B - Monfort Hts/Finneytown - High Prod	3.0	2.0	3.0	12,199	\$670,923	\$256,891
Zone C - Northgate/Mt Healthy - Low Prod	7.0	2.0	6.0	19,627	\$1,079,501	\$854,369
Zone C - Northgate/Mt Healthy - High Prod	5.0	2.0	4.0	15,436	\$848,997	\$623,865
Zone D - Pleasant Run - Low Prod	3.0	1.0	2.0	8,223	\$452,273	\$268,294
Zone D - Pleasant Run - High Prod	2.0	1.0	2.0	7,156	\$393,572	\$209,594
Zone E - Springdale/Sharonville - Low Prod	5.0	2.0	4.0	15,408	\$847,436	\$399,774
Zone E - Springdale/Sharonville - High Prod	4.0	2.0	3.0	13,273	\$730,027	\$282,365
Zone F - Winton/Bond Hill/Roselawn	7.0	2.0	6.0	19,671	\$1,081,918	\$863,168
Zone F - Winton/Bond Hill/Roselawn	5.0	2.0	4.0	15,406	\$847,307	\$628,557
<b>Combined - Low Productivity</b>	<b>33.0</b>	<b>12.0</b>	<b>28.0</b>	<b>99,858</b>	<b>\$5,492,198</b>	<b>\$3,609,272</b>
<b>Combined - High Productivity</b>	<b>24.0</b>	<b>12.0</b>	<b>21.0</b>	<b>82,958</b>	<b>\$4,562,676</b>	<b>\$2,679,750</b>

The number of Access paratransit trips that are shifted from traditional complementary paratransit service to the MOD service will depend on the ability of individual Access customers to navigate the MOD service and the number of trips that can reasonably be served (origin to destination) within contiguous MOD service zones. Calculating Access paratransit trip pairs relative to the MOD zones, a more conservative estimate of the number of Access trips served by MOD within the six MOD zones would result in an estimated annual savings of \$877,000. This would result in a net operating cost for the MOD service in all six zones of between \$3.68 and \$4.62 million. This does not include any assumptions for fare revenue which would further reduce the net operation costs.

## Vehicles

The successful operation of MOD requires vehicles to have sufficient capacity for peak times, wide doors and near level boarding to facilitate quick boardings and alightings, and the vehicle must accommodate safe and efficient ADA accessibility to provide FTA compliant service. During peak times, the operational objective is to carry more passengers. This requires sufficient capacity for many-to-one trips (e.g.: to the mobility hub during the morning peak). Without sufficient capacity, meeting peak service demand will require more vehicles and operators. During most of the operating day, including during peak times, most trips are short and the corresponding passenger time-on-board the vehicle tends to be between five and ten minutes. MOD operates most efficiently by filling and refilling the available capacity (seats). Therefore, quick, efficient, ADA accessible boarding and

alighting is essential. A vehicle that can facilitate these operational objectives, will support and efficient and cost-effective MOD operation. The recommended vehicle characteristics for MOD service are:

- Ambulatory Capacity: 8-16 ambulatory seats
- Wheelchair Capacity: 1-2 wheelchair spaces
- Hybrid Seating: 1-2 ambulatory fold-down seats, when WC space not in use
- Low Floor: one-step boarding from curb, level floor
- Wheelchair Ramp: facilitate WC or scooter
- Wide Transit Door: facilitate quick boarding and alighting

An example of one of the newer low floor electric vehicles is pictured below, the RP Minibus. There is a great deal of movement in the minibus vehicle market, in terms of design, capacity, functionality, fuel source, and these newer designs are beginning to come to market.



While smaller vehicles are typically less expensive to purchase, they also would not meet the recommended objectives of providing capacity, ADA accessibility, and quick boarding and alighting. The market for small public transport vehicles is growing rapidly and the available options continues to grow, in terms of functionality, compliance, alternative fuels, and stylistically appealing models. These vehicles have a 5-7-year lifespan and transit agencies will have more vehicle options in the future. Our recommendation is to start with vehicles that meet the vehicle characteristics listed, this will allow Metro to avoid capacity, ADA, and quick boarding and alighting problems. With operational experience, Metro will have a more definitive basis for decisions about adding other vehicle models into the fleet mix.

### **Recommendations**

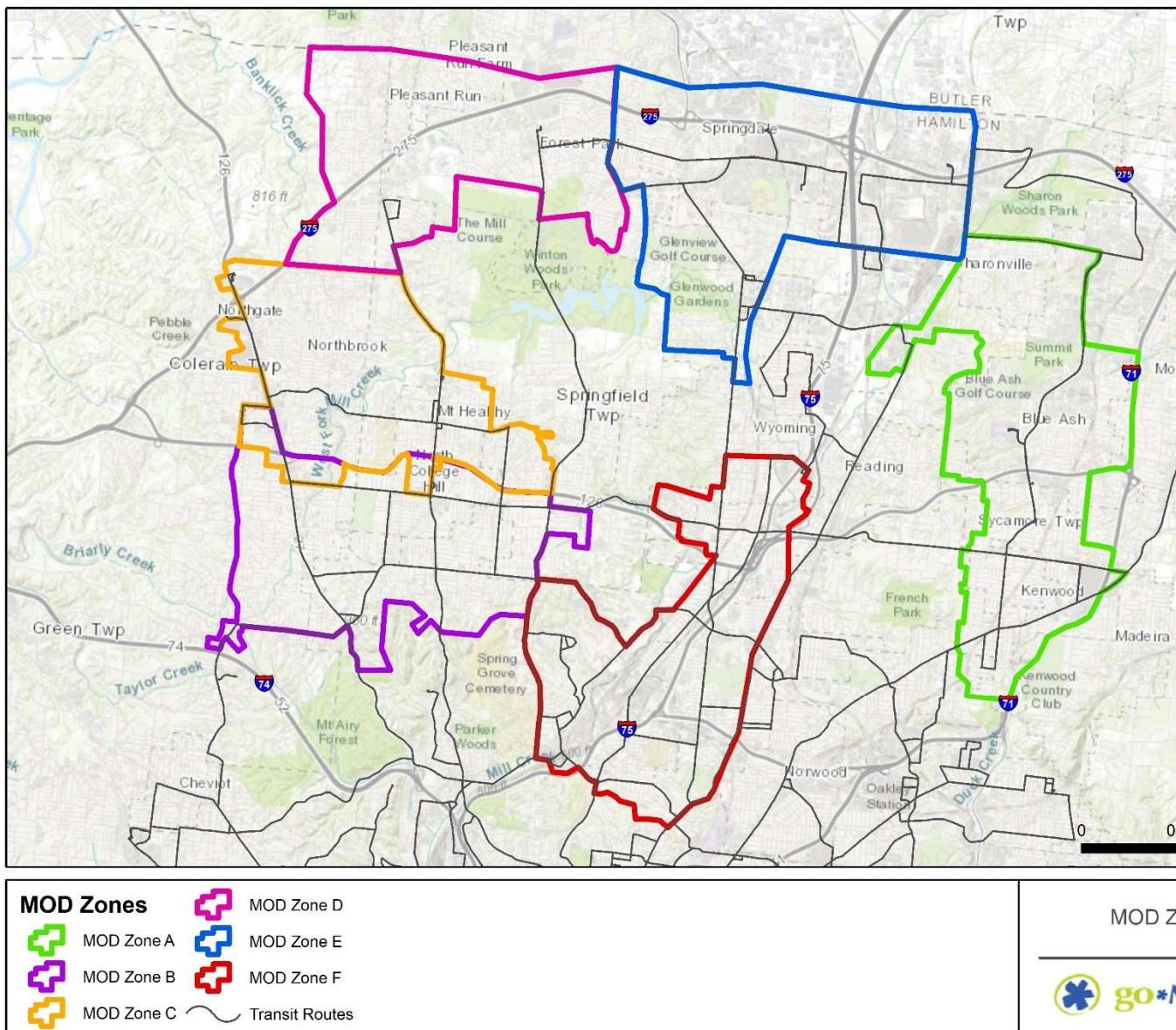
The intent was to identify four to five MOD service zones (see Map 14) and services for demonstration through an initial pilot. A total of six zones were identified and service plans prepared for each. Based on the evaluation and screening considerations of mobility need and gaps in access to transit services, and consideration of the operating requirements, the recommended service zones for initial deployment and testing include the following MOD zones:

- Zone A - Blue Ash - Evendale
- Zone B - Montfort Heights - N College - Finneytown
- Zone C - Northgate - Mt Healthy
- Zone D - Pleasant Run North
- Zone E - Springdale - Glendale - Sharonville

MOD Zone F, Winton, Bond Hill, Roselawn, has high mobility needs and is reasonably well served by existing Metro routes. The primary reason for not advancing this zone immediately is due to obstacles associated with land use and transportation corridors that divide communities in this zone. These obstacles pose additional operational complexities to service this area. Our recommendation is to consider service in Zone F after the initial test pilots to avoid operating complexities.

For deployment planning purposes of the five zones, peak vehicle requirements are 19 to 26, annual revenue hours are 67,500 to 80,200, and the net operating cost range is between \$2.8 and \$3.5 million, assuming more conservative estimates of mitigated paratransit trips.

Map 14: MOD Service Zones



go\*METRO | MOD Service Development and Recommendations

MOD Z



## 7.0 Appendix A: Public Engagement Report

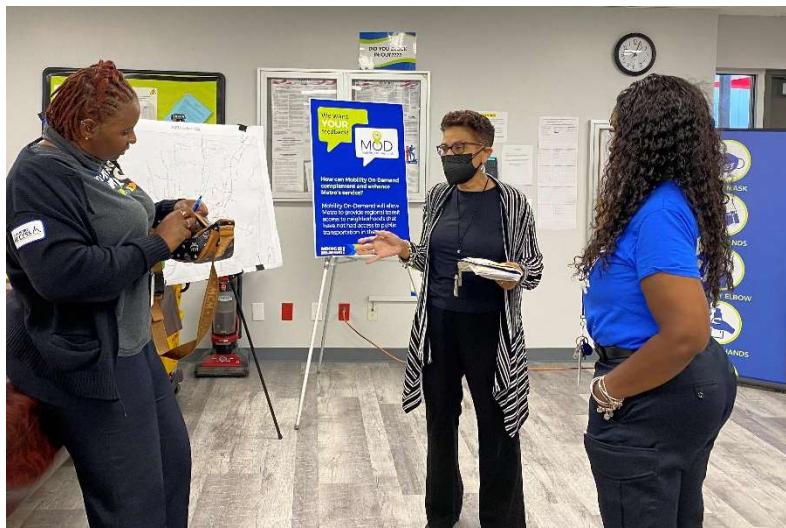
Reinventing Metro promised the Greater Cincinnati region bold, new transit innovations that will help grow the regional economy and better connect the community to jobs, education, health care and entertainment. The Southwest Ohio Regional Transit Authority (SORTA) now has the exciting opportunity to provide regional transit access to neighborhoods that have not had access to public transportation in the past.

This purpose of the public outreach efforts for this project is to research, identify, and allow citizens to prioritize the areas that will benefit from and are conducive to on-demand mobility services. The resulting MOD services are anticipated to be implemented during the next phase of the Reinventing Metro program, by early 2023. The service objectives are to eliminate lack of access to mobility, facilitate access to opportunity for all, and improve the operational performance of the mobility network. This will support and foster improved economic growth and increased Metro ridership as the community exits the pandemic and embraces new transit innovation.

Through this project, up to ten potential MOD service areas will be identified within the existing Metro transit service area which will benefit from and are conducive to on-demand mobility services. Four to five neighborhoods will then be prioritized and recommended for the initial MOD service pilots. These services will expand and improve mobility for residents and visitors.

A public involvement strategy was developed for this project that was successful in sharing project information as well as incorporating meaningful feedback into project decisions. Our goal was to provide an environment that promotes public feedback and input and encouraged dynamic two-way communication to help identify and promote the best on-demand service recommendations. We deployed a wide array of communication techniques, from traditional and grassroots, to more individualized methods, taking advantage of advancing technologies to gather input so members of the public can respond when it best fits their schedule.

This Public Engagement Report describes a combination of virtual and in-person public involvement activities implemented to help all prospective riders and stakeholders understand and embrace the new on-demand services. The messages conveyed during these activities differed from traditional transit service changes because SORTA will be introducing new types of services. The authentic and compassionate voices of the team, equipped with in-depth knowledge of the transit services available in the Greater Cincinnati region, drove community involvement and understanding.



Staff engagement at the Access Operations Center

## **PUBLIC INVOLVEMENT ACTIVITIES**

Residents, students, employees, transit riders, businesses, and community stakeholders were invited to outreach activities to help us understand the unique needs and characteristics of the transit community, stakeholders, businesses, and organizations that rely on transit, as well as those of the general public. The activities were selected to involve and engage underrepresented communities, including older adult populations, persons with disabilities, minorities, and low-income communities. Strategies to gather input from major employers, educational institutions, medical facilities, affordable housing advocates, and other communities of local significance are also included.

The activities were held virtually and in-person, in large group settings, personalized interviews, and through electronic surveys. These activities are further described within this chapter.

### **Public Involvement Outreach Team**

SORTA Staff members were selected based on their expertise and knowledge of existing services, service market, and community context to become members of an internal project Outreach Team. This team met regularly throughout the project duration, following the Public Involvement Kick-Off meeting held on September 7. The SORTA Outreach Team members included:

- Brandy Jones, Vice President of External Affairs
- Dave Etienne, Director of Marketing and Communications
- Harvey Richardson, Division Manager (Operations)
- John Ravasio, Chief Operations Officer
- Khaled Shammout, Chief Strategic Planning, Development and Innovation Officer
- Lisa Aulick, Director of ACCESS (Paratransit)
- Matt Moorman, Manager of Service Planning and Scheduling
- Steve Anderson, Director of Transit Development and Innovation

### **Internal Involvement**

Engaging the internal customers of SORTA—its employees, including operators, supervisors, and administrative personnel was a critical component of this project. Fixed route operators and other



**Screenshot of the Virtual Public Involvement Kick-Off Meeting**

front-line staff are best able to identify areas where fixed route buses should not travel due to rough roads, low-hanging limbs, obstructions, and other unsafe conditions. These employees know the complaints and requests of the riders. Early communication with employees embodies the authority's values, builds support, and provides valuable input from the people who best understand the current customers who ride the system and the neighborhoods through which they travel.

Multiple Open House events were held at the Queensgate, Bond Hill, and ACCESS Operations Centers to engage the fixed route and paratransit operators. Additional Open House events were held at the SORTA Administrative Building. These events were held during the week of October 11, 2021 with multiple opportunities for each group to communicate with the Outreach Team and respond to the surveys.

Over 200 employees engaged with the Outreach Team during this effort.

#### **Stakeholder Interviews**

Identifying community leaders and members of the public willing to be a part of the process is essential to ensuring that the community feels involved with the project. To help enhance and broaden our understanding of local conditions, we gathered



**Operators providing feedback during an Open House Event**

perceptions and ideas about public transportation and mobility needs from key selected stakeholders in the service area. Interviews were conducted by using a guided script of structured questions as well as through casual, but well documented conversations. Stakeholders participated through in-person and virtual interviews.

The stakeholders included:

- The Kroger Company – Jenifer Moore
- Hamilton County Board of Developmental Disabilities Services – Robert Shuemak
- Human Services Chamber of Hamilton County – Gina Marsh
- Southwest Ohio Council on Aging – Judy Eschmann
- The Health Collaborative – Lauren Bartoszek

#### **Discussion Work Groups**

Developing project advocates ancillary to the internal project team demonstrates the transparency and sense of openness to feedback while building trust with the community and ensuring that project decisions reflect their input. We worked with SORTA staff to identify and invite selected participants to the discussion group workshops.

During the workshops, the participants identified areas where an on-demand transportation service may improve access to medical appointments and services to improve the health outcomes and quality of life in Cincinnati's communities.

Three Discussion Work Group sessions were held targeting specific audiences including:

- Human Service Agencies session was held on Thursday, October 14 from 1 PM to 3 PM
- Bus Rider Advocacy Committee was held on Thursday, October 14 from 6 PM to 8 PM
- Everybody Rides Metro group session was held on Friday, October 15 from 1 PM to 3 PM



**Discussion Work Group Session with Representatives from Human Service Agencies**

### Neighborhood Specific Public Meetings

Cincinnati has distinct and diverse neighborhoods led by active community councils. As the focus is narrowed, public meetings were scheduled in each of the selected neighborhoods to facilitate public review and seek comments on general mobility needs and alternative solutions. The neighborhoods included in the neighborhood meetings were selected based on a wider market screening using socio-economic, demographic, and transit service data to identify the subset of candidate neighborhoods.

The meeting locations were selected within each area and as close to a Metro transit stop as possible. Poster boards with maps of all the selected areas as well as detailed maps of each individual area were presented during the meetings. A unique on-line survey was created for each of the six areas. While each survey included the same questions, the map shown was specific to the area. A flyer was also created for each area with a corresponding map and QR code to the appropriate survey.

The Neighborhood Specific Public Meetings were held:

- Monday, February 21
  - College Hill Library,  
1400 W. North Bend Rd
  - Blue Ash Library,  
4911 Cooper Rd
- Tuesday, February 22
  - Avondale Library,  
3566 Reading Rd
  - SORTA Boardroom,  
525 Vine St
- Thursday, February 23
  - St Bernard Branch Library,  
10 McClelland Ave
  - North Central Library,  
11109 Hamilton Ave
- Friday, February 24
  - Forest Park Senior Center, 11555 Winton Rd
  - Groesbeck Library, 2994 Galbraith Rd



**Engaging Library Staff**

Members of the Outreach team met with each Public Meeting participant and guided them through the survey.

#### [Online Surveys](#)

Three separate online surveys were developed and collected for this project. The surveys were designed to inform the reader of the existing service and potential on-demand service opportunities in select areas and provide an easy way to provide input to help us better understand the mobility needs and concerns, especially within the targeted neighborhoods.

The first survey was developed for the SORTA employees and was shared during the Open House events. It asked the employees to identify areas where people who may need transit services are unable to access Metro; where the condition or lack sidewalks or street conditions prohibit access to bus stops and seeks feedback on the type of vehicles and hours for the new MOD service.

The second survey was developed for all Hamilton County residents (riders and nonriders), employees, businesses, and organizations. The survey was prefaced with details of the existing services and proposed on-demand service concepts. It included interactive maps and questions about transit service needs and expectations.

The third and final survey was developed to gain input on each of the six recommended pilot zones. A unique on-line survey was created for each of the six areas asking only two questions: What places in Zone X do you need to travel to and What places within Zone X are hard to get to and why? While each survey included the same questions, the map shown, and Zone description was specific to the area. A flyer was also created for each area with a corresponding map and QR code to the appropriate survey.

## Summary of Activities

The Mobility On-Demand outreach activities were coordinated with the overall project schedule.

**Table 9: Summary of Outreach Activities**

Task Name	Between	
<b>Outreach Kickoff</b> (Virtual)	<b>Tuesday 9/7/21</b>	<b>Tuesday 9/7/21</b>
<b>Conduct Stakeholder Interviews</b> (Virtual)	<b>Monday 6/16/21</b>	<b>Friday 10/26/21</b>
The Kroger Company Hamilton County Board of Developmental Disabilities Services Human Services Chamber of Hamilton County Southwest Ohio Council on Aging The Health Collaborative		
<b>Internal Involvement</b> (In-Person)	<b>Monday 10/11/21</b>	<b>Friday 10/17/21</b>
Access Bond Hill Queensgate Administrative Office		
<b>Publish Surveys</b> (Online)	<b>Monday 10/11/21</b>	<b>Friday 3/11/22</b>
Employee Survey County-wide Survey Zone Specific Surveys (6 zones)		
<b>Facilitate Work Group Discussions</b> (In-Person)	<b>Thursday 10/26/21</b>	<b>Friday 10/17/21</b>
<b>Neighborhood Meetings</b> (In-Person)	<b>Monday 2/21/22</b>	<b>Friday 2/25/22</b>
Avondale Library Blue Ash Library College Hill Branch Library Forest Park Senior Center Groesbeck Branch Library North Central Library SORTA Boardroom		

## PUBLIC INVOLVEMENT DOCUMENTATION

Data from all community outreach and involvement activities were captured, analyzed, and provided to the planning teams and SORTA Planning staff. Statistics, including the number of people reached, meeting attendees, and results of the input are included in this section.

# WE WANT TO HEAR FROM YOU!

Please take a few minutes to help design your new service!

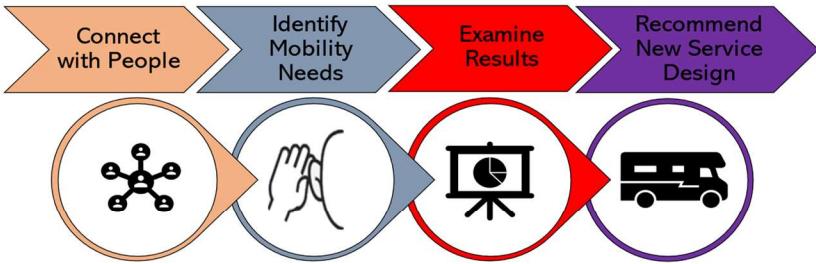
<https://www.research.net/r/2022>



## Planning process and timeline

1. What places, within ZONE B area do you need to travel to?  
Please be specific by providing the pick-up and drop-off locations, include address, names of hospitals, library, shopping centers, stores, banks etc...

2. List places within ZONE B



The flowchart illustrates the four-step planning process:

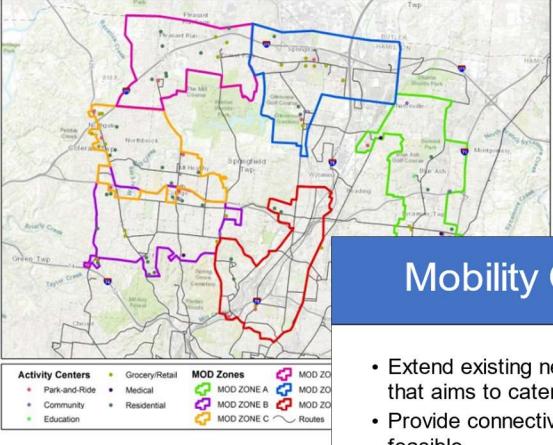
- Connect with People (orange arrow, icon: network nodes)
- Identify Mobility Needs (blue arrow, icon: hand)
- Examine Results (red arrow, icon: pie chart)
- Recommend New Service Design (purple arrow, icon: bus)

February

March

April

## Six Pilot Zones



Activity Centers

- Park-and-Ride
- Community
- Education
- Grocery/Retail
- Medical
- Residential

MOD Zones

- MOD Zone A
- MOD Zone B
- MOD Zone C
- MOD Zone D
- MOD Zone E
- MOD Zone F
- Routes

## Mobility On-Demand (MOD)

- Extend existing network of bus routes by providing a more nimble, flexible option that aims to cater more closely to customers' individual needs.
- Provide connectivity and access where Metro's services are limited or not feasible
- Explore three potential service delivery models:
  - Flex route:** Vehicle maintains a schedule along with a series of defined bus stops and serves off-route locations within the zone upon advance request.
  - Point-to-Point:** Similar to rideshare services like Uber or Lyft, providing curb-to-curb service within the defined zone through advance request.
  - First/Last-mile Connector:** Provides point-to-point service within a zone connecting at a hub or transit center.



**MOD**  
Mobility On-Demand

New, on-demand transit access to areas of the community that are currently underserved by public transportation

**benesch**  
engineers • scientists • planners

**Reliance Associates, Inc.**  
Engineering & Landscaping

**go\*METRO**

## STAKEHOLDER INTERVIEWS

Identifying community leaders and members of the public willing to be a part of the process is essential to ensuring that the community feels involved with the project. To help enhance and broaden our understanding of local conditions, we gathered perceptions and ideas about public transportation and mobility needs from key selected stakeholders in the service area. Interviews were conducted by using a guided script of structured questions as well as through casual, but well documented conversations. Stakeholders participated through in-person and virtual interviews. A detailed summary of their interviews follows this page.

The stakeholders included:

- The Kroger Company – Jenifer Moore
- Hamilton County Board of Developmental Disabilities Services – Robert Shuemak
- Human Services Chamber of Hamilton County – Gina Marsh
- Southwest Ohio Council on Aging – Judy Eschmann
- The Health Collaborative – Lauren Bartoszek



Outreach staff members interviewing SORTA Admin Staff

## Stakeholder Interview – The Kroger Company

**Interviewee:** Jenifer Moore, MBA, Corporate Affairs Manager, The Kroger Company

**Other people present:** Matt Moorman, Randy Farwell, Regine Denis, and Liz Peak

**Date:** Tuesday, October 26, 2021 from 4:00 to 4:45 p.m.

### **Meeting summary:**

Everyone was welcomed, and introductions facilitated. We described On-Demand Mobility and the project purpose, goals, and objectives. A conversation was then held with the individual interviewee in which she was asked the questions below. Responses are in quotes herein.

#### **1. Understand the stakeholder:**

##### **a. What is the primary mission or purpose of your organization?**

“The Corporate Affairs Office of The Kroger Company manages the internal and external communications. Our audience is the company’s associates [employees] and customers of the 104 grocery stores in the Cincinnati and Dayton area. Our customers would also include partnering agencies and their clients including Food Banks and Food Pantries in Cincinnati.”

##### **b. Who are your clients/constituents/customers?**

<input checked="" type="checkbox"/> Residents	<input type="checkbox"/> Students
<input checked="" type="checkbox"/> Employees	<input type="checkbox"/> Visitors
<input type="checkbox"/> Employers	<input type="checkbox"/> Others: _____

“I used to work for AAA and we had a pilot project called Round Town in Toledo for seniors. It is essentially the same as you are describing.”

[Jenifer asked some great questions about the potential vehicle type and route design.]

#### **2. Understand mobility needs of clients:**

##### **a. Have your clients/constituents/customers expressed to you a lack of access to mobility to access places and services?**

“We do hear that a lot from people who live between two stores and how frequently the buses travel in those areas.”

##### **b. Have your clients/constituents/customers expressed to you that they are unable to access Metro services in specific areas of Cincinnati?**

“I believe that Winton Hills is a challenge. I will ask around and identify additional areas”

##### **c. What impact does this lack of access to mobility have to your clients/constituents?**

“I don’t know of any impact right off hand. We do fill in the gaps with our ecommerce opportunities. If you can’t get to a store, there is a delivery option.”

#### **3. Design service and accessibility:**

##### **a. Would your customers be able to walk a few blocks to a central location to meet the service? Or will they require curb-to-curb or door-to-door service?**

“I don’t really know. That would be an individual preference. Some of our customers are pretty shopping savvy and take their own shopping carts with them to help get their food onto the bus and to their home.”

**b. How would your clients/constituents/customers prefer to schedule their trips? Do your clients possess the cognitive ability to navigate apps and other digital-based tools? Do your clients own/use or have access to smart phones with internet capability?**

“AAA had an app and offered seniors a phone number to talk to a person to schedule a trip. We also offered the ability for a child of a parent (even if they are out of town) to call to schedule trips for the parent. Opening up the scheduling capability to accommodate all people was particularly important to our project.”

**c. Do you have any suggestions for the design of a new on-demand service?**

“The service should be wheelchair accessible and have cameras installed. All drivers should have the training and background checks that Access currently requires.

You should partner with businesses along the route to offer promotions to the passengers and to localize the service.

The service should take special consideration of the bags that customers may be taking with them on the vehicle.

You should also operate all night to accommodate our 3<sup>rd</sup> shift workers.”

Regine asked what the barriers are to getting employees to work. Jenifer responded that the lack of childcare and transportation are two of the biggest barriers to employment. Transportation could be more of a personal preference as well as a financial barrier.

**4. Solicit additional project engagement:**

**a. Who in your organization will be able to share the online survey links with your clients/constituents/customers and their families or in your social media?**

“A survey would be very helpful. I would prefer that I would send the link to our store managers and customers. We are about to enter our busy season. I can also make an introduction between you and the food banks and food pantries. You should also reach out to UC and Xavier to gain a college student perspective. You should really read the recent article about the shift of the black population in Cincinnati<sup>1</sup>. It speaks about the poverty rings and that transportation is a big part of that. There are specific references about areas of town and the changes that are occurring.”

The Mobility On-Demand Team thanked the interviewee for her time and explained the project’s next steps and timeline.

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<sup>1</sup> The Cincinnati Enquirer news article can be found

<https://www.cincinnati.com/story/news/2021/08/05/poverty-rise-and-black-cincinnati-families-being-pushed-suburbs/7642835002/>

## Stakeholder Interview – Hamilton County DDS

**Interviewee:** Robert Shuemak, advocate, Hamilton County Developmental Disabilities Services

**Other people present:** Matt Moorman and Liz Peak

**Date:** Monday, October 25, 2021 from 3:00 to 3:45 p.m.

### Meeting summary:

The project was introduced by describing On-Demand Mobility and the project purpose, goals, and objectives. The team, then conducted a conversation with the interviewee and asked him questions. Responses are in quotes herein.

- 1. Understand the stakeholder:** Hamilton County Developmental Disabilities Services is a government social services agency supporting more than 7,600 people with intellectual and developmental disabilities.
  - a. What is the primary mission or purpose of your organization?** Promote and support opportunities for people with developmental disabilities to live, work, learn and fully participate in their communities.
  - b. Who are your clients/constituents/customers?**

<input checked="" type="checkbox"/> Residents	<input type="checkbox"/> Students
<input type="checkbox"/> Employees	<input type="checkbox"/> Visitors
<input type="checkbox"/> Employers	<input type="checkbox"/> Others: _____

“We support people who are blind, frail, newborn as well as people who have developmental disabilities. My main area of focus is on transportation, accessibility in the community, and accessible technologies. These areas are often intertwined. I have been heavily involved with Metro in the past 10 years on their accessibility for people who are experiencing blindness and use power wheelchairs to access the buses.”

“I am not an Access rider anymore. I prefer the bus so that I don’t have to schedule my trips in advance. I can just go out the door and catch the bus. I’m on a very busy street with 6 routes coming by my door and can easily get to doctors and entertainment.”

- 2. Understand mobility needs of clients:**

- a. Have your clients/constituents/customers expressed to you a lack of access to mobility to access places and services?**

“My mother lives in Blue Ash. It is a well-to-do area that employs many people. It is a big hub of people. However, the bus runs to the college and around the outskirts of Blue Ash. But it does not go towards the center of Blue Ash. My mom’s house is 2 miles away from the bus stop. An On-Demand service will help me get to her on the regular bus service.”

- b. Have your clients/constituents/customers expressed to you that they are unable to access Metro services in specific areas of Cincinnati?**

“The Westside is just outside of the city limits with people who have been having lots of problems getting around. This includes the Colerain area, Westin Hills, and Bridgetown. If I was on the planning committee, I would pilot a service in each area of town – from the Westside to the Eastside and the northern outskirts of town too.”

**c. What impact does this lack of access to mobility have to your clients/constituents?**

“When I must meet new clients or go to meetings where I have not been to before, I need someone to go with me. I am blind myself. A mobility on demand service will allow me to remain independent, even in new areas.”

**d. Do you think an on-demand service will help alleviate the impacts of lack of access to mobility?**

**3. Design service and accessibility:**

**a. Would your clients/constituents/customers be able to walk a few blocks to a central location to meet the service? Or will they require curb-to-curb or door-to-door service?**

“Door-to-door would work the best for people who are blind or disabled. In my experience, Access drivers will assist people who need it. Calling the passengers to let them know that their ride is outside is good too. The service will just need to be flexible. We all have different needs.”

**b. How would your clients/constituents/customers prefer to schedule their trips? Do your clients possess the cognitive ability to navigate apps and other digital-based tools? Do your clients own/use or have access to smart phones with internet capability?**

“Voice activation is best for people who are blind. I work for several companies to help them test and implement speaking technologies. Uber Eats has a set up that works well with the iPhone and voice activation. A lot of people love the text messaging capability, even people with vision and hearing impairments.”

**c. Do you have any suggestions for the design of a new on-demand service?**

“When I think of On-Demand, I think of right now – like an Uber. Metro talked about one time that an on-demand service would operate throughout the outskirts of town.

Metro does a good job in making sure that their services are accessible. But there is still room for improvement. You must make sure that the technology aspect is accessible. I do a lot of work testing applications for Apple and Microsoft and can help Metro test new software too.”

**4. Solicit additional project engagement:**

**a. Who in your organization will be able to share the online survey links with your clients/constituents/customers and their families or in your social media?**

“I would reach out to the Down Syndrome Association, Autism Association, Hearing and Speech centers, and the Children’s Hospital. If you send the survey to me, I can have our PR person send it out to all our contacts.”

The interviewee was thanked for his time and input. The team then explained the project’s next steps and timeline.

## Stakeholder Interview – Hamilton County Commission

**Interviewees:** Gina Marsh, Chief of Staff, Office of Hamilton County Commissioner Denise Driehaus and former Executive Director of the Human Services Chamber of Hamilton County

**Other people present:** Darryl Haley, SORTA Chief Executive Officer and General Manager; Khaled Shammout, SORTA Chief Strategic Planning, Development and Innovation Officer; Steve Anderson, SORTA Director Transit Development & Innovation; Lisa Aulick, SORTA Director of Paratransit Services; and Liz Peak

**Date:** July 22, 2021 at 3:00 p.m.

### Meeting summary:

Each of the participants introduced themselves. SORTA's CEO summarized the purpose of the conversation by stating that SORTA is approaching the Greater Cincinnati Region Paratransit Coordination study with no preconceived ideas on what paratransit passengers' needs are. We are reaching out to people and agencies that support people with disabilities and learning what they think the community needs and gathering suggestions.

Gina Marsh was commended for the support that the Human Services Chamber gave to the Levy and the results of the Equitable Public Transit Project. Afterwards, the interviewees were guided through a conversation with the questions below.

### What led you to begin the Equitable Public Transit Project in 2018?

Gina replied that when it comes to human service needs, transportation along with housing are two of the most important issues. The Human Services Chamber wanted to find a way to give the people who ride the bus, a voice and the opportunity identify changes that they would like to see in the transit system.

Gina added that she knew a levy was in the works and wanted to be ready. A grant from the Greater Cincinnati Foundation was received to fund outreach into neighborhoods that heavily used public transit services. Residents in these neighborhoods were asked to share their challenges and what they would like to see in a reinvented transit system. Some of the challenges identified were typical everywhere and some were specific to certain neighborhoods. The change requests included more service at night and on the weekends, more bus shelters, and things of that nature.

### A second survey was mentioned in the report. Did that survey ever launch?

Gina replied that they had planned to launch the survey in another set of neighborhoods. However, COVID-19 struck and lingered. The Human Services Chamber had to limit the survey and outreach activities.

During the Pandemic, the Public Policy Committee and The Health Collaborative reported that there is a major food desert issue in the region and transportation is at the heart of it. There are large communities that are completely cut off from food supplies. While there are food delivery services, most of these residents could not afford that additional expense.

Gina conducted her own study of challenged neighborhoods to see how long it would take for residents of certain neighborhoods to get to a grocery store via transit. She found that some residents must ride two or more buses for 40 minutes to get to a grocery store.

The Chief Strategic Planning, Development and Innovation Officer shared that about a year ago, his staff completed a similar study looking at how long people must ride on a bus to get to certain destinations including grocery stores. This is a concern for SORTA as well.

Gina encouraged SORTA to work with Michaela Oldfield<sup>2</sup> at Green Umbrella and The Health Collaborative. They were looking at hiring an intern together to further explore food, health, and other neighborhood-based data. Gina did ask that the 2018 survey data be shared with SORTA.

**What were your expectations following the release of your report?**

The idea was to bring these ideas forward and work with SORTA to see them implemented. Many of the recommendations were addressed with the “Everybody Ride Metro” and the “Reinventing Metro Plan”.

There were a few other things that may still be in the works including:

- Discounted rides for children
- More bus shelters
- Better lighting at shelters
- More convenient option for those who do not have access to the internet

**Is there anything that stands out in your mind that we should take another look at as we implement the regional paratransit coordination project and on-demand service study?**

The Human Services Chamber made recommendations prior to the Pandemic to expand paratransit service beyond the current boundaries to serve as many people as possible in Hamilton County and to reduce the amount of time that these passengers are on the paratransit vehicles.

Khaled responded that SORTA is completing an analysis to understand the needs of the community and the capabilities of all the transportation providers. We are bringing the providers and human service agencies together next week to identify strategies to make transportation services more efficient and able to serve more people, more effectively. Gina was invited to attend this meeting.

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<sup>2</sup> Michaela Oldfield, JD, PhD, Director, Greater Cincinnati Regional Food Policy Council  
[michaela@greenumbrella.org](mailto:michaela@greenumbrella.org) and <https://greenumbrella.org/Staff>

## **Stakeholder Interview – Council on Aging of Southwestern Ohio/ home52**

**Interviewee:** Judy Eschmann, Vice President, Community and Business Operations Council on Aging of Southwestern Ohio

**Other people present:** Liz Peak

**Date:** June 16, 2021 from 9:00 to 10:00 a.m.

### **Meeting summary:**

The interviewee was thanked for the presentation and the insight she provided during the Greater Cincinnati Region Paratransit Coordination Project Launch meeting on May 18 and for trying to gather additional information for the project. She was also informed of the upcoming study to examine strategies to extend service beyond the fixed-route bus network through new on-demand solutions.

#### **1. Can you tell me about your motivation for launching the home52 program?**

The CoA has long been the administrator of the senior services levy (property tax) programs in Hamilton, Butler, Clinton, and Warren counties. Clermont County has a senior services levy, but CoA is not the administrative agent. The levy funded programs are known in the community as the Elderly Services Program (ESP) which provides care management and supportive services to help seniors live safely and independently in their homes for as long as possible. Our care managers perform an assessment of our client's needs (daily living skills) and develop person-centered care plans to help seniors remain independent. In Hamilton County alone, 5,400 seniors have a care manager and person-centered care plan. Many of these seniors require home-delivered-meals, mobility aids, or assistance with cleaning their homes or personal care. Many of our seniors require transportation to medical appointments, grocery stores or socialization activities. These services are provided to the program participants at no cost or with a co-pay based on the senior's income.

In Clinton, Hamilton, and Warren counties, the levy funding also supports a program called Fast Track Home (FTH). The Fast Track Home program is designed to support seniors being discharged to home from hospitals and nursing homes by providing care management support and services to ensure seniors have the support they need to recover at home. This is a 60-day program and is free to participating seniors. Along with home-delivered-meals and other supportive services, FTH includes transportation to follow-up medical appointments.

Prior to launching our home52 Transportation model, we contracted with transportation companies and assigned clients to those companies to provide transportation as defined in the care plans. While some client feedback indicated the transportation services they were receiving were satisfactory, there were many instances where the transportation fell short of meeting the client's need. Through client calls to care managers and customer service surveys, we received several complaints from clients particularly about untimely transportation, no-shows, not hearing the vehicle or the vehicle left before the client got to the door. We talked with our contracted transportation companies to learn more about their pain points which included excessive client no shows. Our conversations with health care partners mirrored our client feedback with complaints about no-show appointments or clients waiting for excessive lengths of time after the appointment for the return trip home. Looking at transportation through a social determinant of health (SDoH) lens, we created a model to reduce no-show and dead head miles for transportation companies, improve client access to medical care and

assist medical providers with serving vulnerable patients and reducing last minute cancellations. Our model was created with the feedback we received from clients, transportation companies and health care partners.

The new model is person-centered and is great for seniors, disabled adults, and vulnerable populations. It allows riders to get the additional hands-on support they need when traveling. Not all seniors require or want the additional support, but it is available if they need it.

When the on-demand trip is requested, the transportation provider is selected by the software based on the most appropriate vehicle type, vehicle location and the cost of the trip. This reduces vehicle deadhead miles and saves the funding agency money.

The driver is required to go to the door to meet the client. If the client is not immediately present, the driver calls the home52 dispatch center. The dispatch center will first try to call the client and if no response, will call the emergency contact person.

## **2. How has the response to the program been since you launch in May?**

It has been operating for 6-weeks now and we are very, very pleased with the results. We are receiving immediate feedback from our clients, medical facilities, and drivers. Our clients are telling us that the drivers are offering friendly transportation services that help them feel confident about traveling again. The medical providers love the heads up our dispatchers give them if the client is running late for any reason. Some of the transportation providers like it for a variety of reasons. Some drivers are still learning how to use the technology. Depending on the size of the transportation provider, not all companies were using technology until home52.

That is not to say that there have not been any issues. However, we are able to address the issues, following up immediately to keep them from happening again.

## **3. What will happen if there is more demand than you have the capability and finances to provide?**

We sent out an RFP to select the transportation providers. The RFP is a requirement for programs funded by tax levies. Eight providers completed the RFP process and were selected. However, we do expect to continue to grow and need more providers and funding. We have started a recruitment process and hope to add another six providers soon. We believe many of the smaller providers did not respond to the RFP because it was a little intimidating and required a significant administrative time investment. I feel that smaller providers are just as passionate about providing great customer service as I am.

We are launching the transportation coordination service one zone at a time with a new zone opening each month. So far, it has been working very well.

## **4. What happens if a senior request a trip for a purpose that is not in their care plan?**

The senior is asked to talk to their case manager about their request and possibly have their care plan modified to pay for the trip or they can self-pay. While many of our seniors may not be able to afford the trip cost (\$20 or more depending on how far they are traveling), their family members may be able to do so. In about two months, we expect to be able to take credit card payments. This will also help

some medical providers that would prefer to use a credit card to pay for trips that they request for their patients.

**5. Do you provide trips for other programs outside of the levy programs?**

We hope to work directly with medical practices and hospitals soon. Medical practices and hospitals can call us directly if they have a patient with an immediate but nonemergency need. For example, if an elderly patient is not feeling well and the physician wants to see them right away, the medical facility can call us to arrange the transportation. We will invoice the facility for payment, or they can use a credit card. These are often Medicare clients. We are not certified to do Medicare billing. The hospitals and medical practices bill Medicare for services and pay us directly.

We hope to be ready by fall and prepared to respond to an RFP to provide NEMT (Non-Emergency Medical Transportation) services in Hamilton County. I am inquiring now with Hamilton County JFS to learn when the next RFP opportunity will be available. We have also submitted a City of Cincinnati Human Services grant application to be able to offer transportation to older adults living in the City of Cincinnati's approximately 20 low-income housing buildings to medical appointments. Grant awards will be announced in July 2021.

We are receiving requests from other groups asking for our service. I just received an email from a YMCA asking if our service could be provided to their members. Currently, a care plan may indicate that trips to the YMCA are permissible. We just do not have the funding and the resources to transport everyone to the YMCA.

Our model can serve everyone. Riders choose whether they need additional hands-on, door-to-door or through-the-door assistance. Not everyone wants or needs the additional support, but it is available when they do. When or if we expand to providing transportation coordination to less vulnerable populations, our model will remain a person-centered model that can serve diverse populations.

**6. Now that you are using a more robust scheduling software, could you consider sharing trip origin and destination data in the future to help us with this and the on-demand project?**

We are still learning about the capabilities of this software and working with the vendor to develop the reports we need. I will talk with our Business Intelligence team to see what and how we can share that information. We appreciate all the feedback we were able to receive prior to the launch of home52 and welcome any additional support.

## Stakeholder Interview – Health Collaborative

**Interviewee:** Lauren Bartoszek, PhD, CHES Senior Manager, Population Health Strategies for the Health Collaborative

**Others present:** Khaled Shammout, Chief Strategic Planning, Development and Innovation Officer for SORTA, Steve Anderson, AICP Director Transit Development & Innovation for SORTA, and Liz Peak

**Date:** June 21, 2021 from 3:00 to 4:00 p.m.

### Meeting summary:

The interviewee introduced the Health Collaborative as a 501 (C)3 nonprofit with the goal to lead data driven health improvements as the region's health data exchange. The agency operates on a membership model and partners with all the health systems in the region. Their primary role is to use the Health Bridge platform to help doctors and medical facilities share data across platforms. The Health Collaborative is a 2015 merger of three organizations: Health Bridge, Community Health Improvement Collective and a Physicians Council.

SORTA's Chief Strategic Planning, Development and Innovation Officer shared some project background information concerning the Reinventing Metro Plan and its components. One of the components is the regional paratransit coordination project. SORTA is also preparing to examine strategies to extend service beyond the fixed-route bus network though new on-demand solutions. Comments from the interviewee and data from the Health Collaborative will benefit both the paratransit and on-demand projects.

### Community Health Needs Assessment (CHNA)

The Health Collaborative produces a collaborative CHNA (Community Health Needs Assessment) every 3 years as a regional report covering 26 counties and health departments. The data referenced in the CHNA represents the aggregate data from 26 counties. Lauren explained that the Health Collaborative is technically a 14-county region, crossing into Kentucky, even though the CHNA is a 26-county region going all the way up to the Greater Dayton region.

A new CHNA is due to come out this fall with a much broader (geographically) and deeper (with more specific information) data about social determinates of health and equity. The data collection period just wrapped up 2 weeks ago includes just under 10,000 survey responses, 40 focus groups and 32 interviews across the 26 counties.

They hope that the way the report will be written this fall will give people the information they need to make informed, and data driven decisions. Over the next 6 months, as the CHNA themes comes out, specific working groups will be put together to determine what can be done to improve health outcomes. It is likely that transportation will be one of the themes.

Lauren also recommended that SORTA partner with TANK and reach out to Saint Elizabeth Hospital. Transportation is one of Saint Elizabeth Hospital's priority areas.

## **Human Services Chamber Transportation Subcommittee**

Lauren shared that Gina Marsh, Executive Director of the Human Services Chamber had launched a project called the Equitable Public Transit Project<sup>3</sup>. It was funded by the Greater Cincinnati Foundation and the Seasongood Foundation. The project was a data collection project that was launched in phases by neighborhoods.

The first phase was completed prior to the pandemic in a face to face mode at bus stops and locations where riders frequent. They received over 800 survey responses. Lauren will contact Gina to ask if she can share the summary PowerPoint and the raw survey responses with us.

The second phase launched just as the pandemic began. This really slowed down their process. For this reason, they are now shifting focus on areas that have food access and childhood hunger issues. Michaela Oldfield, Executive Director of the Food Policy Council<sup>4</sup> is the expert on understanding the food insecurity issues in Cincinnati and may be able to grant access to this data. Historically, food insecurity issues are often related to transportation and money.

The Human Services Chamber has a transportation subcommittee that meets monthly. Lauren has been attending since early this year and feels that this may be a good place to start. She does not know if anyone from SORTA is attending but can ask that SORTA be invited to future subcommittee meetings.

## **Health Collaborative Data Ownership**

Lauren explained that the Health Collaborative is the conduit of health data. The Health Collaborative does not own the data and cannot release it without permission from the owner. This data is highly confidential and falls under HIPPA regulations. Lauren can share what she knows. She just needs to get permission to share data.

Neighborhood level data is really challenging. The Health Collaborative may be able to help connect us with multiple data sources to better paint the picture and tell the story.

The Health Collaborative runs a project called the Accountable Health Care Community. It is a pilot project from the Centers of Medicare and Medicaid Services (CMS). They pay the Health Collaborative to operate as a bridge organization to work with clinical sites (hospitals, health departments, etc.) to screen patients with 10 questions about their needs (transportation, food, housing, and violence). If they screen positive for a need, they are navigated to a resource. Transportation and food are often the highest needs. While the Health Collaborative does have heat maps identifying areas where beneficiaries with transportation needs live, she cannot share the maps or data without permission. It may take about 30 days to receive this permission.

## **Wrap Up**

Emails to be sent to Gina Marsh, Michaela Oldfield, and CMS to request data sharing authorization.

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<sup>3</sup> The Equitable Public Transit Project <https://humanserviceschamber.org/portfolio/equitablepublictransit/>

<sup>4</sup> The Greater Cincinnati Regional Food Policy Council <https://www.cincinnatiregionalfood.org/>

#### MOBILITY ON-DEMAND DISCUSSION WORK GROUP SESSION NOTES

Developing project advocates ancillary to the internal project team demonstrates the transparency and sense of openness to feedback while building trust with the community and ensuring that project decisions reflect their input. We worked with SORTA staff to identify and invite selected participants to the discussion group workshops.

During the workshops, the participants identified areas where an on-demand transportation service may improve access to medical appointments and services to improve the health outcomes and quality of life in Cincinnati's communities.

Three Discussion Work Group sessions were held targeting specific audiences including:

- Human Service Agencies - October 14 from 1:00 p.m. to 3:00 p.m. (10 attendees)
- Bus Rider Advocacy Committee - October 14 from 6:00 p.m. to 8:00 p.m. (4 attendees)
- Everybody Rides Metro Group - October 15 from 1:00 p.m. to 3:00 p.m. (2 attendees)



**Bus Rider Advocacy Committee members sharing their views**

Community Services Focus Group (10 Participants) - October 14, 2021 (1:00 – 3:00 p.m.)

- Center For Independent Living Options - Patrick Ober
- Cincinnati Chamber - Pete Metz
- Cincinnati Works - Matt Mooney, Glenna Parks, and Mike Setzer (volunteer)
- Clifton Heights Community Urban Redevelopment - Matt Bourgeois
- Council on Aging / home52 - Jen Williams
- Greater Cincinnati Homeless Coalition - Josh Soring
- UC Health - Justin Hatfiel and Nick Provenza

***Does the population you serve complain of a lack of access to places and services due to limited mobility options?***

- Economically disadvantaged neighborhoods progressively see reductions in services and routes which over time impacts the residents' ability to get to work and also limits the type of work that is available.
- Where individuals can work is based on their ability or lack of ability to have access.
- Employers are facing shortages of workers because the workers cannot get there.
- Cincinnati Chamber is working in partnership with OKI to identify Job Hubs which includes a transit access component. An interactive map identifies the Cincinnati region's densest employment hubs and details their accessibility to the workforce via car or public transit. The Job Hubs tool at [Jobhubs.oki.org](http://Jobhubs.oki.org) will highlight areas of improvement for regional transit access and infrastructure.
- There is a need for creating new trips that does not exist today because people cannot access jobs.
- Jobs may be there but may not be a fit when the jobs start at various times or require overtime or work on the weekend. If the fixed route bus only makes 1 or 2 stops during those times, it creates a misalignment.
- In addition to looking at the density of where the jobs are, is there a way to add a layer that looks at the average wage to identify where the "good" jobs are located? This is not a feature currently included in Jobhub.
- The project will need information on where clients need to go to prioritize the focus areas.
- Where clients need to go:
  - Westwood, Avondale, and Sedamsville neighborhoods are not pedestrian friendly. Things are spread out there so getting to grocery stores and to a job are not easy. These individuals may have physical and/or cognitive disabilities but not only interested in paratransit services. They may need to travel to Clifton for a doctor's appt or downtown for work. They are not just staying in their neighborhoods to get services. They must use transit to get to various parts of the city.
  - Need to connect the options available in 5 neighborhoods of: Avondale, Clifton, CUF, Corryville and Mt. Auburn.
    - \* Each neighborhood has a lot to offer and have destination-based amenities (Corryville has a large Kroger, CUF has an Urban Target & restaurants, Clifton has a movie theatre and hardware store) that are unique to that neighborhood. But, if individuals in

Corryville want to go to the hardware store, there is no easy way to get there. It is too far to walk and to drive there and park is hard too.

- \* There is no public transit solution for going between these neighborhoods even though they are close to one another. It is too far to walk.
- \* They each have jobs, amenities, housing, and healthcare. There would be benefits to connecting them for greater and easier access (better quality of life, economic growth, makes each neighborhood more desirable for living/raising family).
- \* Should be able to get from any of the neighborhoods to all the neighborhoods.
- \* Communication is important as SORTA develops the pilot so residents in one neighborhood know what is available in the other neighborhoods and how to access transit options.
- \* Time is as important as geography especially for entry level workers who work 2<sup>nd</sup>/3<sup>rd</sup> shifts.
- \* Time of day may influence the pilot solution and flexibility is needed. One time of day may require route deviation vs. point-to-point which may be needed at other times of day to accommodate 2<sup>nd</sup>/3<sup>rd</sup> shift work requirements.
- \* Access to healthcare is limited by access to mobility and impacts individuals and the healthcare system.
- Employment needs are different
  - Need to consider getting outside of 275 loop where Metro service ends, or needs more frequency (especially routes that only run during 1<sup>st</sup> shift hours).
  - Better paying jobs are typically outside of the 275 loop and are typically off shift jobs (over time routes have moved more to supporting mostly 1<sup>st</sup> shift jobs).
  - If the fixed route service is 24-hours, there may be an MOD option that can link to a fixed routes service to allow for more extended hours of employment (to allow for 2<sup>nd</sup>/3<sup>rd</sup> shift).

***Share the impact the lack of access has on your customer and to the services you provide.***

- Employer asks: “Do you have reliable transport?” No car, no job; no job, no car.
- Lack of access requires greater reliance on friends, family, and neighbors to provide transport and restricts their independence.
- There are potential impacts to health and wellness of individuals if they don’t have access to transportation to receive healthcare.
- Lack of access impacts daily living (ex: Grocery shopping, church, etc.).
- It also stunts business growth.
- It causes unfilled job openings.

***How might this new on-demand service impact your customer and your agency’s service delivery?***

- Customers may achieve economic self-sufficiency (ex: reach to employers).
- If implemented well, this could open more housing options, opportunity for collaboration, and more employment opportunities.
- It may increase sales for businesses.
- It may remove the need for a car and increase affordability for residents.

- Customers will be able to get to a sick appointment instead of waiting until it becomes an urgent care or emergency room trip.

***Do you believe your population would be able to walk a few blocks to a central location to meet the service? Or will they require curb to curb or door to door service?***

- Most people could be served by a central location.
- Door to door is many times more attractive.
- Yes, some can walk to a central location.
- Yes, 1-2 blocks.
- Most people would be able to walk a few blocks. However, certainly some folks would need curb to curb or door to door.
- No, curb to curb or door to door.
- Both.
- Our population would need all available options (walk, door to door, curb to curb).
- Potentially, patients that can ambulate better could walk. Some have a need for door to door depending on their condition.

***How would your clients prefer to schedule their trips?***

- Tech-based solution.
- A mixture of smart phones and phone calls.
- Smartphone app.
- Smartphone/online would be accessible for many we serve.
- A recurring subscription.
- Phone call.
- Technology.
- Phone – Most would need to talk with someone unless there is a caregiver involved.
- Combination: Smartphone App and Phone call.
- Employers'.

***How much do you think your population could pay for an on-demand trip?***

- Build into the monthly pass.
- Something reasonable: Less than \$5.00.
- The cost would need to be the same as a regular bus ride. If it is connecting to a flex route or an option where another ride will be needed, it should be one cost, not treated as 2 trips.
- Many could not afford to pay.
- \$2.50.
- \$1.00-\$2.00 (all short trips).
- New employees need free. Long term employee could pay \$2-\$3 per trip.
- If it were a time-efficient on-demand trip, most could probably pay \$5-\$7 per ride.
- Employers - \$30-\$40/hour. Riders - \$5/day.

***Do you think an on-demand service will have a negative impact on a community group of people?***

- No (3).

- The problem with on-demand would result from a lack of easy access to request a ride or confusion regarding how the process works.
- Potential negative impact on private TSP providers and some small businesses.
- Should only provide positive outcomes within healthcare if it is affordable.
- Yes, our rideshare drivers' loss of income.
- No, it would be helpful.
- No, it will be great!

***Do you have suggestions for the design of a new on-demand service?***

- Multiple methods to request trips.
- Flexible design based on use cases not geography.
- Regional Hub/Spoke Wheel.
- Go outside of each hub to link with wider regional areas (Bus Route Lines).
- Divide the City/County into specific areas so they become self-contained zones with identified resources (grocery stores, RX, housing, jobs, etc.).
- Ensure your population is involved in the selection of pilot neighborhoods and on-demand service design.
  - Involve Workforce organization; United Way and other groups, etc.; and Employers. Get into the weeds with them to understand.
- Provide solutions to connect with your population and their network or systems with the use of social media.
  - Public libraries, use food, Community Councils.
- A localized on-demand transportation solution in our neighborhoods (Uptown, Clifton, Mount Auburn, Corryville, and Avondale). This could take the form of a circulator that mostly moved around UC's main campus with spokes into the individual neighborhoods on arterial roads (Auburn, Ludlow Avenue, Short Vine, MLK, Calhoun and Clifton Avenue etc.). Flex routes could work very well off these main lines would connect to Northside Transit Center for referral access (Ludlow) and connect East to Woodburn in Walnut Hills.
- Conceptionally this sounds excellent, however the technology divide and other impacts those living in poverty must be considered to ensure community success.
- Promote short trips, walkable access, and availability always (no-lag).
- It is important to design zones with a lot of flexibility. A zone might be linear or even discontinuous, for workforce trips, bring people from Sharonville to jobs in Sharonville will not help much. But Madisonville to Sharonville zone might work.
- Get into the weeds, transportation is tricky. Choose a few large similarly located employers as part of the pilot in tandem with workforce development organizations like Cincinnati Works. Don't just rely on what people say they need to have a tested and monitored pilot.
- Design needs to be straight forward and simple to access. In addition to connecting points, the time it takes to get from place to place is important. Access that takes so long it impedes other life functions or needs is not really considered providing access. Cost need to meet ability to pay.
- Same day, same hour on-demand accessible paratransit rides.

***How do we ensure that your population is involved in the selection of pilot neighborhoods and on-demand service design?***

- Community Councils and Community Development Coalitions.
- Multiple Neighborhood Community Councils/CDCs.
- Go to places people live to get their input. Also, go where people work, shop, and do business.
- Partner with senior housing communities/use surveys to gather feedback.
- Work through Matt Bourgeois to connect with community councils and business associations in the Uptown area. Could be done via in-person meetings, social media, and direct email surveys.
- Involve workforce development organizations and school systems like Cincinnati Works, CAA, Urban League, United Way (funds supporting WFDO), Santa Maria Price Hill Will, and YWCA.
- Post appointment questionnaire.
- Meet with business leaders beforehand (use Cincinnati Works for introductions).
- We have dozens of organizations who together work with thousands of people. We need to connect SORTA with our members organizations who can work with us to connect the people needing services. Follow up with Josh Spring Homeless Coalition [joshspring@cincihomeless.org](mailto:joshspring@cincihomeless.org).
- Specifically include people with physical disabilities in the discussion and creation of the on-demand service design. You will not know the gaps or flaws with the accessibility of a design without their assessment or input.

***How do we connect with your population and their network or systems with the use of social media?***

- Leverage social media and inform grocery stores (person to person, community based).
- Leverage facilities and social media vehicles, Facebook, Next Door, etc.
- Neighborhood Facebook.
- Next door pages.
- UC student groups.
- Public Libraries.
- Community Councils.
- Social Media is an option for some but should not be relied on for everyone.
- Using “High-Contact” locations (Grocery, pharmacy, doctor, and realtor) to promote new ride options and service routes.

Riders Focus Group (4 Participants) - October 14, 2021 (6:00 – 8:00 p.m.)

- Ray Johnson – Works with several nonprofits, Public Allies (a social justice, leadership organization), Brighton Center (help individuals and families reach self sufficiency), Winton Place Youth Center, and is a training specialist for small businesses.
- Ellen Haney – Works for Cincinnati Public Schools as an ESL teacher (not only helps her students but also their families to ensure they have stability). She helps connect families to the services they need (legal, job, housing, etc.).
- Dani Burris – Works for a human service agency and is a mom.
- Jennifer Foster – Is a community volunteer and transit advocate.

***Does the population you serve complain of lack of access to places and services due to limited Mobility options?***

- The 51 and 4 buses originally had regular trips to the Norwood Kroger with most passengers being senior residents. When services were changed/reduced, school children began to ride the buses during the time the senior resident's rode. This changed the calmness and tone of the bus ride for the seniors. The seniors wanted more options for riding the bus when children were not present, but there were not enough bus frequency or options for a ride without kids in the morning as it had originally been.
- Clients may not have computers and need to go to other locations to access a computer. These locations often request a long walk. Must take her mother (and other residents) to a fixed route stop to go to work.
- Specific places and neighborhoods:
  - Cleves
  - Westwood (the 51 may go there) and Miami Township
  - Golf Manor
  - A client in Anderson needs to get to Walnut Hills to continue his High School education.
  - Daughter lives in White Oak and her son is in school at Walnut Hills. If he were to ride the fixed route bus to school, he would have to be at the stop by 5:30 to get to school by 8:30am. So, the daughter must transport her son to school and must walk 2 miles to get to the 17 route.
  - Kroger closed in Colerain. To get to the grocery, Jennifer must take the 19 bus at the infrequent and inconvenient times.
  - About a mile up a steep hill from the 19, there are many subsidized apartment complexes (Hawaiian Terrace and Bahama Terrace). Kids from these complexes miss school because they do not have their own transportation and it is a hard walk.
  - It is not just lack of access to transit that is an issue but orientation of the transit network (better connectivity through the network is needed).

***Do you believe your population would be able to walk a few blocks to a close stop (3-4-minute walk)?***

- Yes, but could not be more than a 10-minute walk

- Winton Terrace: Do not have to walk too far to reach a bus stop (according to some). But “not too far” to those who have been economically impacted and have suffered over an extended period of time may need a transit option that will actually come the 1 mile down the road to those apartment complexes and link with/pick up residents who can’t make the 4-minute walk that others think is “not too far.”

***How do you think people would prefer to schedule their trips?***

- Text message or phone call.
  - Text messages would make it easier to schedule using adaptive technology.
  - Many phones provided through various human services programs have unlimited texting but have limits on data usage or storage space required by many apps.
- Should not be purely using an App.
- Could get the level of service provided through Lyft/Uber through a text message format.

***How will people Pay? How much would they pay?***

- Cash (this option is a must have).
- A set fee like Dial-a-ride with a \$2 fee based on the distance traveled.
- Link to Fair Deal Card with rides as an extension of their service and as a transfer.
- Need more consideration for implementing a better kids’ policy (especially for multiple children).
- Consider a family pass.

***Do you think there would be any negative impact to the community/group with on-demand service?***

- There would be a negative impact if Apps are required, and I do not want to use an App. It would be better in that case to have an option to call by phone and request a ride to provide pickup address, destination, and time and would then receive a text message response to confirm pickup.
- Should have an option to register for an account which would have a record of each ride (ability to track riders as a safety measure). SORTA could also track demand.

Community Services Focus Group (2 Participants) - October 15, 2021 (1:00 – 3:00 p.m.)

- Department of Jobs and Families - Kevin Holt, Interim Assistant Director
- SORTA - Caprice Jones, Everybody Rides Metro Manager/Admin Assistant

***Does the population you serve complain of lack of access to places and services due to limited Mobility options?***

- Partner organizations are struggling to find solutions to the lack of access issue.
- The service should use non-CDL drivers using smaller vehicles.
- Find local partners who are willing to buy passes for their population.
- Employers also should buy passes for their employees and support service delivery.
- Recommend having a service that goes to the Airport and Springdale where there are higher wages (especially at the airport).
- Look at where a predominance of apartments and rentals are to determine potential pilot neighborhoods.
- Fairfield area has lots of manufacturing facilities and warehouses but transit service to the area is very infrequent.
- Connectivity between TANK and Metro is an issue. Many people need to get to Amazon and DHL at the airport.
- Roselawn neighborhood has a lot of Senior Living facilities, and the seniors have a tough time getting to the bus stops. Losantiville Road & Reading Road have no sidewalks and the streets are terribly busy.
- Hospitals are being built on the outskirts of the city which may not have frequent enough bus service.

***Share the impact the lack of access has on your customer and to the services you provide.***

- Segregated housing leads to segregated employment and restricted opportunity.
- People tend to get jobs where they can get transportation. Jobs tend to be segregated due to transportation availability.
- There is a jobs/housing gap caused by segregated housing along racial & class lines. Therefore, access to jobs is limited, especially for low-income communities.
- Employer asks: “Do you have reliable transport?” No car, no job; no job, no car.

***How might this new on-demand service impact your customer and the agency service delivery?***

- OD Mobility would allow workers to get out of their neighborhoods for more and better job opportunities.
- Better access to medical care (Mercy Hospital).

***Do you believe your population would be able to walk a few blocks to a central location to meet the service? Or will they require curb to curb or door to door service?***

- Bus stop clusters will work great in some communities.
- Curb to curb will be best in rough neighborhoods and where there are young kids and older adults.
- Depends on the walkability of the neighborhood to determine what would work best.

- There needs to be a mix of door to door and hubs.
- Use Stop/Hubs for flexibility.

***How would your clients prefer to schedule their trips?***

- Need all options for scheduling: Phone call, online, App and text.
- Can get a free phone at 222 Central Parkway.

***How much do you think your population could pay for an on-demand trip?***

- Bus fare recently went from \$1.75 to \$2 and got rid of transfers.
- Would not go above \$2.65.
- Ideally, would like to see a mechanism for providing bus fare electronically without handing out passes.
- Should have an online account-based fare system Employers could use to give employees passes via an account.
- Must move to non-cash environment.

***Do you think an on-demand service will have a negative impact on a community group of people?***

- Must manage unrealistic expectations.
- The service must be equitably applied and provided.

***Do you have suggestions for the design of a new on-demand service?***

- People should have to reserve seating, not just show up to ride.
- Fifth/Third Bank is investing \$25M in Avondale. Children's Hospital is putting a lot of case management services in Avondale. The ODM project would be a perfect companion to those projects.
- The design should also be formed by people's aspirational destinations as well.

***How do we ensure that your population is involved in the selection of pilot neighborhoods and on-demand service design?***

- Send a live feedback link to people they serve.
- Provide an online survey link on their website.
- Use an interactive voice response (IVR) system to survey clients.
- Send links to all Community Councils.

## MOBILITY ON-DEMAND SURVEYS

Three separate online surveys were developed and collected for this project. The surveys were designed to inform the reader of the existing service and potential on-demand service opportunities in select areas and provide an easy way to provide input to help us better understand the mobility needs and concerns, especially within the targeted neighborhoods.

The first survey was developed for the SORTA employees and was shared during the Open House events. It asked the employees to identify areas where people who may need transit services are unable to access Metro; where the condition or lack sidewalks or street conditions prohibit access to bus stops and seeks feedback on the type of vehicles and hours for the new MOD service.

The second survey was developed for all Hamilton County residents (riders and nonriders), employees, businesses, and organizations. The survey was prefaced with details of the existing services and proposed on-demand service concepts. It included interactive maps and questions about transit service needs and expectations.

The third and final survey was developed to gain input on each of the six recommended pilot zones. A unique on-line survey was created for each of the six areas asking only two questions: What places in Zone X do you need to travel to and What places within Zone X are hard to get to and why? While each survey included the same questions, the map shown, and Zone description was specific to the area. A flyer was also created for each area with a corresponding map and QR code to the appropriate survey.

## Introducing Mobility On-Demand!

*Please take our brief survey.*

Metro has the exciting opportunity to study and design on-demand transit service for communities in our region that have not had access to public transportation in the past.

**Mobility On-Demand** will provide accessible, on-demand, localized mobility for all, including connections to Metro's network of more than 40 fixed bus routes.



**Tell us where Mobility On-Demand should go!\***

## SORTA Employee Open House Survey Methodology and Result

Duration:	October 12-14, 2021
Administration:	Face-to-face, Map Display, Project Education, and Information collection
Survey Format:	9 Key Questions ( <i>combination of demographic, open-ended and multiple-choice questions</i> )
Locations:	Access, Administration Office, Bond hill and Queens Gate
Engaged:	204

Total Survey Respondents: 110 (*From Fixed-Route, Access, Maintenance and Administration*)

**1. Please identify any area(s) where people who need transit service are currently unable to access Metro services or must walk great distances to get to a bus stop.**

253 locations were collected and reconciled. List ordered from highest to lowest response frequency.

- Blue Ash (11 mentions)
- Sharonville (10 mentions)
- College Hill and Seven Hills (8 mentions)
- Avondale, Forest Park, I-275, Montgomery, and Springdale (7 mentions)
- Amelia and Westgate (6 mentions)
- Dent, Harrison, Madeira, Price Hill, and Walnut Hills (5 mentions)
- Anderson, Bethesda, Cherry Grove, Evendale, Milford, and Mount Healthy (4 mentions)
- Delhi, Eastgate, Fairfield, Glenway Crossing, Loveland, and Newtown (3 mentions)
- Amberly Village, Aspen Village, Bond Hill, Chariot Area, Cleves, Coney Island, East Westwood, Eastside, Glen Cove, Indian Hills, Kennedy Heights, Kings Island, Roselawn, Rybolt Road, Sayler Park, Sycamore, Tricounty, Westwood, and Winton Terrace (2 mentions)
- P&G population in Mason is a large international population and they are not afraid to travel on public transportation, but they currently have limited access. Only the commuter rail. They could use a shuttle of sorts.
- Sixty-two more areas (1 mention each)

**2. Please identify any area(s) where many elderly or disabled people reside and have difficulty accessing Metro or where the lack of sidewalks and safe paths of travel limit people from accessing Metro bus stops.**

- Amelia Village, Lincoln Heights, and Winton Terrace - Lots of elderly people in all these neighborhoods that need transit access. The 43 goes to Amelia but needs to go further.
- Anderson and Linwood, Avondale, Blue Ash, Cherry Grove, Cleves, Colerain, Harrison, Indian Hill, Marymount, Madeira, Montgomery, Price Hills, Riverside, Roselawn, Sharonville, Seven Hills, and Sycamore - Seniors, People with disabilities.
- Aspen Village, Finneytown (Compton, Winton Road, and Hamilton Avenue), Glen Cove (On Hamilton Road), and Kennedy Heights - Students, Seniors. Remote neighborhoods and they cannot get to key locations or to link to main bus line.
- Avondale where there are elderly senior communities on Reading Road and crossing the street is problem for some of the residents.

- Batavia, Glendale, Delhi, Milford, Sayler Park - Seniors, working business folks, Disabled.
- Belterra, Eastgate, Loveland, Milford, Sharonville, Springdale - There are many elderly people who live in these areas who cannot easily get to places where there is availability of bus service. So, a neighborhood on-demand service would be ideal to get them to the closest Fixed Route bus stops that could get them to the grocery store(s), shopping, and appointments.
- Bethesda and the Eastside - People in Bethesda used to have service. The service in the Eastside is limited.
- Blue Ash, Montgomery, Mount Airy, Symmes Township (Route #3) passing I 275 - High senior population that cannot get past I-275 Linking people to #3 route.
- Bond Hill, South Avondale, Winton Terrace - Mothers with children (Winton Hill) Bond Hill (Need more service in the area) South Avondale (Mother's with children)
- Bridgetown, Mack South, Oak Hill High School (Ebenezer Road) area off Gurley Road, off #33 past Glen Way, Queen City - Elderly and Disabled passengers in this area.
- Chesterdale Road between Crescentville and Kemper - Not sure how many elderly people live in the Tri-County Mall area but there are large groups of immigrants that need easier access to bus service that is too far away.
- College Hills Seniors and Disabled, a legally blind resident needs access to the main line.
- Coney Island, Harrison Avenue, Madeira, Montgomery, Mount Healthy, Sharonville - Senior apartments in Mount Healthy, Amberley area people apply for service but are outside area
- Delhi and Rybolt Road - Elderly, Retirement Community, Schools, Children)
- East Walnut Hills retirees, seniors and Working age need access to the main line.
- East Westwood and Roll Hill - Seniors and mothers with kids.
- English Woods, Kennedy Heights, Millvale - Lots of elderly and bus stops are too far.
- Evanston (off McMillian and Hackberry) Senior High Rise.
- Evendale up Reading Road (Route 43 goes there but does not go far enough) and there is a lot of places in the area that is not covered. Elderly people live in the area that would benefit from on-demand transportation, to get to a bus route stop or to other services in Evendale.
- Forest Park, Fairfield, Loveland, Mason, Newtown - Need more accessible and available (when/as needed) transit service for elderly.
- Glenway Crossing. The hospital on Montgomery Road has very limited service on route 3.
- Harrison and Rybolt Road - Need more frequent accessibility to transit which is now not as close to a bus stop as needed for elderly or those without transportation.
- Heywood St in Price Hill near apartment complexes with one entry and one exit - too far to walk, especially for seniors and disabled.
- Hodge Street has a senior center, and they have a hard time getting out of that building.
- Losantiville, Roselawn - There are many elderly and adult residents in Roselawn apartments who need better/closer/easier access to transit to get to work, shopping and other appointments.
- Madeira. There are elderly in Madeira and/or others who need access to transit and can't easily get to the 11.
- Madisonville. Race Road Mercy Hospital Transitions Nursing Home
- Midway. Seniors need to reconnect to service.

- Montgomery and Loveland - Need to support of elderly population and the jobless folks.
- Mosteller Rd. Able Body working groups requiring shuttles from the area.
- Mount Auburn. Seniors living in area.
- Mount Healthy, Winton Hills, Springdale - Seniors are in the area who have to walk a great distance with narrow streets.
- Mount Lookout. Buses stopped running in the area and youth need to get to work and other locations
- Price Hill (West State streets) and Roberts Street - Mothers with young children and baby carriages to get to daycare and link to main system.
- Seven Hills. Seniors, disabled, retired people, young non-driver workers. Pleasant Run area has lots of people walking long distances to get to a route.
- Sharonville. Elderly of Sharonville would benefit from more access to community grocery stores or shopping areas as well as connection to other FR bus routes.
- Springdale/Forest Park, Cheviot, Ohio area - Urban areas seniors, young families with kids and the underserved people.
- Springdale and Sharonville where there are many factory jobs.
- Walmart off route 28 & 29. People who ride the 32 in West Price Hill have to go grocery store downtown to avoid a transfer to go to the local store at Glenway.
- Walnut Hills. Older Adults and Mothers with several children.
- West Chester. Seniors and working class needing a link to the 42 and 71 to get to work.
- Westside and the West Price Hill Area - Mixed Community
- Westwood/Avondale to College Hill - Side streets don't have easy access to bus stops. Roselawn and Golf Manor where there are senior buildings (#43) needs to go to the local "Save-A-lot" in Norwood.

**3. Please identify any area(s) where low hanging trees and street conditions (especially in the winter) makes the area difficult to serve with a fixed route vehicle.**

- Along route 33 and all over the city the power poles lean in too much
- Anderson
- Avondale
- Beakmann
- Casino Belterra
- Cherry Grove (serious issues with no sidewalks)
- Cincinnati Westside
- Clifton area has a lot of overgrowth.
- CUF
- Eden Park area
- Fixed Route Bus size might pose a problem in areas where there are cul-de-sacs, sharp turns, or limited turning capability in smaller neighborhoods.
- Glendale has steep hills and long streets
- Harrison Avenue #40 up to I 74 Rydebolt Road
- Highlands
- In Roselawn and Losantiville the walk is not easy to get to the 41.
- Kemper Road has no sidewalks

- Linwood
- Madisonville
- Mount Adams
- Mount Healthy has narrow streets
- Northside Neighborhoods, cities with older residential areas.
- Off Hamilton Avenue by the #17 Route, a long and complicated walk for many.
- Price Hill
- River Bend
- Serving the Madeira area would work best with smaller vehicles in order to maneuver better in smaller neighborhood areas where a large bus would not fit easily.
- Turn on Burnet is too tight
- West 8th street has steep hills and long streets
- West side Cincinnati.
- Winton Road
- Wyoming Ave has 2 nursing homes that Access vehicles cannot get to.

**4. What time of day should these services operate?**

- Highest demand for ridership is between 7am – 7pm.
- Considerable number of areas have also been flagged for service both before 7am and beyond 7pm.

**5. Do you have any other comments that could help us design a new on-demand service that could help more people access Metro services?**

Almost 200 comments were received including:

- Vehicle size (62 comments)
  - There needs to be smaller vehicles that can easily drive through the various neighborhoods and ability to make narrow turns.
  - Small vehicles or extend the 41.
  - For last mile connections, there needs to be clearly marked areas to wait for this different service.
  - There should be small buses, similar to Access buses, that link to Fixed Route bus routes or provide service within a prescribed community/area.
- Fares (54)
  - Use fare card for older adults and cost \$0.50 - \$2.00.
  - Access bus size should cost \$1.00.
  - Create a premium service at \$4.00 with a frequent rider discount card.
  - Cost should be up to \$5.00.
  - \$4.00 - \$7.50 based on distance of the service.
- Service parameters (15)
  - Put in another transit center on the north side.
  - A lot of people in the campus area would like this service.
  - More crosstown connections.
  - Retirement communities. Mason community could use event-based connections.
- Accessibility (12)
  - Focus on mobility and disabilities.

- Accessibility for those with disabilities like blindness or in wheelchairs who might not qualify for Access.
  - Wheelchair accessible.
- Transfers (12)
  - Transfers needed.
  - Need to build a transfer hub on the outskirts of town where the drivers can report to work, customers can buy tickets and catch a bus or MOD.
- Marketing (11)
  - Access is not advertised enough. No one knows what we do or that we are also Metro.
  - As we market the service, remember that French, Spanish and Indigenous languages are spoken in this area.
- Hours of operation (7)
  - Bus service should be available all day, 7 days a week.
  - We do not necessarily need late night services.
  - Don't think late night hours are required. Should operate 7 days a week.
  - Service should run regular hours into the afternoon and rush hour time.
- Alternative fuels (4)
  - Power - alternative fuels or electric.
- Driving conditions (4)
  - Must navigate curvy roads.
  - Large trees, limited sidewalks.
  - Steep hills and curvy roads.
  - Vehicles that can go up steep hills like vans, cars or maybe a shuttle vehicle.
- Amenities (2)
  - For last mile connections, there needs to be clearly marked areas to wait for this different service.
  - People really need benches to rest on while they wait especially at Hyde Park and Colerain areas.
- Other Comments (10)
  - Community Councils.
  - Pay raise.
  - Small location.
  - Focus on mobility.
  - I think this is a great way to get people to the bus.
  - Good at first then people will use it as a taxi. They will stop walking to the bus stop.

**6. As a part of this study, we will be reaching out to community and social groups, organizations of faith, employers and social service agencies for their feedback and assistance in selecting potential areas. Could you recommend a group or agency that we should contact?**

- Social Service Agencies (33)
  - Cincinnati Association for the Blind, any business that caters to people with special needs.

- YMCA South Avondale, YMCA Clifford Family.
- Walnut Hills (Urban League).
- Cincinnati and Hamilton County Government agencies focused on the elderly, jobless and homeless.
- Senior home communities.
- Agencies for assistance with Jobs and aging services.
- Senior home communities.
- Recreation Community centers.
- Senior High Rise, Life Skills School on Gilbert & William Hightail.
- Community Groups (26)
  - Colleges and Universities in the Tri-County Area.
  - Community Councils of Avondale/Westwood, etc.
  - All in Cincinnati; Hispanic Chamber; council governments for villages outside of Cincinnati city limits.
  - Community action, Hispanic chamber.
  - Community Groups and Boys and Girls Club.
  - Recreation Community centers.
  - You should work with the townships and local communities.
  - East Westwood Improvement Association Meeting - 7:00pm, second Thursday of the month at Third Presbyterian Church, 3358 McHenry Ave. - 513-542-8333.
  - Hamilton College Hills Recreation Center next to Aiken High School.
  - Santa Maria (migrant communities) Neighborhood Community Councils.
- Faith Based Organizations (20)
  - Bond Hill (New Prospect Church Rev. David Lynch).
  - Church on Belmont.
  - Any churches and neighborhood groups.
  - Members of local churches in the Belterra and Madeira neighborhoods.
  - Third Presbyterian on McHenry, Community Center at Roll Hill.
  - Get feedback from local churches in the area (Allen Temple, Bethel, Agape).
- Public Organizations (16)
  - Might want to send out surveys to citizens of these areas to ask for their input.
  - High Schools in designated neighborhoods
  - Cincinnati Works.
  - Cincinnati Regional Chamber.
  - No suggestions other than riding the bus and asking passengers and going to neighborhood and seeing who is walking and talking to them about their needs.
  - The city used to have an open mic day where people can voice their opinion.
- Other (3)
  - Businesses.
  - Job search service agencies for Cincinnati and throughout Hamilton County.

## On-Line Community Survey

Duration: October 12 through December 31, 2021  
 Administration: On-Line only with links sent to stakeholders, community councils and promoted via SORTA social media, email, and text contacts  
 Survey Format: Educational component with details of the existing services and proposed on-demand service concepts. It included interactive maps and multiple-choice questions about transit service needs and expectations.

Total Survey Respondents: 322

### Responding to questions related to stated use of an MOD service...

#### 1. What day of the week would you use this on-demand service? (Select all that apply)

Weekdays	131	42.4%
Weekdays, Saturday, Sunday	83	26.9%
Saturday	17	5.5%
Weekdays, Sunday	6	1.9%
Weekdays, Saturday	24	7.8%
Saturday, Sunday	33	10.7%
Sunday	15	4.9%
	309	

#### 2. What time of day would you like the on-demand service operate? (If all apply, select G)

Early morning	20	15%
Morning Commute	20	15%
Mid-Day	19	14%
Afternoon Commute	26	19%
Evening	24	18%
Late Night	18	13%
All time of the above time periods	10	7%
	137	

#### 3. How would you like to reserve your on-demand trip? (Select one)

Mobile	190	61%
Website	60	19%
Call	61	20%
	311	

**4. Where would you like to be picked up and dropped off via your on-demand service? (Select one)**

Designated spot within a few blocks	117	39%
Curb	162	53%
Door	24	8%
303		

**5. How much are you willing to pay per trip for a local on-demand service? (Select one)**

\$3.00	72	24%
\$2.00	100	34%
\$3.25 - \$4.00	62	21%
More than \$4.00	41	14%
\$2.75	22	7%
297		

**Responding to questions related to current travel behavior...**

**1. On a typical day, how do you usually travel? (Select one)**

Bus	86	27%
Drive	150	47%
Taxi	9	3%
Ride	21	7%
Other	18	6%
Walk or Bike	22	7%
Access service	7	2%
Social Service Agencies	4	1%
	317	

**2. How often do you use this service? (Select one)**

Less than monthly	29	10%
Several times a week	108	36%
Every day	129	43%
Several times a month	34	11%
	300	

**3. What transportation services have you used? (Select all that apply)**

Local Metro	48	24%
Metro Express	35	18%
Metro Commuter	20	10%
Park and Ride	25	13%
Taxi, Uber, Lyft	42	21%
TANK	21	11%
BCRTA	8	4%
	199	

**Responding to questions related to individual profile...**

**1. What is your age range?**

36-55	123	38%
26-35	77	24%
56-65	37	11%
Over65	20	6%
18-25	57	18%
Under 18	3	1%
Prefer not to answer	5	2%
	322	

**2. Do you identify as:**

Female	196	62%
Male	108	34%
Prefer not to answer	8	3%
Gender Expansive	4	1%
	316	

**3. Do you consider yourself to be:**

White/Caucasian	138	44%
Two or more races	8	3%
Black/African American	72	23%
Asian/Pacific Islander	31	10%
Other or prefer not to answer	15	5%
Hispanic	47	15%
	311	

**4. What is your income range?**

>60k	61	21%
30k-60k	61	21%
<15k	87	30%
15k-30k	78	27%
	287	

**5. Do you have regular access to a vehicle?**

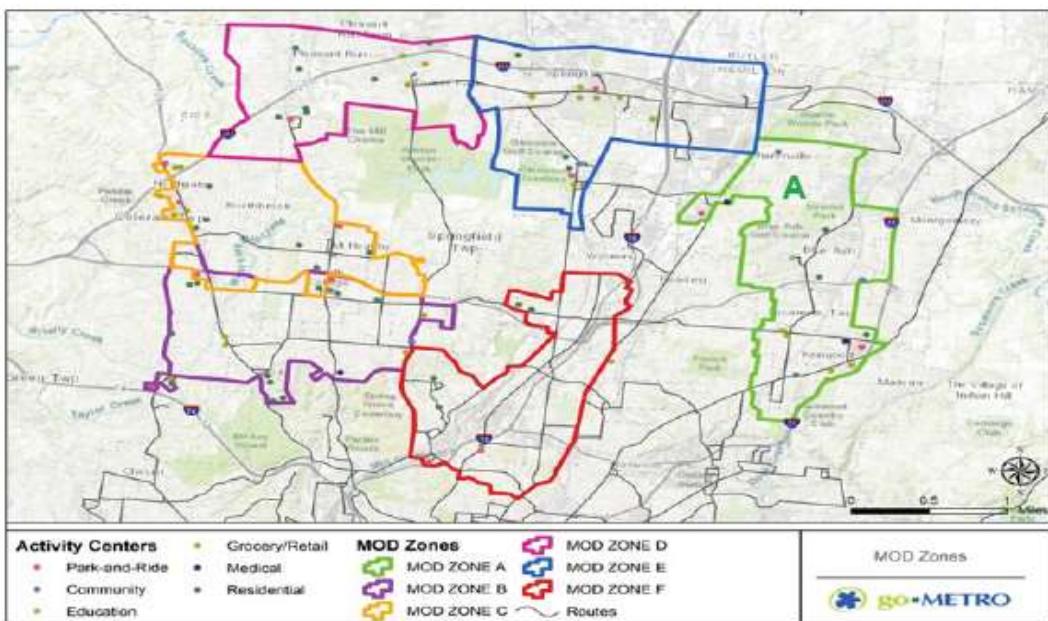
Yes	199	63%
No	116	37%
	315	

**6. Do you have any physical limitations or special accessibility needs?**

No	273	86%
Yes	43	14%
	316	

## Zone Specific Survey Flyer and Outreach





## MOBILITY ON-DEMAND Service Design Study (Zone A)

Metro has the exciting opportunity to provide regional transit access to neighborhoods that have not had access to transit in the past. The first phase of the study has just finished and identified six (6) zones which will benefit from and are favorable to on-demand services which means to get a ride, you will need to call or use an app. This shared ride will use small vehicles to take you where you need to go in your designated zone area including connecting to a bus.

Your feedback will help us further define these zones and the type of service that will best work there.

## WE WANT TO HEAR FROM YOU!

Please take a few minutes  
to help design your new  
service!

[https://www.research.net/r/2022\\_GoMetro\\_ZoneA](https://www.research.net/r/2022_GoMetro_ZoneA)



### Project Goals

To provide mobility in areas of Hamilton County where traditional fixed route service cannot go or does not reach.

#### 1: Connect people and places

- Deliver localized mobility
- Provide regional access
- Connect jobs, housing, and major activity centers

#### 2: Drive economic growth

- Facilitate access to employment
- Reduce travel time to retail
- Enable access to healthcare
- Expand access to education

#### 3: Improve our quality of life

- Remove transportation barriers
- Expand mobility choices
- Facilitate access to the fixed route transit network

## Zone Specific Survey

Duration:	February 21 - 24, 2021
Administration:	Face-to-face, Map Display, Project Education, and Information collection
Survey Format:	2 open ended questions
Locations:	College Hill Library, Blue Ash Library, Avondale Library, SORTA Boardroom, St Bernard Branch Library, North Central Library, Forest Park Senior Center, and Groesbeck Library
Engaged:	61

Total Survey Respondents: 36

- Monday – College Hill Library = 6 people
- Monday – Blue Ash Library = 4 people signed in, and a dozen given the flyers
- Tuesday – Avondale Library = 10 people
- Tuesday – SORTA Board Room = 4 people
- Thursday – North Central Library = 6 people
- Thursday – St. Bernard Library = No visitors
- Friday – Forest Park Senior Center = 4 people
- Friday – Groesbeck Branch Library = 2 people

### Zone A

1. What places, within ZONE A area do you need to travel to?
  - I need to get to the Camp Washington area from Blue Ash. While a couple of routes to go to the Camp Washington Area, I still must walk about 2 miles to get to my job. A MOD service would be great in the Camp Washington area, especially on the weekends.
  - Businesses near Summit Park; Kenwood area; Deer Park area behind Silverton; Kroger in Montgomery; Harper Ferry near Sycamore.
  - Consider the expansion to include the Madisonville area where there are large older adult communities that are socially isolated, lack of resources, and have a lack of access to transportation and food. Unable to afford Uber/Lyft or delivery services. Please consider expanding services into the communities in Madisonville for dial a ride service.
  - Reading Road and Colerain to Social Security Office, Walmart, Thrift stores. Need a route from Oakley to the Northside transfer stations.
  - Ridge Road to Target, Meijers, Cinema, Kroger, Oakley Transfer Station, and Kenwood too. Keep Hunt Road.
  - More access to bus stops to connect to Metro's fixed routes.
  - Reed Hartman and Cornell passed Cooper and Creek Road. Only the 61 is out there. Need to go to the Kenwood, Kroger at Harpers Point, Hart, and Sharon; Kenwood Mall, Tri-county mall; restaurant, doctors office.
  - Need to get to work.
  - Blue Ash service has always been hit or miss. New hub on Northside is great. Wife works downtown uses apps, would go to Kenwood Mall, Trader Joes, T-Mobile, Starbucks, doctors, group health north of mall. Corryville. Hamiltonville has been very convenient.

- Live Blue Ash and Spencer; Kroger, library, restaurants, doctors' office on Montgomery Road, Walmart on Reading.

2. List places within Zone A that are hard to get to. Please share why.

- UC Blue Ash is not walkable. A lot of the business parks are not walkable either. The 4 and 3X do not operate frequently and often does not even show up. Sundays are particularly hard to travel to work. The MOD would be helpful on the weekend.
- Need more benches on Reading Road.
- Cincinnati Eye Institute off Reed Hartman. There is no bus service within 2 miles and no sidewalk.
- From Kenwood to Kings Island is a big issue during daytime when park is open.
- Going into the City as a whole. A lot of manufacturing jobs out there in this area.
- Currently living in Kenwood and need to travel to the center of Sharonville (off the Mosteller Rd. exit)
- Corryville by the university has lots of service. Within north side take bus to trees game.
- Needs to be further extended into Montgomery Road. Montgomery Inn restaurant requires their workers to have transportation. This would help them out if it was extended further into Montgomery.

#### Zone B

1. What places, within ZONE B area do you need to travel to?

- What is Zone B? This survey QR code was published in my neighborhood newsletter asking us to complete the survey, but I don't understand what Zone B is.
- Fourworld Apartments on Gilbert and Deli to go to UC Hospital. Four worlds APTA to CVS in Colerain.
- Shopping up and down Hamilton Ave. Finneytown to Bentwood Plaza. The use of 1st mile and last mile service.
- More access to bus stops to connect to Metro's fixed routes.
- This would be great for those with disabilities due to the horrible infrastructure.
- Live on Cedar: Currently frequents the following locations: Kroger Grocery, Dollar General, Planet Fitness, Credit Union on Hamilton, Storage facility on North Bend, Restaurants in the same area. Barnhill school on Reading.
- Cedar /Hamilton Ave. To downtown Walnut Hills, Evendale Walmart.
- Target for sure. Just north of the boundary. Walmart is in there. Home Depot too. Colerain high school is just outside. Springfield High school is outside too. Saint? All boys high school. Macaulay high school is good and in there. Walnut Hill middle school. North side area has restaurant and UC (Tickle Pickle).
- Originate at Larch and Hamilton. Places I go; Kroger, Mercy West Hospital, Church on North Bend (Church of God in Christ); Doctors' Office on North Bend and Winton; North College Hill between Savannah and Galbert. Also travel to bakery west of Hamilton.
- Leaving College Hill Library going to Reading Road. (Work at College Hill Library) Transfer at Reading and North (by the Walgreen. It takes about 1 and 1/2 hours to get home due to the connection. Problem is frequency of the trip (if miss one have to wait 45-60 minutes. Usually do shopping in College Hill. Go to Mt, Healthy, Finneytown. Kroger (use bank

within the Kroger.) gym membership (planet fitness) . Usually use day pass. Work 4 days a week.

- Our Lady of Victory Church and many others do not have an accessible pathway from the bus stop. A mod service would be great.
- I need to go to St Elizabeth's Hospital. It takes over 2 hours to get there and then the stop is a couple of blocks away from the clinic.
- Samuel W Bell Home for the Sightless at 3775 Muddy Creek Rd. It is too dangerous to cross the street to catch the bus-32.

2. List places within ZONE B that are hard to get to. Please share why.
  - What is Zone B? This survey QR code was published in my neighborhood newsletter asking us to complete the survey, but I don't understand what Zone B is.
  - Hamilton Ave Kroger access from Four world apts.
  - Walking may be an issue like 4 to 5 miles to bus stops. Hard to connect Mt. Airy to Finneytown.
  - To get to bus stops themselves Hamilton Restaurants Kroger Post office for picking up packages Jobs in Coleraine
  - No access to the Oakley area. Would like to go there.
  - Evendale Walmart.
  - Hilltop plaza, especially on Sunday. West end of Gilbert due to bus access limitations; from Home to North Bend and Winston; Summit Park (no bus access); Mount Adams (playhouse in the park), this service cuts off at 7pm on weekdays.
  - The plaza. Can't use student discount with app. Attend Cincinnati State.
  - It is difficult to identify bus stop locations when you are sightless. Drivers are failing to call out stops and are turning down the voice annunciation system. Drivers are not communicating with passengers, especially those with disabilities. All job connection locations should be accessible. Many are not accessible to those who are blind.

#### Zone C

1. What places, within ZONE C area do you need to travel to?
  - North gate mall area to work.
  - Kids need to be able to come to the library when their parents are working. Older people need to get to their appointments. This is great!
  - More access to bus stops to connect to Metro's fixed routes.
2. List places within ZONE C that are hard to get to. Please share why.
  - My house is up the hill and too far away from a bus stop.
  - It is a long way to walk to get to the bus stop.
  - Walking too far to the bus stop.

#### Zone D

1. What places, within ZONE D area do you need to travel to?
  - Work at America's on Waycross Road. Work in H.R. There is no bus service. Makes it hard to get workers because they often do not have transportation. We have openings that can't fill because we can't get folk here. Company would even be interested in sponsoring the service for their employees.

- This is the only senior center in Forest Park. Hear seniors wanting to go to Mercy Fairfield on Mack Rd. Mercy Health across the street from the senior center. Also, grocery, Kroger on Kemper Road and Walmart on Smiley Road.
- Hamilton Avenue and Kemper Road to connect to bus at McDonalds on Hamilton and Waycross.
- Colerain Town Center, Meijer

2. List places within ZONE D that are hard to get to. Please share why.

- This service and event were not well advertised. I stumbled upon it and did pass it on to some others.
- Pleasant run area is not in the zone and should probably be expanded to cover. There is a new grocery store there and a new speedway gas station. It is becoming a commercial mode. Also, the Butler area has a lot of growth and a growing Hispanic population.
- The senior center does not provide transportation and is therefore difficult for some seniors to get to. This service would serve as a great opportunity for seniors to access the center.
- During the daytime, when there is no bus - Meijer is the one that don't have bus service all day. But had to walk more than 1 miles to route 17 or 19.

#### Zone E

1. What places, within ZONE E area do you need to travel to?

- I live on Riga Court 45240; the nearest bus stop is too far for myself or minor child to walk safely. Please put a bus stop or create a way that makes it easier for residents in Forest Park to get around. There are not any buses that comes on the residential streets. We need to travel to grocery stores in and out of the neighborhood.
- Tri-County (Target or Restaurants)

2. List places within ZONE E that are hard to get to. Please share why.

- It is hard to get a bus stop near my home. Too far to walk. Besides that, I would love to have bus service or shuttle services that will allow us to travel back and forth and in and out of our community.
- Hard to get a bus from the above places.

#### Zone F

1. What places, within ZONE F area do you need to travel to?

- Work on Tennessee Avenue Norwood/Reading Road to Kroger/Starbucks.
- Don't live in the area but it visits the library. Bus route 43 from Reading Road to Avondale, catholic charities, and other social service organizations. Sifton small mall. Veterans Hospital, Ohio mental health services for the disabled.
- Live in the Norwood area. Come to library in St. Bernard. Take Route 4 to get where need to go in my neighborhood, however, must walk ½-mile to bus stop. Can't do that anymore due to leg problems. I would use MOD two go to Kroger in Norwood, blue ash college, Cincinnati eye institute. I don't drive. Would use in the winter.

2. List places within ZONE F that are hard to get to. Please share why.

- St. Bernard's transportation is pretty good. They have their own little bus but must be St. Bernard resident to use.

## 8.0 Appendix B: Transit Service Performance Evaluation

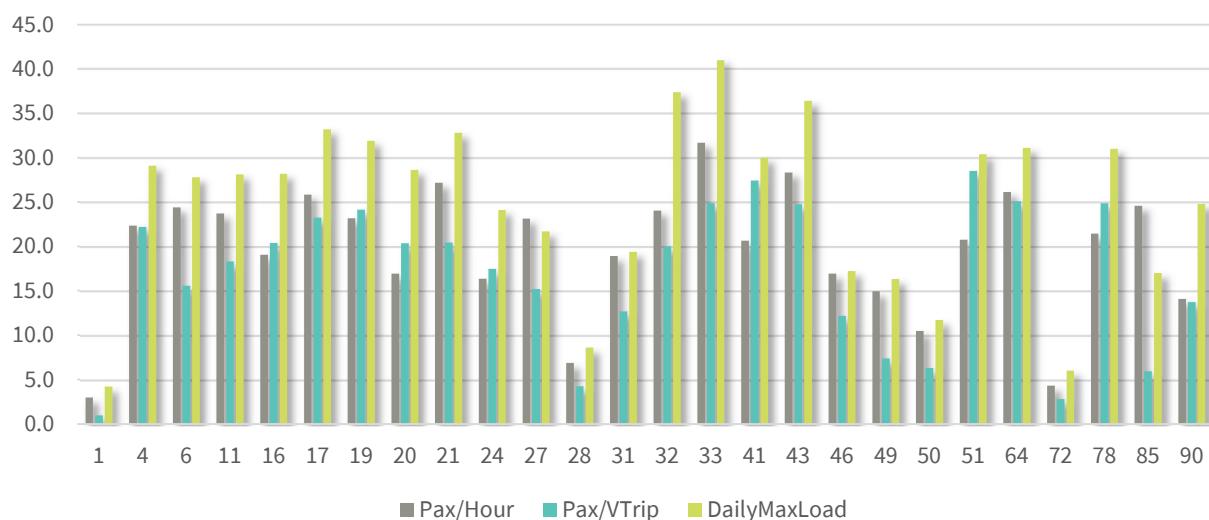
Transit service performance indicators were assessed to see how efficiently SORTA supplies fixed route and express transit service and how effectively those services meet the needs of the areas served.

Performance indicators have been included in the following figures. These indicators help highlight the recent performance trajectory of the transit agency and can be useful for addressing negative trends before their impact to the agency becomes too burdensome.

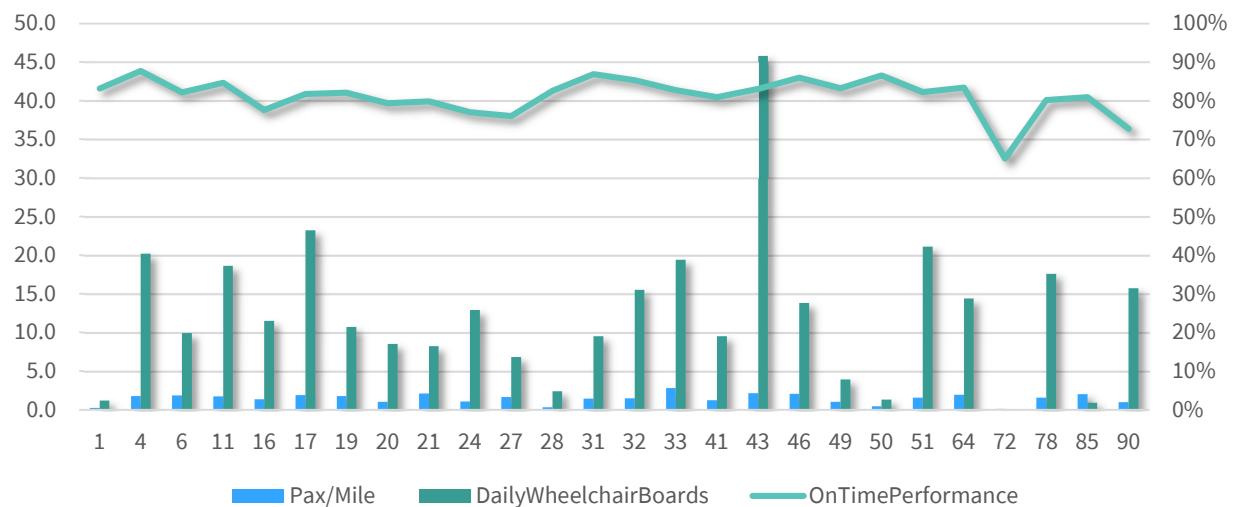
The local fixed-route indicators included in Figure 1 through Figure 3 reveal an agency that includes some routes that are battling performance related issues in several key trends similarly to other transit systems around the US. To this end, agencies have attempted to improve the network by adding new and/or enhanced service, resulting in more miles and hours of service that correspondingly drive-up operating costs.

Figure 4 through Figure 6 display the performance indicators for the express routes operated by SORTA. The on-time performance for the express routes is much lower compared to the local fixed routes. However, most express routes tend to have a steady number of passengers per hour, except for Route 23 and Route 67. Another interesting metric is the number of daily wheelchair boardings compared to other routes in the network. Routes 29 and 43 have significantly higher wheelchair boardings compared to other local and express routes.

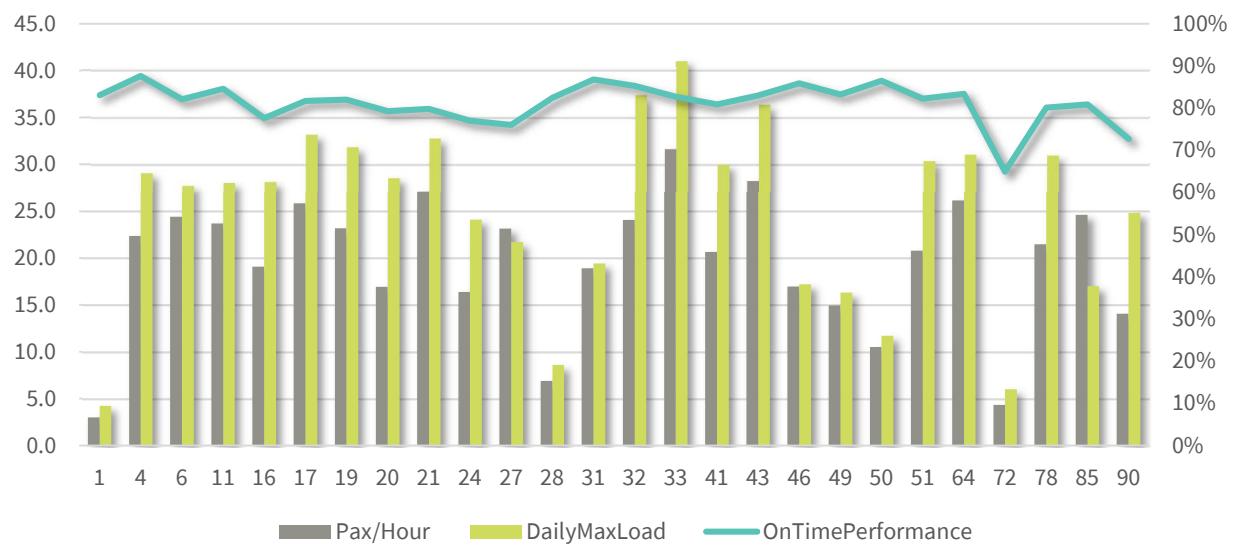
**Figure 1: Local Routes (2019) – Passengers per Hour and Passengers per Trip**



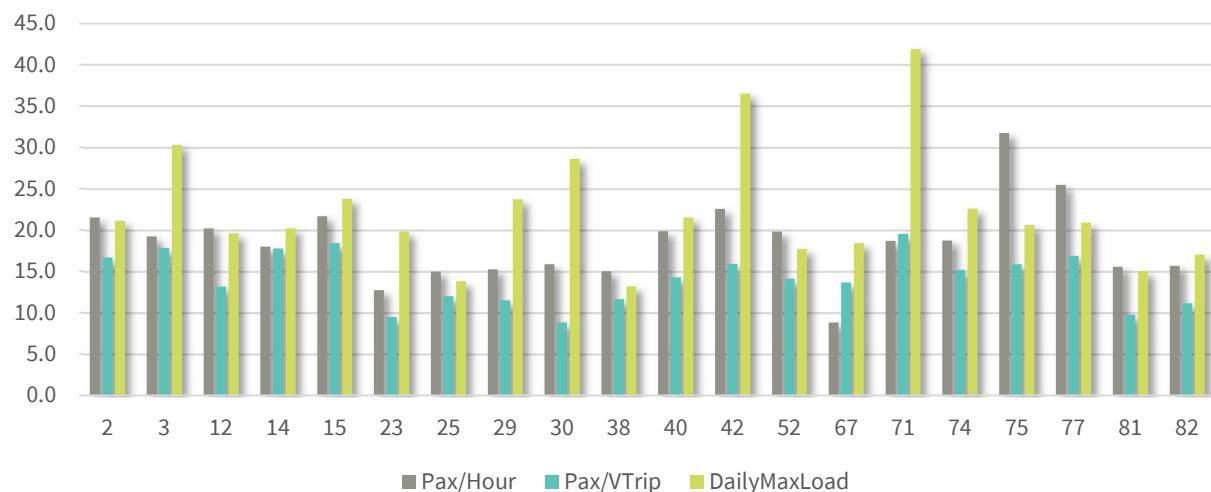
**Figure 2: Local Routes (2019) – Passengers per Mile, On-time Performance, Wheelchair Boardings**



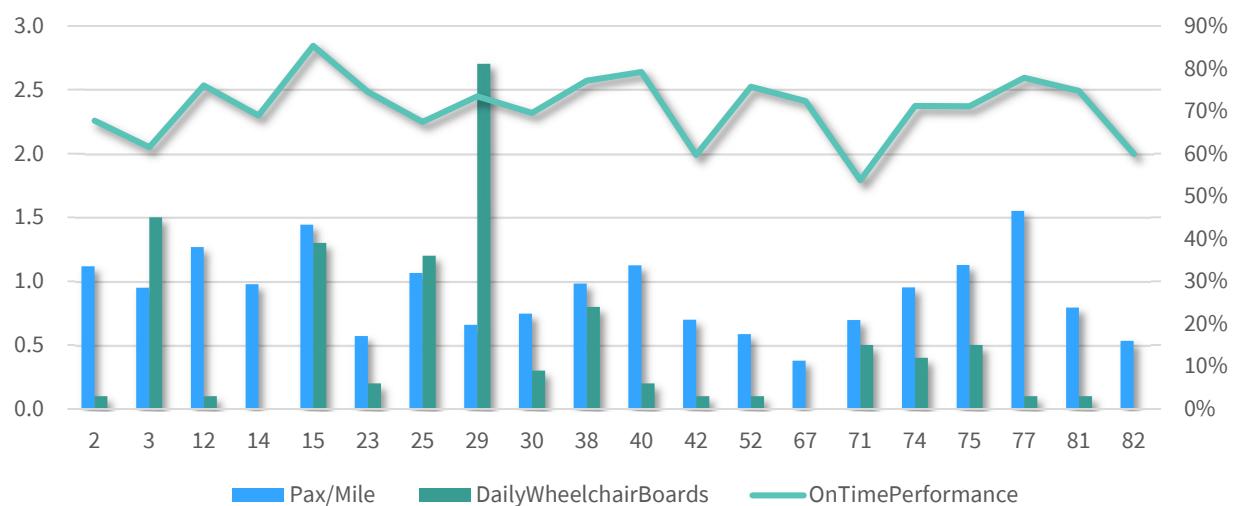
**Figure 3: Local Routes (2019) – Daily Max Load**



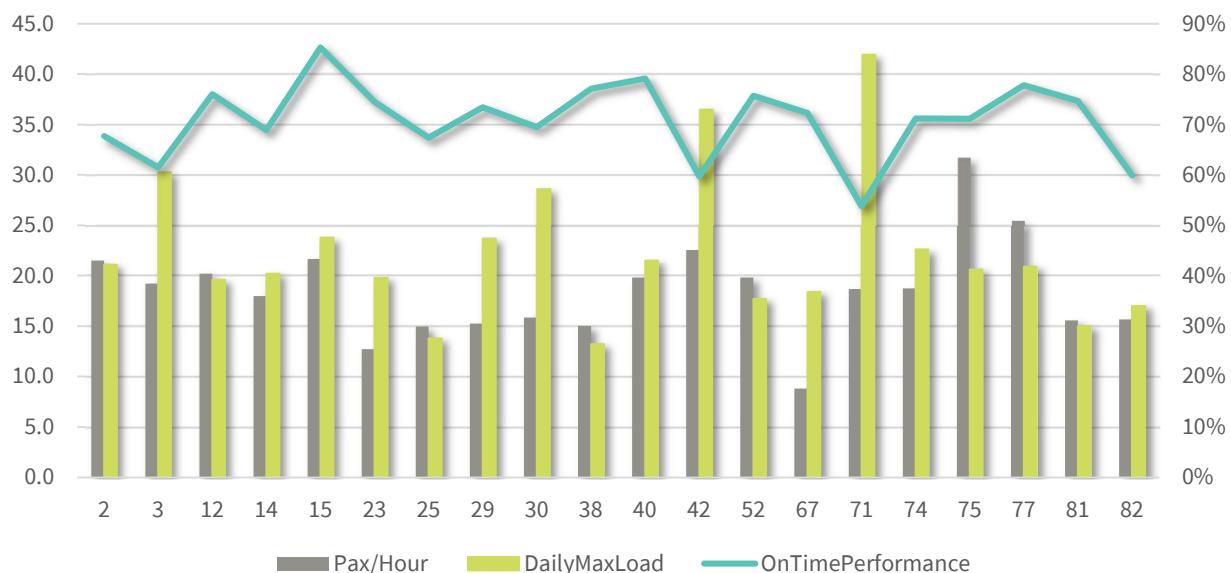
**Figure 4: Express Routes (2019) – Passengers per Hour and Passengers per Trip**



**Figure 5: Express Routes (2019) – Passengers per Mile, On-time Performance, Wheelchair Boardings**



**Figure 6: Express Routes (2019) – Daily Max Load**



SORTA operates local and express services, as shown in the charts above. Local routes operate from 3:45 AM to 1:37 AM, while 7 of the local routes operate 24 hours. Local routes have peak and off-peak frequencies for weekday service, but the average peak frequency is 29-minutes with the lowest every 15-minutes and the highest every 55-minutes. Express routes operated by SORTA start as early as 5:33 AM and end as late as 6:54 PM, on weekdays. Similarly, the express routes also have on and off-peak frequency, with the lowest every 15-minutes and the highest every 60-minutes.

Based on data provided by SORTA, over 128,000 jobs are within  $\frac{1}{4}$ -mile of local transit routes. In addition, over 718,000 people are within a  $\frac{1}{4}$ -mile of transit. However, there is a significant number of people that would benefit from using public transit where services are non-existent (unserved) or insufficient (underserved).

## 9.0 Appendix C: Service Area Screening Efforts

As presented Section 4 of this document, areas within Hamilton County were analyzed and evaluated in terms of both mobility need and the availability of transit and paratransit services.

Heat maps were generated to show where paratransit trips originate and end in the service area. The pick-up and drop offs are shown below by neighborhood. The greatest number of paratransit trips originate and end in the Springdale/Glendale/West Sharon Woods neighborhood zone.

In addition, Blue Ash/Evendale also see a high number of paratransit trips beginning and ending in the zone. Other neighborhood zones were found to have a medium to low number of paratransit trips beginning and ending in the zones.

Incorporating the results using the heat maps, the project team modified the potential service zones to include additional areas (see Map 15) that were not part of the initial set of zones.

**Table 10: Service Area and Mobility Needs – Expanded Screening**

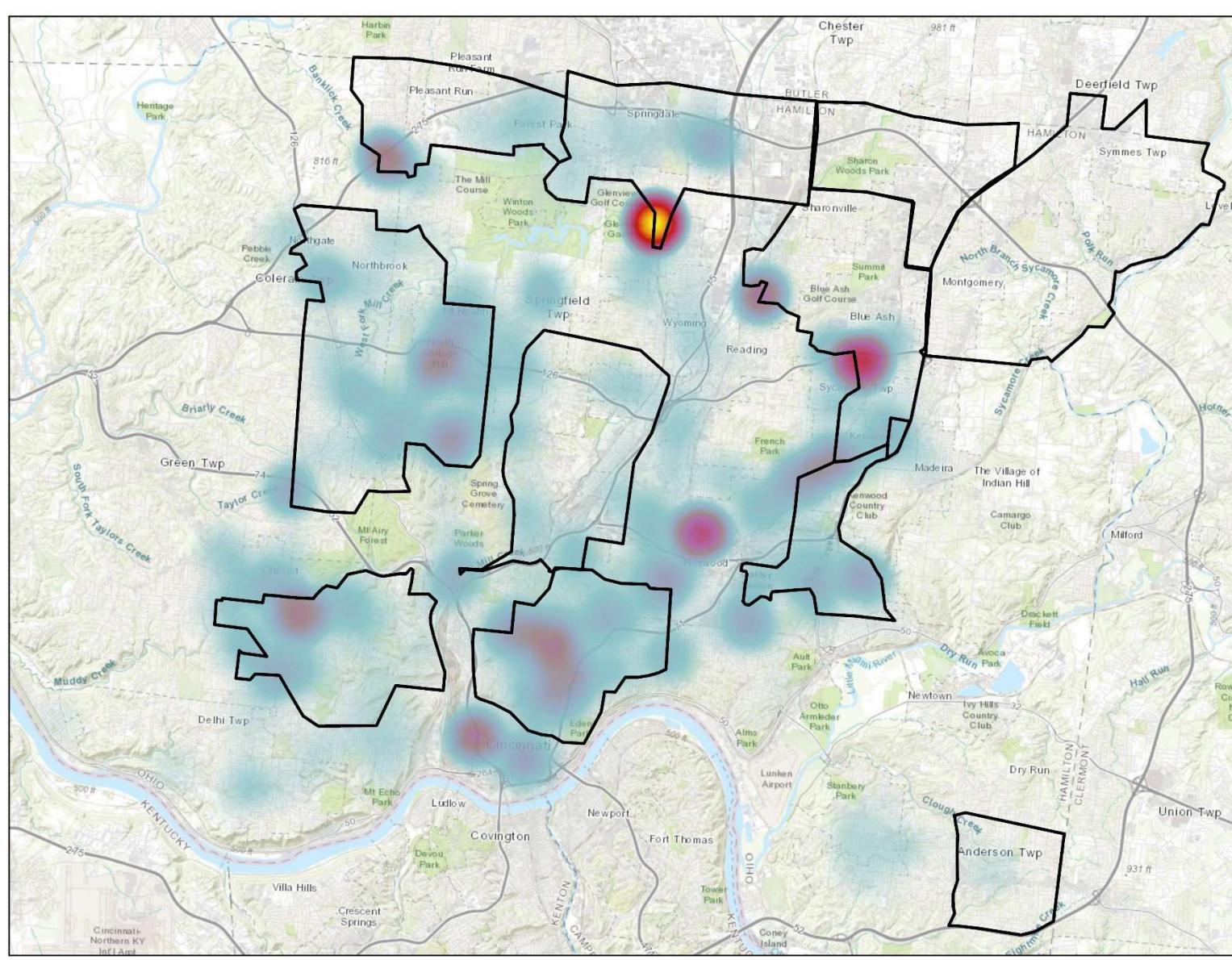
Neighborhood	Population	Minority	Older Adults	Youth (15-24)	Poverty	Transit Need Index <sup>1</sup>	Local Access <sup>2</sup>	Local Score <sup>3</sup>	Rank
Avondale/Evanston/Uptown/Walnut Hills	60,865	55%	9%	36%	39%	1.40	94.5%	0.08	11
Westwood	47,320	67%	9%	13%	33%	1.22	84.0%	0.20	9
Winton Hills	28,479	50%	15%	12%	25%	1.01	71.2%	0.29	8
Monfort Heights/Mt. Healthy/ Northgate	75,678	52%	15%	11%	15%	0.93	55.2%	0.41	4
Springdale/Glendale/W. Sharon Woods	16,819	57%	18%	11%	20%	1.06	47.6%	0.56	2
Pleasant Run	20,002	61%	15%	12%	12%	1.00	17.7%	0.83	1
Madisonville	15,157	52%	16%	11%	17%	0.95	79.9%	0.19	10
Blue Ash/Evendale	16,961	21%	19%	8%	6%	0.54	37.1%	0.34	6
Sharon Woods/Highpoint	10,610	26%	21%	10%	8%	0.65	38.5%	0.40	5
Montgomery/Loveland	36,687	19%	17%	10%	5%	0.51	17.8%	0.42	3
Anderson Township	14,643	11%	0%	19%	10%	0.40	15.7%	0.34	7

<sup>1</sup>Sum of (each need factor\*population)/population

<sup>2</sup>Percent of service area within 1/4-mile fixed route transit buffer (local)

<sup>3</sup>Need index – Index Need\*Local Transit Access – (local)

**Map 15: Paratransit Pick-up and Dropoff Hot Spots by Neighborhood Zone**



The set of 11 neighborhoods (see Map 16) were evaluated in more detail using the quantitative and qualitative analyses developed in the first two screenings. This subsection discusses the methodology used to further the evaluation and select the top five or six neighborhoods for detailed service design and recommendations. Map 18 shows the expanded zones and Tables 11 and 12 show the evaluation factors and rankings as described below.

### ***Transit Need Index***

The project team included the results from the Transit Need Index and applied a scale to the results. Any Transit Need Index below 0.65 was considered “Low”, 0.65 to 1.0 was considered “Medium”, and any results greater than 1.0 were considered “High”. Based on the categories used to score the Transit Need Index, Avondale/Evanston/Uptown/Walnut Hills ranked the highest, followed by Westwood.

### ***Local Access***

Local Access was also reconsidered as a key component to evaluating the top neighborhoods. Local Access is the percent of service area within ¼-mile of fixed route transit service. This was identified through ArcGIS by placing a ¼-mile buffer around all routes. To narrow the results, the project team used a similar methodology, as applied in the Transit Need Index, by applying breakpoints. Any Local Access results below 30 was considered “Low”, 30 to 75 was considered “Medium”, and any results greater than 75 were considered “High”. Areas with low Local Access demonstrate an area that may not be adequately served by existing fixed route transit service but may be more suitable for MOD. The neighborhoods zones with the lowest Local Access scores are Montgomery/Loveland, Pleasant Run, and Anderson Township.

### ***Job Access Zip Codes***

Zip codes, provided by Cincinnati Works, were considered in the analysis to highlight the top zip codes in Hamilton County where members of their organization are struggling financially and seeking better employment opportunities. The neighborhoods with zip codes with the highest Job Access are Avondale/Evanston/Uptown/Walnut Hills, Monfort Heights/Mt. Healthy/Northgate, Westwood, and Winton Hills.

### ***Paratransit Boardings***

Paratransit ridership was collected to determine the average paratransit ridership in each of the 11 neighborhoods. Since the MOD service will be available to all persons, this data is an important figure to consider. The project team applied a scale to the results similar to the other measures used in this analysis. Paratransit Boardings results below 35 was considered low and given a “1”, 35 to 75 was considered medium and given a “2”, and any results greater than 75 were considered high and given a (3). The neighborhood zones with the highest boardings are Avondale/Evanston/Uptown/Walnut Hills, Monfort Heights/Mt. Healthy/Northgate, Springdale/Glendale/W. Sharon Woods.

### ***Local Boardings***

Along with Paratransit Boardings, Local Boardings was also evaluated. The project team collected average daily boardings at the stop level for each neighborhood using an ArcGIS based analysis. As previously mentioned, this is an important metric to consider when identifying neighborhoods where on-demand service may be available in the future. The neighborhoods with the highest boardings are

Avondale/Evanston/Uptown/Walnut Hills, Westwood, Monfort Heights/Mt. Healthy/Northgate, and Winton Hills.

### ***Need Scoring***

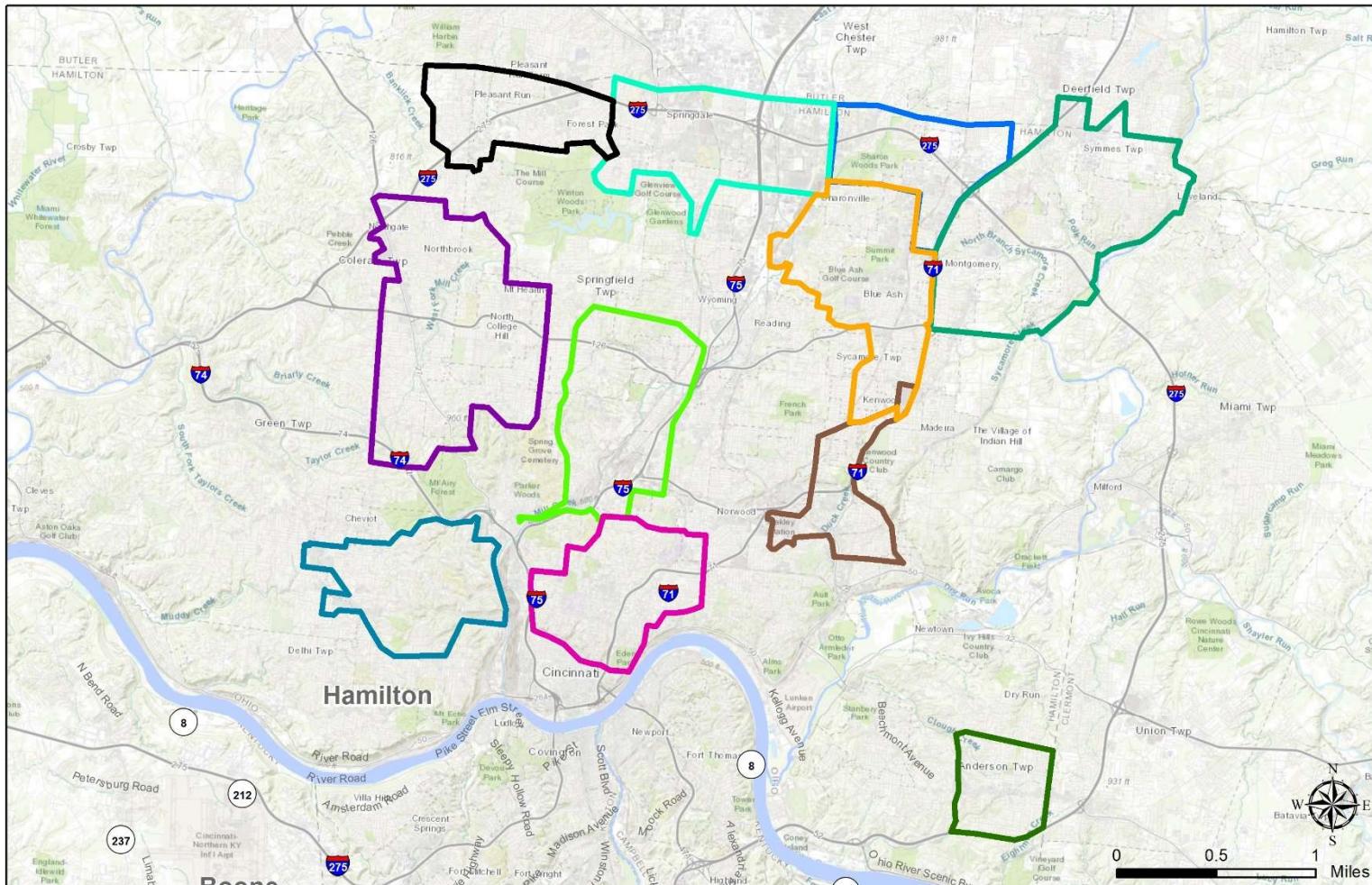
The Need Scoring was used to combine the supporting evaluations to support the Need Gap Rank. The Need Scoring is the sum of the Need Index, Job Access, and Paratransit Boardings rank. A 1.5 weight was applied to the Need Index results for any value 1.00 and greater. The neighborhoods with the highest Need Scoring are Avondale/Evanston/Uptown/Walnut Hills, Monfort Heights/Mt. Healthy/Northgate, Westwood, and Springdale/Glendale/W. Sharon Woods.

### ***Need Gap Rank***

The Need Gap Rank was calculated by neighborhood zone to find the transit need minus the transit access. Neighborhoods that are currently served with a significant amount of local fixed route service decreased the overall need. The neighborhoods with the greatest Need Rank Gaps are Springdale/Glendale/W. Sharon Woods, Monfort Heights/Mt. Healthy/Northgate, Pleasant Run, and Blue Ash/Evendale.

The results of these screenings, the public outreach efforts, and the spatial optimization modeling yielded the six MOD zones developed for the initial MOD service deployments.

Map 16: Third Screening Neighborhood Zones



 Anderson Township  Avondale/Evanston/Updtown/Walnut Hills  Blue Ash/Evendale 	 Monfort Heights/Mt Healthy/Northgate  Montgomery/Loveland  Pleasant Run 	 Sharon Woods/Highpoint  Westwood 	<p>Third Screening Neighborhood Zones</p> 
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**Table 11: Service Area and Mobility Needs – Third Screening**

Neighborhood	Need Index <sup>1</sup>	Local Access <sup>2</sup>	Job Access Zip Codes <sup>3</sup>	Paratransit Boardings <sup>4</sup>	Local Boardings <sup>5</sup>	Need Scoring <sup>6</sup>	Need Gap Rank <sup>7</sup>	Proposed Status
Avondale/Evanston/Uptown/Walnut Hills	1.40	94.5%	1	78.96	8,316	6.10	0.34	REMOVE
Westwood	1.22	84.0%	1	52.68	4,238	4.84	0.77	REMOVE
Winton Hills	1.01	71.2%	1	27.71	1,530	3.52	1.01	KEEP
Monfort Heights/Mt. Healthy/Northgate	0.93	55.2%	1	92.56	1,923	4.93	2.21	KEEP
Springdale/Glendale/W. Sharon Woods	1.06	47.6%		76.26	358	4.59	2.41	KEEP
Pleasant Run	1.00	17.7%		25.50	285	2.51	2.06	KEEP
Madisonville	0.95	79.9%		38.48	1,075	2.95	0.59	REMOVE
Blue Ash/Evendale	0.54	37.1%		48.64	551	2.54	1.60	KEEP
Sharon Woods/Highpoint	0.65	38.5%		0.00	0	1.65	1.01	REMOVE
Montgomery/Loveland	0.51	17.8%		0.00	0	1.51	1.24	REMOVE
Anderson Township	0.40	15.7%		2.45	76	1.40	1.18	REMOVE

<sup>1</sup>Sum of (each need factor\*population)/population

<sup>2</sup>Percent of service area within 1/4-mile fixed route transit buffer (local)

<sup>3</sup>Areas with high Job Access assistance zip codes

<sup>4</sup>Average weekday paratransit boardings

<sup>5</sup>Local transit boardings (average daily)

<sup>6</sup>Need scoring (add Need Index + Job Access + Paratransit), Need Index greater than 1 is weighted 1.5

<sup>7</sup>Need Gap Rank (Need Scoring less Local Transit Access)

**Table 12: Service Area and Mobility Needs – Third Screening Results and Comments**

Neighborhood	Proposed Status	Comments
Avondale/Evanston/Uptown/Walnut Hills	REMOVE	<b>High need index</b> , high transit
Westwood	REMOVE	<b>High need index</b> , high transit
Winton Hills	KEEP	<b>High need index</b> , high transit, low paratransit, job access
Monfort Heights/Mt. Healthy/Northgate	KEEP	Medium need index, medium transit, high paratransit, job access
Springdale/Glendale/W. Sharon Woods	KEEP	<b>High need index</b> , medium transit, high paratransit
Pleasant Run	KEEP	<b>High need index</b> , low transit, low paratransit
Madisonville	REMOVE	Medium need index, high transit
Blue Ash/Evendale	KEEP	Low need index, medium transit, medium paratransit
Sharon Woods/Highpoint	REMOVE	Medium need index, medium transit
Montgomery/Loveland	REMOVE	Low need index, low transit, low paratransit
Anderson Township	REMOVE	Low need index, low transit, low paratransit

## 10.0 Appendix D: Service Delivery Optimization Analysis Maps

Spatial optimization modeling was used to identify the concentration and distribution of mobility need and to evaluate strategies to service each MOD zone with MOD services. The optimization model evaluated serving each zone by testing and evaluating changes to a set of variables. The variables altered are:

- PP = the number of service nodes (assumes a sub-zone partitioning), variables tested included 2 nodes or 3 nodes.
- Sdist = the maximum distance from a node to be considered for service (the furthest distance (straight line) a vehicle would be allowed to travel in responding to a request, the variables included 2 miles, 2.5 miles, 3, miles.
- Cover = the percentage of an area to be covered when responding to a service request. This variable is directly associated with area (sqmi) but also can be interpreted in terms of time (the percentage of trip requests served within the immediate time period for which a solution is being calculated). The variables included are 90%, 95%, 100%.

In addition to these variables, two other factors were employed in the model. These include:

- $Sdist2$  = the minimum distance from a bus stop or node for which a solution will be considered. This factor effectively excludes solutions that are less than  $1/2$ -mile. This was used a constant applied to all solutions.
- $W$  = a weighting factor applied to add preference to average distance objective related to bus stop and nodal benefit objective. Several  $W$  values were tested on the first MOD zone evaluated (Zone A) before determining  $w = 0.01$  as the default value.

The key outputs examined for each scenario include:

- Workload = reflects a balance of trips served for each node with the optimal solution achieving a close to equal distribution of work between nodes.
- Average distance = the calculated average trip length per solution, lower trip length optimal.

The point-to-point spatial optimization model is reflected below and results follow of each zone.

## Point-to-Point spatial optimization model

$$\begin{aligned}
 & \text{Minimize} && \sum_i \sum_{j \in N_i} \alpha_i d_{ij} Z_{ij} \\
 & \text{Maximize} && \sum_j \beta_j X_j \\
 & \text{Subject to} && \sum_{j \in N_i} Z_{ij} \leq 1 \quad \forall i \\
 & && Z_{ij} \leq X_j \quad \forall i, j \in N_i \\
 & && \sum_j X_j = p \\
 & && \sum_i \sum_{j \in N_i} \alpha_i Z_{ij} \geq \lambda \sum_i \alpha_i \\
 & && X_j = \{0,1\} \quad \forall j \\
 & && Z_{ij} = \{0,1\} \quad \forall i, j \in N_i
 \end{aligned}$$

## Zone A – Blue Ash/Evendale

**Two (2) Sub-zones (p=2)**

**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneA\_2\_2.0\_0.5\_0.01\_0.9):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 17842.57718235312  
 o3= 179.29561780204625  
 X solution: [18, 96]  
 Workload : [11012, 6813]  
 Average distance= 1.0009860971867108

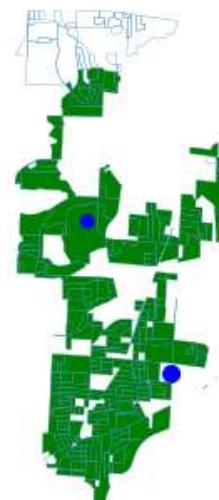
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneA



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneA\_2\_2.0\_0.5\_0.001\_1.0):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.001  
 covper = 1.0  
 o1= 18548.14333993325  
 o3= 182.72117235717434  
 X solution: [63, 96]  
 Workload : [11195, 6628]  
 Average distance= 1.0406858183208916

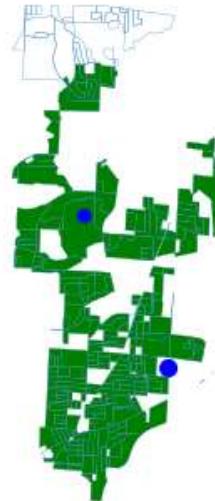
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneA



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneA\_2\_2.0\_0.5\_0.0001\_1.0):**

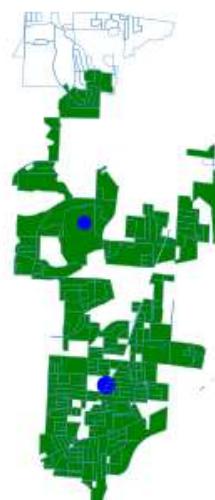
pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.0001  
 covper = 1.0  
 o1= 18554.4412460861  
 o3= 182.72117235717434  
 X solution: [63, 96]  
 Workload : [11189, 6634]  
 Average distance= 1.0410391766866465

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneA


**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneA\_2\_2.0\_0.5\_0.1\_0.95):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.1  
 covper = 0.95  
 o1= 15126.03882146258  
 o3= 97.68339455153357  
 X solution: [19, 96]  
 Workload : [11536, 6289]  
 Average distance= 0.848585628132543

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneA

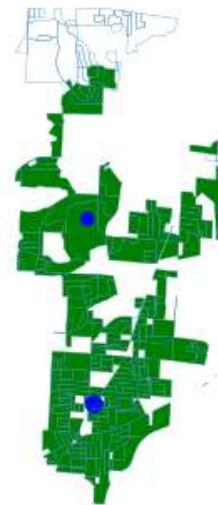


### Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneA\_2\_2.0\_0.5\_0.2\_0.95):

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.2  
 covper = 0.95  
 o1= 14699.348760215738  
 o3= 50.203189355451094

X solution: [12, 96]  
 Workload : [11361, 6464]  
 Average distance= 0.8246478967862967

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneA



Zone Scenarios	Zone	Run	PP	Sdist	W	Coverpct	Avg Dist	Wkld A	Wkld B	Wkld C	Wkld Ratio	Tot Wkld
2_2.0_0.5_0.01_1.0	A	<b>2-1</b>	2	2.00	0.01	1.00	0.00000000	0	0	0	0.00	0
2_2.5_0.5_0.01_1.0	A	<b>2-2</b>	2	2.50	0.001	1.00	1.13417800	13962	5838	0	2.39	19800
2_3.0_0.5_0.01_1.0	A	<b>2-3</b>	2	3.00	0.0001	1.00	1.13282778	11160	8640	0	1.29	19800
2_2.0_0.5_0.01_0.95	A	<b>2-4</b>	2	2.00	0.2	0.95	1.08663069	13431	5379	0	2.50	18810
2_2.5_0.5_0.01_0.95	A	<b>2-5</b>	2	2.50	0.01	0.95	1.05817493	10492	8325	0	1.26	18817
<b>2_3.0_0.5_0.01_0.95</b>	A	<b>2-6</b>	2	3.00	0.01	0.95	1.05817493	10492	8325	0	1.26	<b>18817</b>
2_2.0_0.5_0.010.90	A	<b>2-7</b>	2	2.00	0.01	0.90	1.00098610	11012	6813	0	1.62	17825
2_2.5_0.5_0.01_0.90	A	<b>2-8</b>	2	2.50	0.01	0.90	0.98164852	10492	7331	0	1.43	17823
2_3.0_0.5_0.01_0.90	A	<b>2-9</b>	2	3.00	0.01	0.90	0.98164852	10492	7331	0	1.43	17823
3_2.0_0.5_0.01_1.0	A	<b>3-1</b>	3	2.00	0.01	1.00	0.97615970	10492	6724	2584	1.13	19800
3_2.5_0.5_0.01_1.0	A	<b>3-2</b>	3	2.50	0.01	1.00	0.97615970	10492	6724	2584	1.13	19800
3_3.0_0.5_0.01_1.0	A	<b>3-3</b>	3	3.00	0.01	1.00	1.08314790	8426	6902	4472	0.74	19800
3_2.0_0.5_0.01_0.95	A	<b>3-4</b>	3	2.00	0.01	0.95	0.94039840	9787	6724	2298	1.08	18809
3_2.5_0.5_0.01_0.95	A	<b>3-5</b>	3	2.50	0.01	0.95	1.01382107	7843	6902	4071	0.71	18816
3_3.0_0.5_0.01_0.95	A	<b>3-6</b>	3	3.00	0.01	0.95	1.01382107	7843	6902	4071	0.71	18816
3_2.0_0.5_0.01_0.90	A	<b>3-7</b>	3	2.00	0.01	0.90	0.94619135	6902	6507	4416	0.63	17825
3_2.5_0.5_0.01_0.90	A	<b>3-8</b>	3	2.50	0.01	0.90	0.93482351	6902	6850	4071	0.63	17823
3_3.0_0.5_0.01_0.90	A	<b>3-9</b>	3	3.00	0.01	0.90	0.93482351	6902	6850	4071	0.63	17823

## Zone B – Monfort Heights – North College - Finneytown

pp = number of stops / centers to select (reflecting a sub-zone partitioning)

sdist = the maximum distance from stop / center considered to demand

sdist2 = distance considered from selected stop / center to other stops / centers in summing benefit

w = weight used in preference to average distance objective related to stop / center benefit objective

covper = minimum total percent of demand to be covered

### 2 sub-zones (p=2)

#### Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_2\_2.0\_0.5\_0.01\_1.0):

pp = 2

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB

sdist = 2.0

sdist2 = 0.5

w = 0.01

covper = 1.0

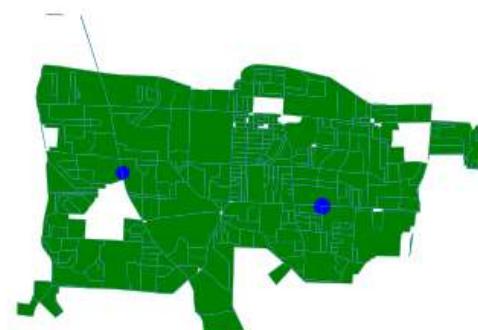
o1= 52521.80902054765

o3= 85.58455310853778

X solution: [108, 125]

Workload : [31506, 21066]

Average distance= 0.9990452906594318



#### Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_2\_2.5\_0.5\_0.01\_1.0):

pp = 2

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB

sdist = 2.5

sdist2 = 0.5

w = 0.01

covper = 1.0

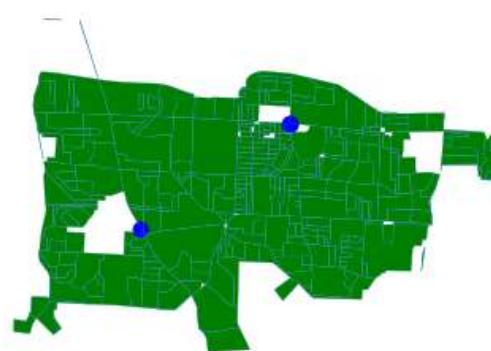
o1= 56914.820009752955

o3= 190.83410657364212

X solution: [67, 293]

Workload : [27969, 24603]

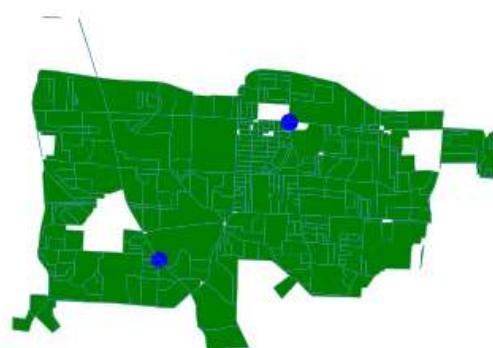
Average distance= 1.0826070914127854



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_2\_3.0\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 57249.08908905908  
 o3= 197.70977163053004  
 X solution: [67, 120]  
 Workload : [28256, 24316]  
 Average distance= 1.0889654015266508

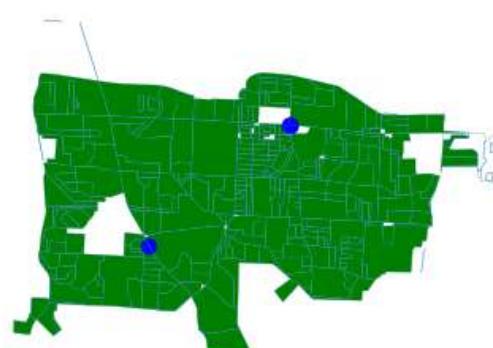
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_2\_2.0\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 51015.84300288702  
 o3= 192.5530228378641  
 X solution: [67, 159]  
 Workload : [26731, 23212]  
 Average distance= 1.0214813487953671

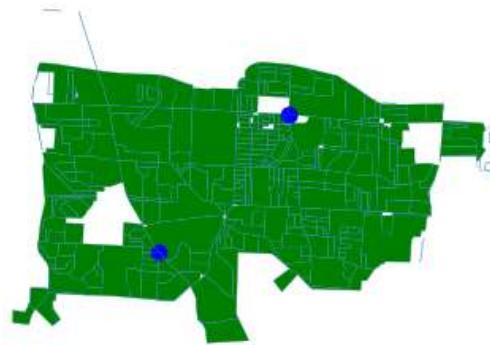
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_2\_2.5\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 51120.90771440615  
 o3= 197.70977163053004  
 X solution: [67, 120]  
 Workload : [26069, 23874]  
 Average distance= 1.023585041235131

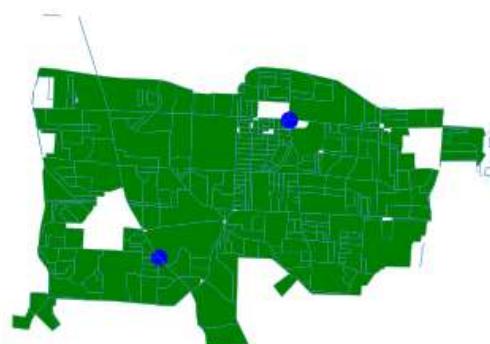
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_2\_3.0\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 51120.90771440615  
 o3= 197.70977163053004  
 X solution: [67, 120]  
 Workload : [26069, 23874]  
 Average distance= 1.023585041235131

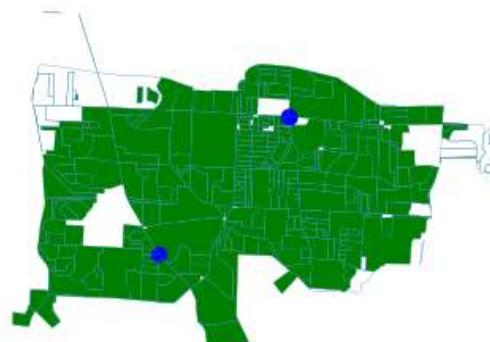
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_2\_2.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 46098.59498914292  
 o3= 197.70977163053004  
 X solution: [67, 120]  
 Workload : [25614, 21697]  
 Average distance= 0.9743737183560466

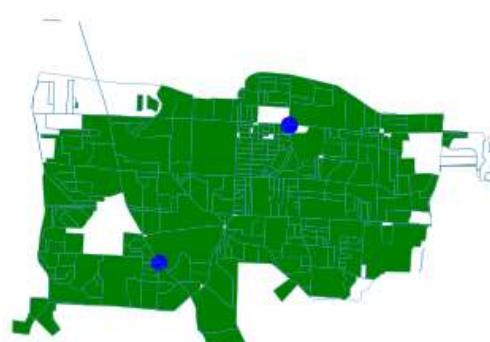
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_2\_2.5\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 46098.59498914292  
 o3= 197.70977163053004  
 X solution: [67, 120]  
 Workload : [25614, 21697]  
 Average distance= 0.9743737183560466

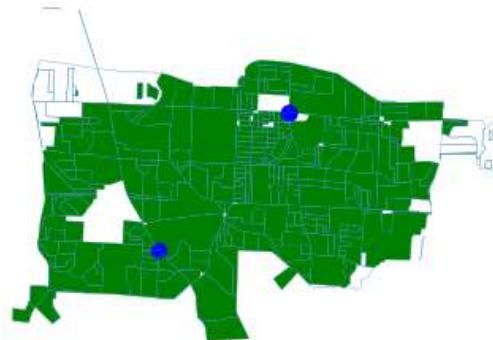
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_2\_3.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 46098.59498914292  
 o3= 197.70977163053004  
 X solution: [67, 120]  
 Workload : [25614, 21697]  
 Average distance= 0.9743737183560466

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB

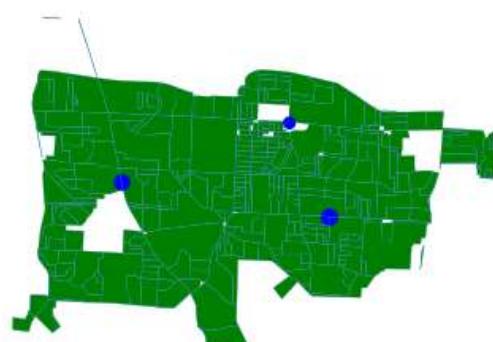


**3 sub-zones (p=3)**

**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_3\_2.0\_0.5\_0.01\_1.0):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 46033.76341395469  
 o3= 222.5030924130462  
 X solution: [67, 108, 125]  
 Workload : [11222, 21432, 19918]  
 Average distance= 0.8756327211054306

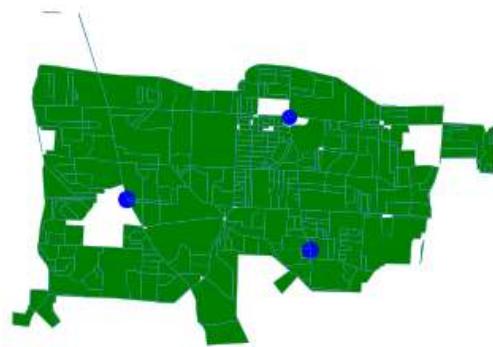
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_3\_2.5\_0.5\_0.01\_1.0):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 44961.01046917293  
 o3= 232.28454448803322  
 X solution: [67, 77, 167]  
 Workload : [15006, 18286, 19280]  
 Average distance= 0.8552273162362651

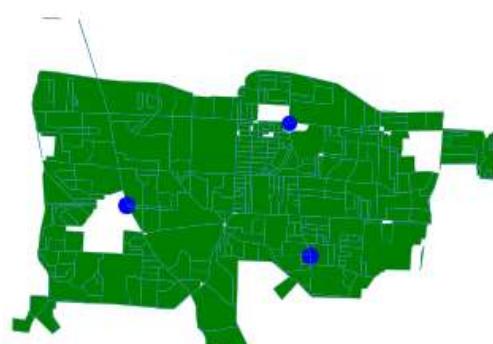
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_3\_3.0\_0.5\_0.01\_1.0):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 44961.01046917299  
 o3= 232.28454448804476  
 X solution: [67, 77, 167]  
 Workload : [15006, 18286, 19280]  
 Average distance= 0.8552273162362662

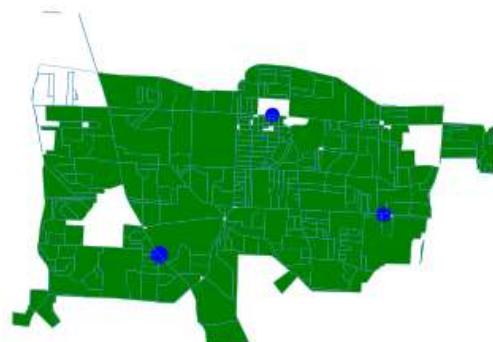
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_3\_2.0\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 39957.93033513124  
 o3= 239.52567527659096  
 X solution: [65, 120, 127]  
 Workload : [15170, 20917, 13859]  
 Average distance= 0.8000226311442606

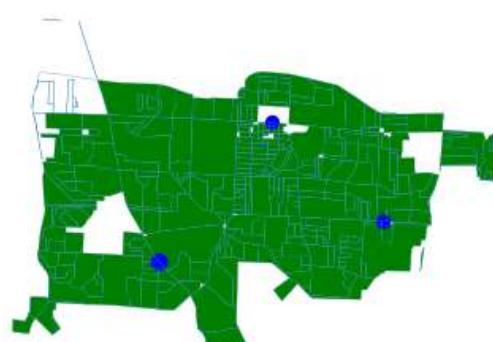
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_3\_2.5\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 39957.93033513124  
 o3= 239.52567527659096  
 X solution: [65, 120, 127]  
 Workload : [15170, 20917, 13859]  
 Average distance= 0.8000226311442606

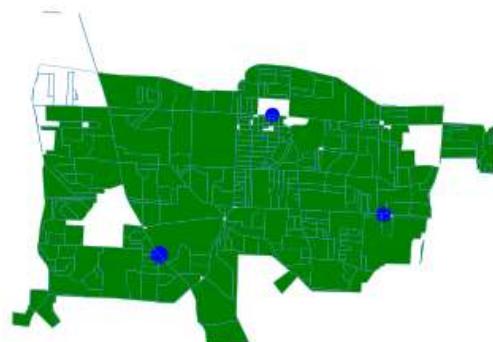
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_3\_3.0\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 39957.93033513124  
 o3= 239.52567527659096  
 X solution: [65, 120, 127]  
 Workload : [15170, 20917, 13859]  
 Average distance= 0.8000226311442606

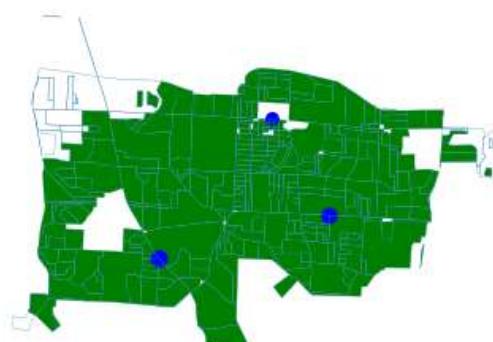
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_3\_2.0\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 34884.25393849498  
 o3= 233.0989833846432  
 X solution: [108, 120, 127]  
 Workload : [16605, 19097, 11611]  
 Average distance= 0.7373080112970004

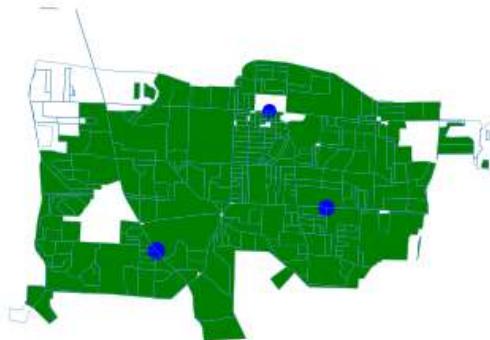
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_3\_2.5\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 34884.25393849498  
 o3= 233.0989833846432  
 X solution: [108, 120, 127]  
 Workload : [16605, 19097, 11611]  
 Average distance= 0.7373080112970004

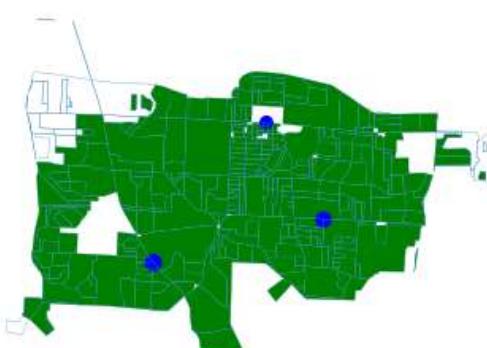
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneB\_3\_3.0\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 34884.25393849498  
 o3= 233.0989833846432  
 X solution: [108, 120, 127]  
 Workload : [16605, 19097, 11611]  
 Average distance= 0.7373080112970004

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneB



Zone Scenarios	Zone	Run	PP	Sdist	W	Coverpt	Avg Dist	Wkld A	Wkld B	Wkld C	Wkld Ratic	Tot Wkld
2_2.0_0.5_0.01_1.0	B	<b>2-1</b>	2	2.00	0.01	1.00	0.99904529	31506	21066	0	1.50	52572
2_2.5_0.5_0.01_1.0	B	<b>2-2</b>	2	2.50	0.01	1.00	1.08260709	27969	24603	0	1.14	52572
<b>2_3.0_0.5_0.01_1.0</b>	<b>B</b>	<b>2-3</b>	2	3.00	0.01	1.00	<b>1.08896540</b>	<b>28256</b>	<b>24316</b>	<b>0</b>	<b>1.16</b>	<b>52572</b>
2_2.0_0.5_0.01_0.95	B	<b>2-4</b>	2	2.00	0.01	0.95	1.02148135	26731	23212	0	1.15	49943
2_2.5_0.5_0.01_0.95	B	<b>2-5</b>	2	2.50	0.01	0.95	1.02358504	26069	23874	0	1.09	49943
2_3.0_0.5_0.01_0.95	B	<b>2-6</b>	2	3.00	0.01	0.95	1.02358504	26069	23874	0	1.09	49943
2_2.0_0.5_0.01_0.90	B	<b>2-7</b>	2	2.00	0.01	0.90	0.97437372	25614	21697	0	1.18	47311
2_2.5_0.5_0.01_0.90	B	<b>2-8</b>	2	2.50	0.01	0.90	0.97437372	25614	21697	0	1.18	47311
2_3.0_0.5_0.01_0.90	B	<b>2-9</b>	2	3.00	0.01	0.90	0.97437372	25614	21697	0	1.18	47311
3_2.0_0.5_0.01_1.0	B	<b>3-1</b>	3	2.00	0.01	1.00	0.87563272	21432	19918	11222	0.69	52572
3_2.5_0.5_0.01_1.0	B	<b>3-2</b>	3	2.50	0.01	1.00	0.85522732	19280	18286	15006	0.58	52572
<b>3_3.0_0.5_0.01_1.0</b>	<b>B</b>	<b>3-3</b>	3	3.00	0.01	1.00	<b>0.85522732</b>	<b>19280</b>	<b>18286</b>	<b>15006</b>	<b>0.58</b>	<b>52572</b>
3_2.0_0.5_0.01_0.95	B	<b>3-4</b>	3	2.00	0.01	0.95	0.80002263	20917	15170	13859	0.72	49946
3_2.5_0.5_0.01_0.95	B	<b>3-5</b>	3	2.50	0.01	0.95	0.80002263	20917	15170	13859	0.72	49946
3_3.0_0.5_0.01_0.95	B	<b>3-6</b>	3	3.00	0.01	0.95	0.80002263	20917	15170	13859	0.72	49946
3_2.0_0.5_0.01_0.90	B	<b>3-7</b>	3	2.00	0.01	0.90	0.73730801	19097	16605	11611	0.68	47313
3_2.5_0.5_0.01_0.90	B	<b>3-8</b>	3	2.50	0.01	0.90	0.73730801	19097	16605	11611	0.68	47313
3_3.0_0.5_0.01_0.90	B	<b>3-9</b>	3	3.00	0.01	0.90	0.73730801	19097	16605	11611	0.68	47313

## Zone C – Northgate – Mt. Healthy

pp = number of stops / centers to select (reflecting a sub-zone partitioning)

sdist = the maximum distance from stop / center considered to demand

sdist2 = distance considered from selected stop / center to other stops / centers in summing benefit

w = weight used in preference to average distance objective related to stop / center benefit objective

covper = minimum total percent of demand to be covered

### 2 sub-zones (p=2)

#### Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_2\_2.0\_0.5\_0.01\_1.0):

pp = 2

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC

sdist = 2.0

sdist2 = 0.5

w = 0.01

covper = 1.0

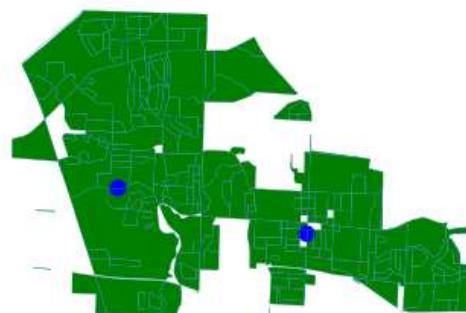
o1= 32538.13426607

o3= 116.77883959322806

X solution: [4, 95]

Workload : [17988, 17957]

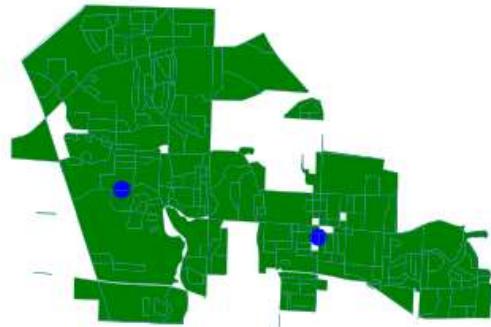
Average distance= 0.9052200380044513



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_2\_2.5\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 32538.13426607  
 o3= 116.77883959322806  
 X solution: [4, 95]  
 Workload : [17988, 17957]  
 Average distance= 0.9052200380044513

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_2\_3.0\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 32538.134266070007  
 o3= 116.77883959322806  
 X solution: [4, 95]  
 Workload : [17988, 17957]  
 Average distance= 0.9052200380044514

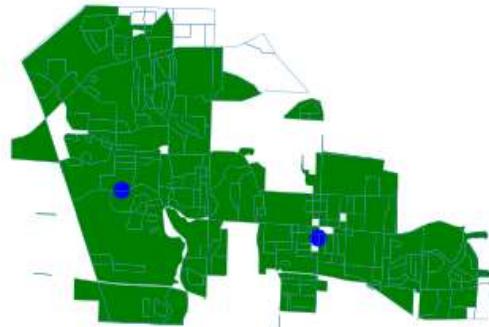
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_2\_2.0\_0.5\_0.01\_0.95):**

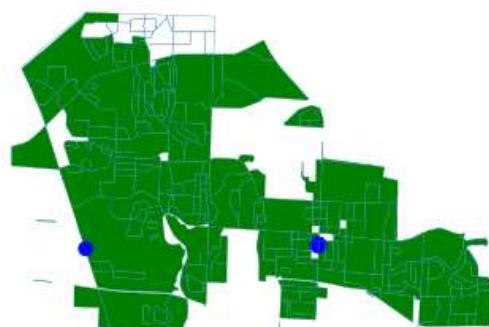
pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 29450.31698123425  
 o3= 116.77883959322806  
 X solution: [4, 95]  
 Workload : [16532, 17619]  
 Average distance= 0.8623559187500879

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC


**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_2\_2.5\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 33284.07927934519  
 o3= 155.87096464176375  
 X solution: [95, 114]  
 Workload : [19538, 14614]  
 Average distance= 0.9745865331267625

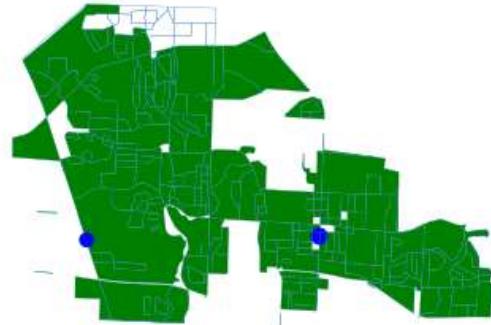
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_2\_3.0\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 33284.07927934519  
 o3= 155.87096464176375  
 X solution: [95, 114]  
 Workload : [19538, 14614]  
 Average distance= 0.9745865331267625

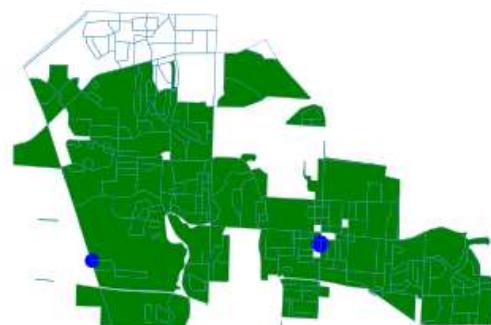
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_2\_2.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 30226.12361647571  
 o3= 160.43837071526787  
 X solution: [95, 110]  
 Workload : [19696, 12661]  
 Average distance= 0.9341448099785429

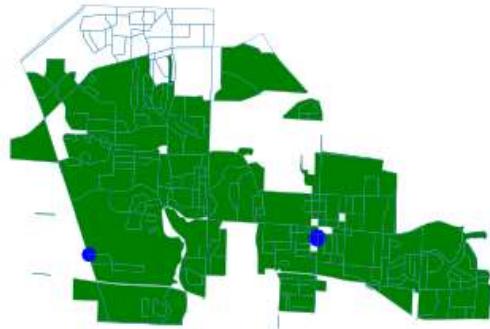
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_2\_2.5\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 30226.12361647571  
 o3= 160.43837071526787  
 X solution: [95, 110]  
 Workload : [19696, 12661]  
 Average distance= 0.9341448099785429

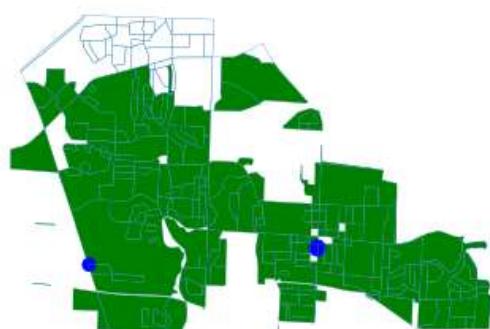
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_2\_3.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 30226.12361647571  
 o3= 160.43837071526787  
 X solution: [95, 110]  
 Workload : [19696, 12661]  
 Average distance= 0.9341448099785429

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC

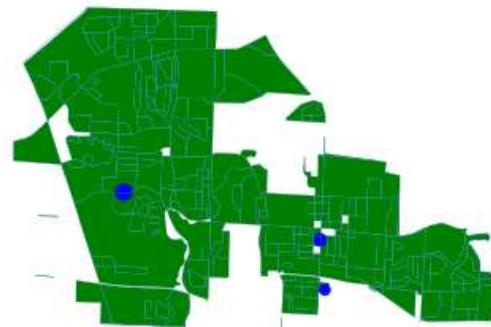


### 3 sub-zones (p=3)

#### Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_3\_2.0\_0.5\_0.01\_1.0):

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 31121.201124759034  
 o3= 210.79178316414573  
 X solution: [4, 95, 125]  
 Workload : [17679, 10798, 7468]  
 Average distance= 0.8658005598764511

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



#### Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_3\_2.5\_0.5\_0.01\_1.0):

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 31121.201124759024  
 o3= 210.79178316414573  
 X solution: [4, 95, 125]  
 Workload : [17679, 10798, 7468]  
 Average distance= 0.8658005598764508

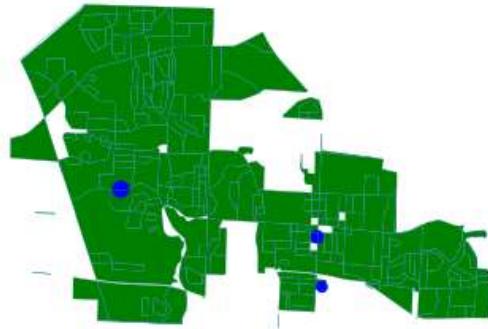
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_3\_3.0\_0.5\_0.01\_1.0):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 31121.201124759027  
 o3= 210.79178316414573  
 X solution: [4, 95, 125]  
 Workload : [17679, 10798, 7468]  
 Average distance= 0.86580055598764509

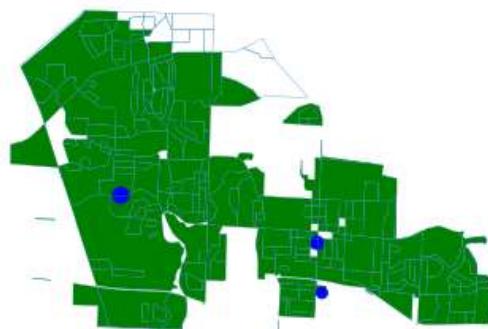
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_3\_2.0\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 28051.67317793319  
 o3= 210.79178316414573  
 X solution: [4, 95, 125]  
 Workload : [15883, 10798, 7468]  
 Average distance= 0.8214493302273328

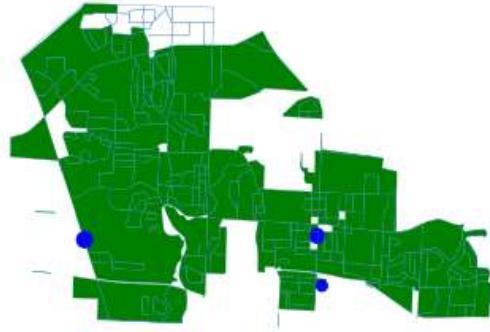
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_3\_2.5\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 31875.59540554109  
 o3= 249.88390821268143  
 X solution: [95, 114, 125]  
 Workload : [12379, 14614, 7159]  
 Average distance= 0.9333449111484273

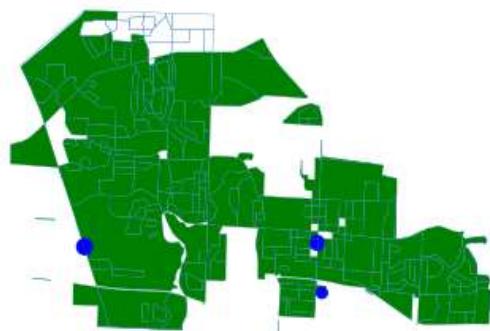
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_3\_3.0\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 31875.59540554109  
 o3= 249.88390821268143  
 X solution: [95, 114, 125]  
 Workload : [12379, 14614, 7159]  
 Average distance= 0.9333449111484273

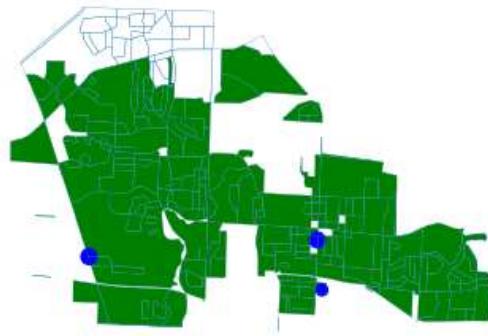
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_3\_2.0\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 28817.639742671614  
 o3= 254.45131428618555  
 X solution: [95, 110, 125]  
 Workload : [12537, 12661, 7159]  
 Average distance= 0.8906153148521684

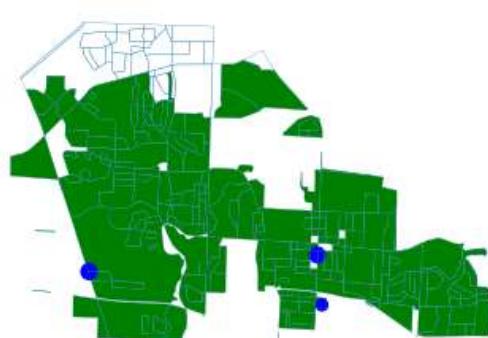
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_3\_2.5\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 28817.639742671614  
 o3= 254.45131428618555  
 X solution: [95, 110, 125]  
 Workload : [12537, 12661, 7159]  
 Average distance= 0.8906153148521684

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneC\_3\_3.0\_0.5\_0.01\_0.90):**

pp = 3

sdist = 3.0

sdist2 = 0.5

w = 0.01

covper = 0.90

o1= 28817.639742671614

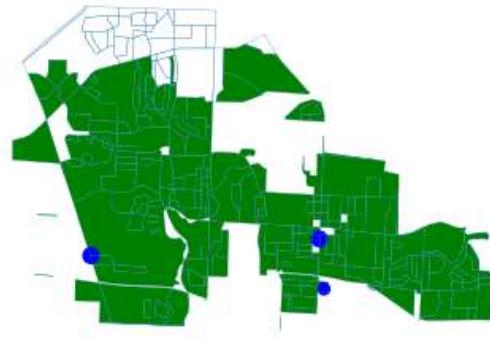
o3= 254.45131428618555

X solution: [95, 110, 125]

Workload : [12537, 12661, 7159]

Average distance= 0.8906153148521684

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneC



Zone Scenarios	Zone	Run	PP	Sdist	W	Coverpct	Avg Dist	Wkld A	Wkld B	Wkld C	Wkld Ratic	Tot Wkld
2_2.0_0.5_0.01_1.0	C	<b>2-1</b>	2	2.00	0.01	1.00	0.90522004	17988	17957	0	1.00	35945
2_2.5_0.5_0.01_1.0	C	<b>2-2</b>	2	2.50	0.01	1.00	0.90522004	17988	17957	0	1.00	35945
2_3.0_0.5_0.01_1.0	C	<b>2-3</b>	2	3.00	0.01	1.00	0.90522004	17988	17957	0	1.00	35945
<b>2_2.0_0.5_0.01_0.95</b>	C	<b>2-4</b>	2	2.00	0.01	0.95	0.86235592	17619	16532	0	1.07	34151
2_2.5_0.5_0.01_0.95	C	<b>2-5</b>	2	2.50	0.01	0.95	0.97458653	19538	14614	0	1.34	34152
2_3.0_0.5_0.01_0.95	C	<b>2-6</b>	2	3.00	0.01	0.95	0.97458653	19538	14614	0	1.34	34152
2_2.0_0.5_0.01_0.90	C	<b>2-7</b>	2	2.00	0.01	0.90	0.93414481	19696	12661	0	1.56	32357
2_2.5_0.5_0.01_0.90	C	<b>2-8</b>	2	2.50	0.01	0.90	0.93414481	19696	12661	0	1.56	32357
2_3.0_0.5_0.01_0.90	C	<b>2-9</b>	2	3.00	0.01	0.90	0.93414481	19696	12661	0	1.56	32357
3_2.0_0.5_0.01_1.0	C	<b>3-1</b>	3	2.00	0.01	1.00	0.86580056	17679	10798	7468	0.97	35945
3_2.5_0.5_0.01_1.0	C	<b>3-2</b>	3	2.50	0.01	1.00	0.86580056	17679	10798	7468	0.97	35945
3_3.0_0.5_0.01_1.0	C	<b>3-3</b>	3	3.00	0.01	1.00	0.86580056	17679	10798	7468	0.97	35945
3_2.0_0.5_0.01_0.95	C	<b>3-4</b>	3	2.00	0.01	0.95	0.82144933	15883	10798	7468	0.87	34149
3_2.5_0.5_0.01_0.95	C	<b>3-5</b>	3	2.50	0.01	0.95	0.93334491	12379	14614	7159	0.57	34152
3_3.0_0.5_0.01_0.95	C	<b>3-6</b>	3	3.00	0.01	0.95	0.93334491	12379	14614	7159	0.57	34152
3_2.0_0.5_0.01_0.90	C	<b>3-7</b>	3	2.00	0.01	0.90	0.89061531	12537	12661	7159	0.63	32357
3_2.5_0.5_0.01_0.90	C	<b>3-8</b>	3	2.50	0.01	0.90	0.89061531	12537	12661	7159	0.63	32357
3_3.0_0.5_0.01_0.90	C	<b>3-9</b>	3	3.00	0.01	0.90	0.89061531	12537	12661	7159	0.63	32357

## Zone D – Please Run North

**2 sub-zones (p=2)**

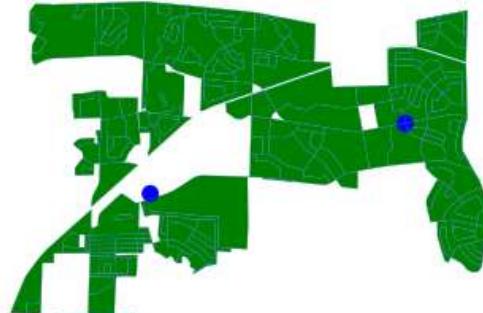
**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_2\_2.0\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0

NO FEASIBLE SOLUTION

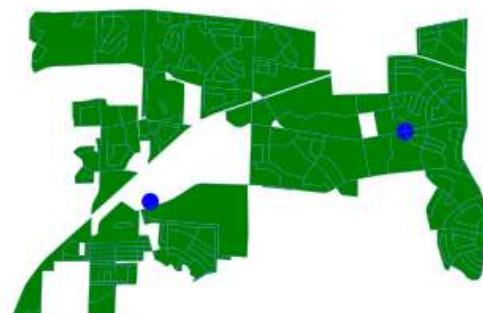
**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_2\_2.5\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 29482.47013526894  
 o3= 156.6966729520189  
 X solution: [23, 56]  
 Workload : [16091, 15551]  
 Average distance= 0.931751157805099



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_2\_3.0\_0.5\_0.01\_1.0):**

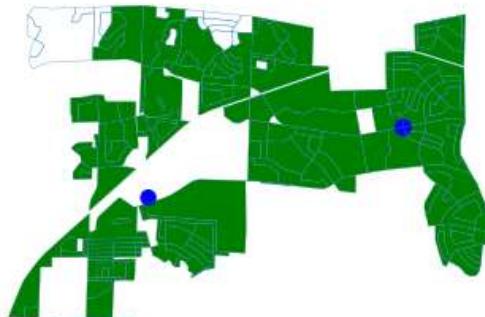
pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 29482.47013526894  
 o3= 156.6966729520189  
 X solution: [23, 56]  
 Workload : [16091, 15551]  
 Average distance= 0.931751157805099



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_2\_2.0\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 26620.74399502559  
 o3= 156.6966729520189  
 X solution: [23, 56]  
 Workload : [15995, 14067]  
 Average distance= 0.8855280418809657

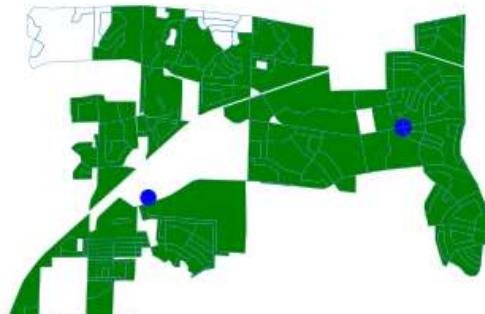
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_2\_2.5\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 26620.74399502559  
 o3= 156.6966729520189  
 X solution: [23, 56]  
 Workload : [15995, 14067]  
 Average distance= 0.8855280418809657

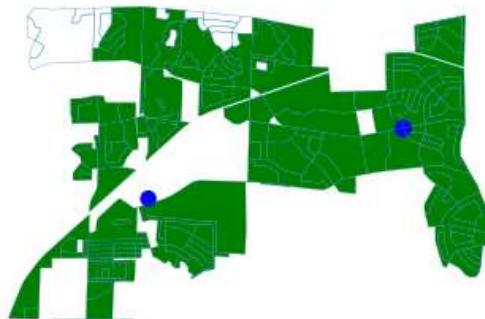
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_2\_3.0\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 26620.74399502559  
 o3= 156.6966729520189  
 X solution: [23, 56]  
 Workload : [15995, 14067]  
 Average distance= 0.8855280418809657

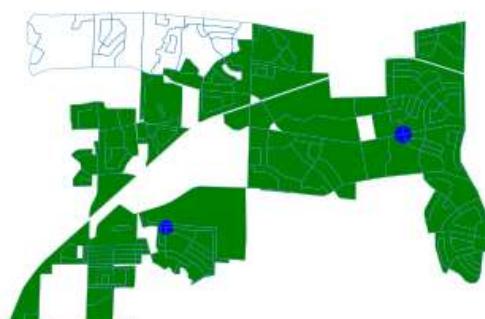
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_2\_2.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 23974.095737621567  
 o3= 156.9422324183363  
 X solution: [19, 23]  
 Workload : [11672, 16808]  
 Average distance= 0.8417870694389595

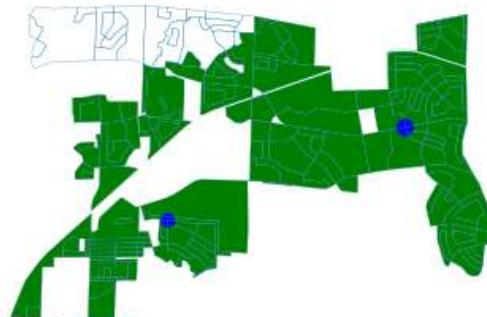
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_2\_2.5\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 23974.095737621567  
 o3= 156.9422324183363  
 X solution: [19, 23]  
 Workload : [11672, 16808]  
 Average distance= 0.8417870694389595

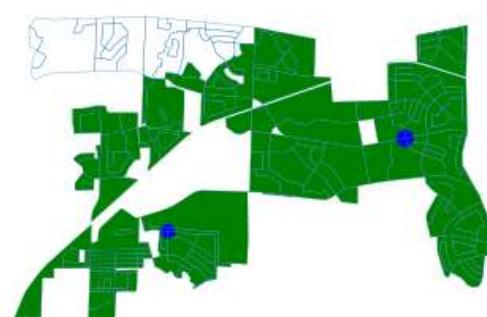
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_2\_3.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 23974.095737621567  
 o3= 156.9422324183363  
 X solution: [19, 23]  
 Workload : [11672, 16808]  
 Average distance= 0.8417870694389595

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



### 3 sub-zones (p=3)

#### Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_3\_2.0\_0.5\_0.01\_1.0):

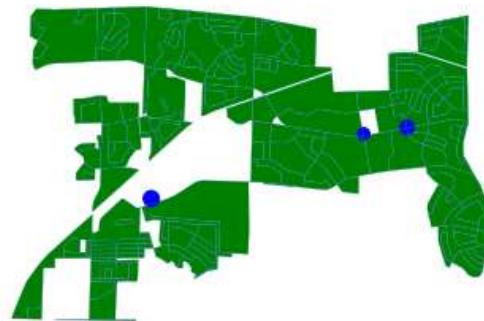
pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0

NO FEASIBLE SOLUTION

#### Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_3\_2.5\_0.5\_0.01\_1.0):

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 27166.630649356648  
 o3= 237.9115642605566  
 X solution: [14, 32, 56]  
 Workload : [7725, 10820, 13097]  
 Average distance= 0.8585623743554974

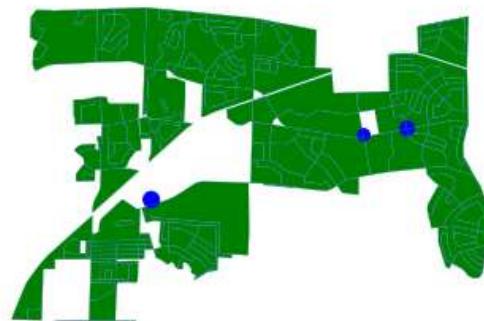
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



#### Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_3\_3.0\_0.5\_0.01\_1.0):

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 27166.630649356648  
 o3= 237.9115642605566  
 X solution: [14, 32, 56]  
 Workload : [7725, 10820, 13097]  
 Average distance= 0.8585623743554974

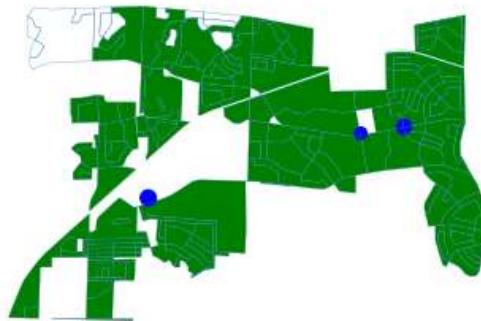
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_3\_2.0\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 24366.222279165067  
 o3= 237.9115642605566  
 X solution: [14, 32, 56]  
 Workload : [7391, 10701, 11969]  
 Average distance= 0.8105592721188606

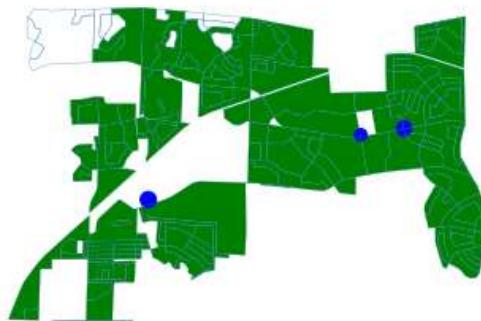
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_3\_2.5\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 24366.222279165067  
 o3= 237.9115642605566  
 X solution: [14, 32, 56]  
 Workload : [7391, 10701, 11969]  
 Average distance= 0.8105592721188606

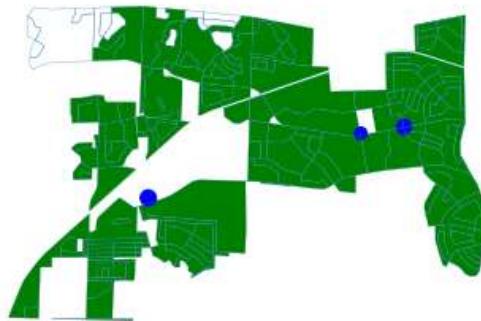
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_3\_3.0\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 24366.222279165067  
 o3= 237.9115642605566  
 X solution: [14, 32, 56]  
 Workload : [7391, 10701, 11969]  
 Average distance= 0.8105592721188606

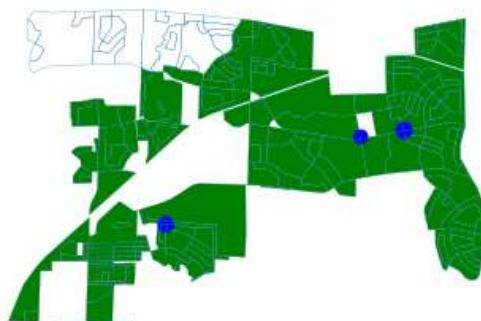
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_3\_2.0\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 21701.73688300139  
 o3= 238.15712372687403  
 X solution: [14, 19, 32]  
 Workload : [7925, 9858, 10701]  
 Average distance= 0.7618921809788439

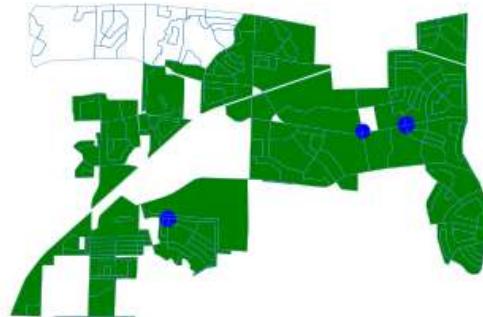
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_3\_2.5\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 21701.73688300139  
 o3= 238.15712372687403  
 X solution: [14, 19, 32]  
 Workload : [7925, 9858, 10701]  
 Average distance= 0.7618921809788439

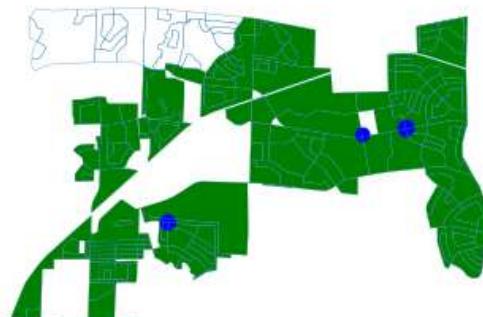
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneD\_3\_3.0\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 21701.73688300139  
 o3= 238.15712372687403  
 X solution: [14, 19, 32]  
 Workload : [7925, 9858, 10701]  
 Average distance= 0.7618921809788439

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneD



Zone	Run	PP	Sdist	W	Coverpct	Avg Dist	Wkld A	Wkld B	Wkld C	Wkld Ratic	Tot Wkld
D	<b>2-1</b>	2	2.00	0.01	1.00	0.00000000	0	0	0	0.00	0
D	<b>2-2</b>	2	2.50	0.01	1.00	0.93175116	16091	15551	0	1.03	31642
D	<b>2-3</b>	2	3.00	0.01	1.00	0.93175116	16091	15551	0	1.03	31642
D	<b>2-4</b>	2	2.00	0.01	0.95	0.88552804	15995	14067	0	1.14	30062
D	<b>2-5</b>	2	2.50	0.01	0.95	0.88552804	15995	14067	0	1.14	30062
D	<b>2-6</b>	2	3.00	0.01	0.95	0.88552804	15995	14067	0	1.14	30062
D	<b>2-7</b>	2	2.00	0.01	0.90	0.84178707	11672	16808	0	0.69	28480
D	<b>2-8</b>	2	2.50	0.01	0.90	0.84178707	11672	16808	0	0.69	28480
D	<b>2-9</b>	2	3.00	0.01	0.90	0.84178707	11672	16808	0	0.69	28480
D	<b>3-1</b>	3	2.00	0.01	1.00	0.00000000	0	0	0	0.00	0
D	<b>3-2</b>	3	2.50	0.01	1.00	0.85856237	13097	10820	7725	0.71	31642
D	<b>3-3</b>	3	3.00	0.01	1.00	0.85856237	13097	10820	7725	0.71	31642
D	<b>3-4</b>	3	2.00	0.01	0.95	0.81055927	11969	10701	7391	0.66	30061
D	<b>3-5</b>	3	2.50	0.01	0.95	0.81055927	11969	10701	7391	0.66	30061
D	<b>3-6</b>	3	3.00	0.01	0.95	0.76189218	10701	9858	7925	0.60	28484
D	<b>3-7</b>	3	2.00	0.01	0.90	0.76189218	10701	9858	7925	0.60	28484
D	<b>3-8</b>	3	2.50	0.01	0.90	0.76189218	10701	9858	7925	0.60	28484
D	<b>3-9</b>	3	3.00	0.01	0.90	0.76189218	10701	9858	7925	0.60	28484

## Zone E – Springdale – Glendale - Sharonville

2 sub-zones (p=2)

**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_2\_2.0\_0.5\_0.01\_1.0):**

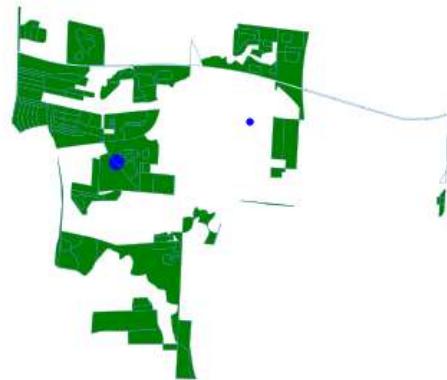
pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0

NO FEASIBLE SOLUTION

**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_2\_2.5\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 18342.648572138725  
 o3= 51.714870715394014  
 X solution: [25, 68]  
 Workload : [2784, 15063]  
 Average distance= 1.0277720945894955

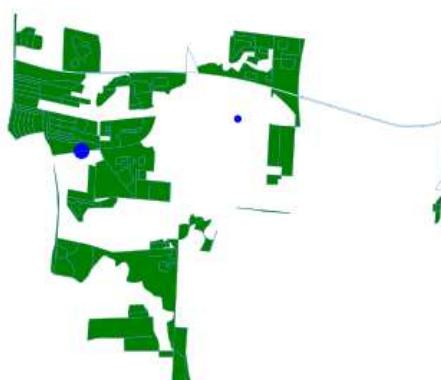
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_2\_3.0\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 17708.947462048956  
 o3= 66.06923391931466  
 X solution: [33, 168]  
 Workload : [2836, 15011]  
 Average distance= 0.9922646642040094

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_2\_2.0\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 15172.274594801569  
 o3= 115.2469231327537  
 X solution: [133, 175]  
 Workload : [13191, 3769]  
 Average distance= 0.8945916624293377

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_2\_2.5\_0.5\_0.01\_0.95):**

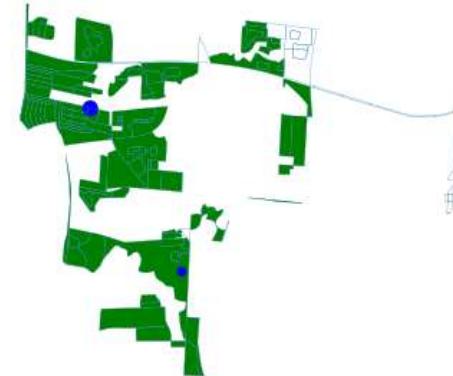
pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 14308.094455470688  
 o3= 113.26198411335449  
 X solution: [117, 175]  
 Workload : [12780, 4179]  
 Average distance= 0.8436873904988907

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_2\_3.0\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 14308.094455470688  
 o3= 113.26198411335449  
 X solution: [117, 175]  
 Workload : [12780, 4179]  
 Average distance= 0.8436873904988907



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_2\_2.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 12517.862770059008  
 o3= 113.26198411335449  
 X solution: [117, 175]  
 Workload : [11975, 4095]  
 Average distance= 0.778958479779652



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_2\_2.5\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 12441.376679917801  
 o3= 113.26198411335449  
 X solution: [117, 175]  
 Workload : [12295, 3771]  
 Average distance= 0.7743916768279473

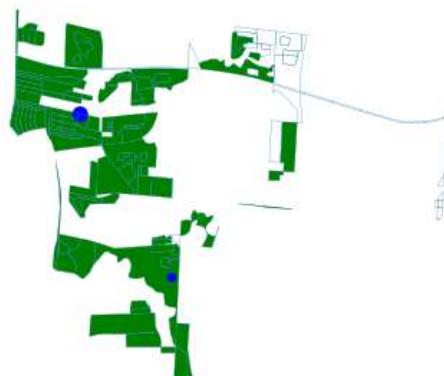
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_2\_3.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 12441.376679917801  
 o3= 113.26198411335449  
 X solution: [117, 175]  
 Workload : [12295, 3771]  
 Average distance= 0.7743916768279473

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



### 3 sub-zones (p=3)

#### Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_3\_2.0\_0.5\_0.01\_1.0):

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 13383.033724669824  
 o3= 114.71487762239926  
 X solution: [117, 119, 175]  
 Workload : [11753, 2602, 3492]  
 Average distance= 0.7498758180461603

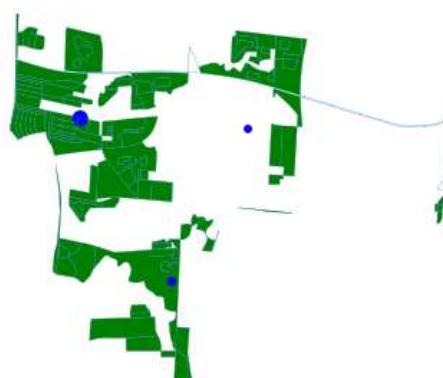
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



#### Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_3\_2.5\_0.5\_0.01\_1.0):

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 13252.185401224999  
 o3= 129.13876817704426  
 X solution: [25, 117, 175]  
 Workload : [2697, 11658, 3492]  
 Average distance= 0.7425441475444051

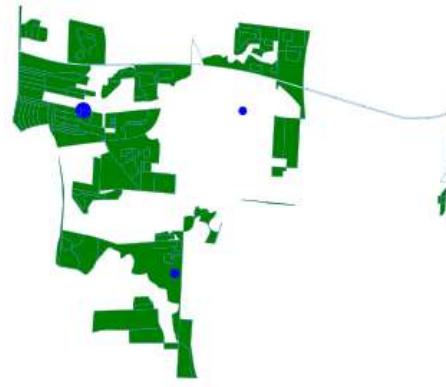
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



### Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_3\_3.0\_0.5\_0.01\_1.0):

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 13192.404054676557  
 o3= 144.2584583842421  
 X solution: [33, 117, 175]  
 Workload : [2784, 11571, 3492]  
 Average distance= 0.7391944895319413

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



### Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_3\_2.0\_0.5\_0.01\_0.95):

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 15128.37032722369  
 o3= 194.70896416482663  
 X solution: [27, 133, 175]  
 Workload : [471, 13191, 3298]  
 Average distance= 0.8920029674070572

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_3\_2.5\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 14162.533047384122  
 o3= 192.191979635073  
 X solution: [98, 117, 175]  
 Workload : [1604, 12720, 2635]  
 Average distance= 0.8351042542239591

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_3\_3.0\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 14162.533047384122  
 o3= 192.191979635073  
 X solution: [98, 117, 175]  
 Workload : [1604, 12720, 2635]  
 Average distance= 0.8351042542239591

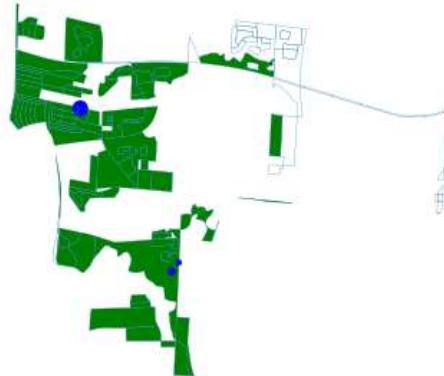
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_3\_2.0\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 12378.498728471286  
 o3= 192.191979635073  
 X solution: [98, 117, 175]  
 Workload : [1559, 11915, 2596]  
 Average distance= 0.7702861685420838

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_3\_2.5\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 12322.299103502517  
 o3= 192.191979635073  
 X solution: [98, 117, 175]  
 Workload : [1599, 11832, 2635]  
 Average distance= 0.7669799018736784

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneE\_3\_3.0\_0.5\_0.01\_0.90):**

pp = 3

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneE

sdist = 3.0

sdist2 = 0.5

w = 0.01

covper = 0.90

o1= 12322.299103502517

o3= 192.191979635073

X solution: [98, 117, 175]

Workload : [1599, 11832, 2635]

Average distance= 0.7669799018736784



Zone	Run	PP	Sdist	W	Coverpct	Avg Dist	Wkld A	Wkld B	Wkld C	Wkld Ratic	Tot Wkld
E	<b>2-1</b>	2	2.00	0.01	1.00	0.00000000	0	0	0	0.00	0
E	<b>2-2</b>	2	2.50	0.01	1.00	1.02777209	15063	2784	0	5.41	17847
E	<b>2-3</b>	2	3.00	0.01	1.00	0.99226466	15011	2836	0	5.29	17847
E	<b>2-4</b>	2	2.00	0.01	0.95	0.89459166	13191	3769	0	3.50	16960
E	<b>2-5</b>	2	2.50	0.01	0.95	0.84368739	12780	4179	0	3.06	16959
E	<b>2-6</b>	2	3.00	0.01	0.95	0.84368739	12780	4179	0	3.06	16959
E	<b>2-7</b>	2	2.00	0.01	0.90	0.77895848	11975	4095	0	2.92	16070
E	<b>2-8</b>	2	2.50	0.01	0.90	0.77439168	12295	3771	0	3.26	16066
E	<b>2-9</b>	2	3.00	0.01	0.90	0.77439168	12295	3771	0	3.26	16066
E	<b>3-1</b>	3	2.00	0.01	1.00	0.74987582	11753	2602	3492	1.93	17847
E	<b>3-2</b>	3	2.50	0.01	1.00	0.74254415	11658	3492	2697	1.88	17847
E	<b>3-3</b>	3	3.00	0.01	1.00	0.73919449	11571	3492	2784	1.84	17847
E	<b>3-4</b>	3	2.00	0.01	0.95	0.89200297	13191	3298	471	3.50	16960
E	<b>3-5</b>	3	2.50	0.01	0.95	0.83510425	12720	2635	1604	3.00	16959
E	<b>3-6</b>	3	3.00	0.01	0.95	0.83510425	12720	2635	1604	3.00	16959
E	<b>3-7</b>	3	2.00	0.01	0.90	0.77028617	11915	2596	1559	2.87	16070
E	<b>3-8</b>	3	2.50	0.01	0.90	0.76697990	11832	2635	1599	2.79	16066
E	<b>3-9</b>	3	3.00	0.01	0.90	0.76697990	11832	2635	1599	2.79	16066

## Zone F – Winton – Bond Hill - Roselawn

**2 sub-zones (p=2)**

**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_2\_2.0\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0

NO FEASIBLE SOLUTION

**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_2\_2.5\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 48045.391910972554  
 o3= 332.44404592404635  
 X solution: [42, 106]  
 Workload : [15803, 24344]  
 Average distance= 1.1967367900708037

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_2\_3.0\_0.5\_0.01\_1.0):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 48045.391910972554  
 o3= 332.44404592404635  
 X solution: [42, 106]  
 Workload : [15803, 24344]  
 Average distance= 1.1967367900708037

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_2\_2.0\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 41855.17902380286  
 o3= 302.42030850896896  
 X solution: [106, 356]  
 Workload : [24151, 13985]  
 Average distance= 1.0975240985893346

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysql\_**

**AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_2\_2.5\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 43633.39566618709  
 o3= 332.44404592404635  
 X solution: [42, 106]  
 Workload : [14477, 23666]  
 Average distance= 1.1439424184303042

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_2\_3.0\_0.5\_0.01\_0.95):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 43633.39566618709  
 o3= 332.44404592404635  
 X solution: [42, 106]  
 Workload : [14477, 23666]  
 Average distance= 1.1439424184303042

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_2\_2.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 39605.83751338419  
 o3= 332.44404592404635  
 X solution: [42, 106]  
 Workload : [12987, 23144]  
 Average distance= 1.096173300306778

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_2\_2.5\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 39604.795694947614  
 o3= 332.44404592404635  
 X solution: [42, 106]  
 Workload : [12988, 23144]  
 Average distance= 1.096114128610307

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_2\_3.0\_0.5\_0.01\_0.90):**

pp = 2  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 39604.795694947614  
 o3= 332.44404592404635  
 X solution: [42, 106]  
 Workload : [12988, 23144]  
 Average distance= 1.096114128610307

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



### 3 sub-zones (p=3)

#### Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_2.0\_0.5\_0.01\_1.0):

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 32382.774734563813  
 o3= 254.93041387646056  
 X solution: [115, 191, 238]  
 Workload : [14325, 15566, 10256]  
 Average distance= 0.8066050946412886

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



#### Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_2.5\_0.5\_0.01\_1.0):

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 45671.177132881196  
 o3= 530.5793417457762  
 X solution: [42, 106, 132]  
 Workload : [15803, 17007, 7337]  
 Average distance= 1.1375987529051037

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_3.0\_0.5\_0.01\_1.0):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 1.0  
 o1= 45671.1771328814  
 o3= 530.5793417457852  
 X solution: [42, 106, 132]  
 Workload : [15803, 17007, 7337]  
 Average distance= 1.1375987529051088

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_2.0\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 39480.96424571151  
 o3= 500.5556043306989  
 X solution: [106, 132, 356]  
 Workload : [16814, 7337, 13985]  
 Average distance= 1.0352675751445226

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_2.5\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 41259.18088809576  
 o3= 530.5793417457762  
 X solution: [42, 106, 132]  
 Workload : [14477, 16329, 7337]  
 Average distance= 1.0816973202971911

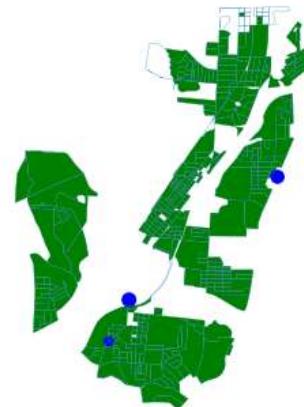
Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_3.0\_0.5\_0.01\_0.95):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.95  
 o1= 41259.18088809576  
 o3= 530.5793417457762  
 X solution: [42, 106, 132]  
 Workload : [14477, 16329, 7337]  
 Average distance= 1.0816973202971911

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_2.0\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 37231.62273529284  
 o3= 530.5793417457762  
 X solution: [42, 106, 132]  
 Workload : [12987, 15807, 7337]  
 Average distance= 1.0304620059033196

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysol\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_2.5\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 37230.58091685626  
 o3= 530.5793417457762  
 X solution: [42, 106, 132]  
 Workload : [12988, 15807, 7337]  
 Average distance= 1.030404652852216

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_3.0\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 37230.58091685626  
 o3= 530.5793417457762  
 X solution: [42, 106, 132]  
 Workload : [12988, 15807, 7337]  
 Average distance= 1.030404652852216

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**BONUS Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_2.0\_0.5\_0.3\_0.90):**

pp = 3  
 sdist = 2.0  
 sdist2 = 0.5  
 w = 0.3  
 covper = 0.90  
 o1= 25241.96922359944  
 o3= 27.179340263567166  
 X solution: [13, 164, 303]  
 Workload : [15098, 9639, 11401]  
 Average distance= 0.698488273385340

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



**BONUS Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_2.5\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 2.5  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 25241.96922359944  
 o3= 27.179340263567166  
 X solution: [13, 164, 303]  
 Workload : [15098, 9639, 11401]  
 Average distance= 0.6984882733853407

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF


**BONUS Scenario (mysql\_AM\_Blocks\_AggNeed\_6\_9\_ZoneF\_3\_3.0\_0.5\_0.01\_0.90):**

pp = 3  
 sdist = 3.0  
 sdist2 = 0.5  
 w = 0.01  
 covper = 0.90  
 o1= 25241.96922359944  
 o3= 27.179340263567166  
 X solution: [13, 164, 303]  
 Workload : [15098, 9639, 11401]  
 Average distance= 0.6984882733853407

Point-to-Point Solution - Blocks\_AggNeed\_6\_9\_ZoneF



Zone Scenarios	Zone	Run	PP	Sdist	W	Coverpct	Avg Dist	Wkld A	Wkld B	Wkld C	Wkld Ratic	Tot Wkld
2_2.0_0.5_0.01_1.0	F	<b>2-1</b>	2	2.00	0.01	1.00	0.00000000	0	0	0	0.00	0
2_2.5_0.5_0.01_1.0	F	<b>2-2</b>	2	2.50	0.01	1.00	1.19673679	24344	15803	0	1.54	40147
2_3.0_0.5_0.01_1.0	F	<b>2-3</b>	2	3.00	0.01	1.00	1.19673679	24344	15803	0	1.54	40147
2_2.0_0.5_0.01_0.95	F	<b>2-4</b>	2	2.00	0.01	0.95	1.09752410	24151	13985	0	1.73	38136
2_2.5_0.5_0.01_0.95	F	<b>2-5</b>	2	2.50	0.01	0.95	1.14394242	23666	14477	0	1.63	38143
2_3.0_0.5_0.01_0.95	F	<b>2-6</b>	2	3.00	0.01	0.95	1.14394242	23666	14477	0	1.63	38143
2_2.0_0.5_0.01_0.90	F	<b>2-7</b>	2	2.00	0.01	0.90	1.09617330	23144	12987	0	1.78	36131
2_2.5_0.5_0.01_0.90	F	<b>2-8</b>	2	2.50	0.01	0.90	1.09611413	23144	12988	0	1.78	36132
2_3.0_0.5_0.01_0.90	F	<b>2-9</b>	2	3.00	0.01	0.90	1.09611413	23144	12988	0	1.78	36132
3_2.0_0.5_0.01_1.0	F	<b>3-1</b>	3	2.00	0.01	1.00	0.80660509	14325	15566	10256	0.55	40147
3_2.5_0.5_0.01_1.0	F	<b>3-2</b>	3	2.50	0.01	1.00	1.13759875	17007	15803	7337	0.73	40147
3_3.0_0.5_0.01_1.0	F	<b>3-3</b>	3	3.00	0.01	1.00	1.13759875	17007	15803	7337	0.73	40147
3_2.0_0.5_0.01_0.95	F	<b>3-4</b>	3	2.00	0.01	0.95	1.03526758	16814	13985	7337	0.79	38136
3_2.5_0.5_0.01_0.95	F	<b>3-5</b>	3	2.50	0.01	0.95	1.08169732	16329	14477	7337	0.75	38143
3_3.0_0.5_0.01_0.95	F	<b>3-6</b>	3	3.00	0.01	0.95	1.08169732	16329	14477	7337	0.75	38143
3_2.0_0.5_0.01_0.90	F	<b>3-7</b>	3	2.00	0.01	0.90	1.03046201	15807	12987	7337	0.78	36131
3_2.5_0.5_0.01_0.90	F	<b>3-8</b>	3	2.50	0.01	0.90	1.03040465	15807	12988	7337	0.78	36132
3_3.0_0.5_0.01_0.90	F	<b>3-9</b>	3	3.00	0.01	0.90	1.03040465	15807	12988	7337	0.78	36132
3_2.0_0.5_0.01_0.90	F	<b>3-7</b>	3	2.00	0.03	0.90	0.69848827	15098	11401	9639	0.72	36138
3_2.5_0.5_0.01_0.90	F	<b>3-8</b>	3	2.50	0.01	0.90	0.69848827	15098	11401	9639	0.72	36138
3_3.0_0.5_0.01_0.90	F	<b>3-9</b>	3	3.00	0.01	0.90	0.69848827	15098	11401	9639	0.72	36138

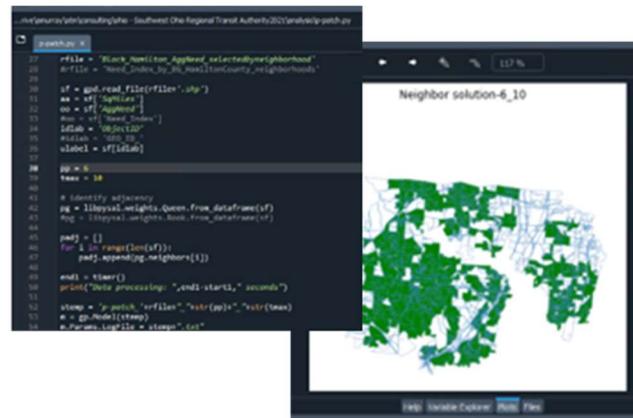
## 11.0 Appendix E: Mobility Needs Optimization Analysis Maps

The six MOD zones developed through the service area development process were refined and finalized using spatial optimization and initial MOD service planning. The intent of the spatial optimization modeling was to use advanced mathematical analytics to help identify the optimal service area and mobility solution for each zone.

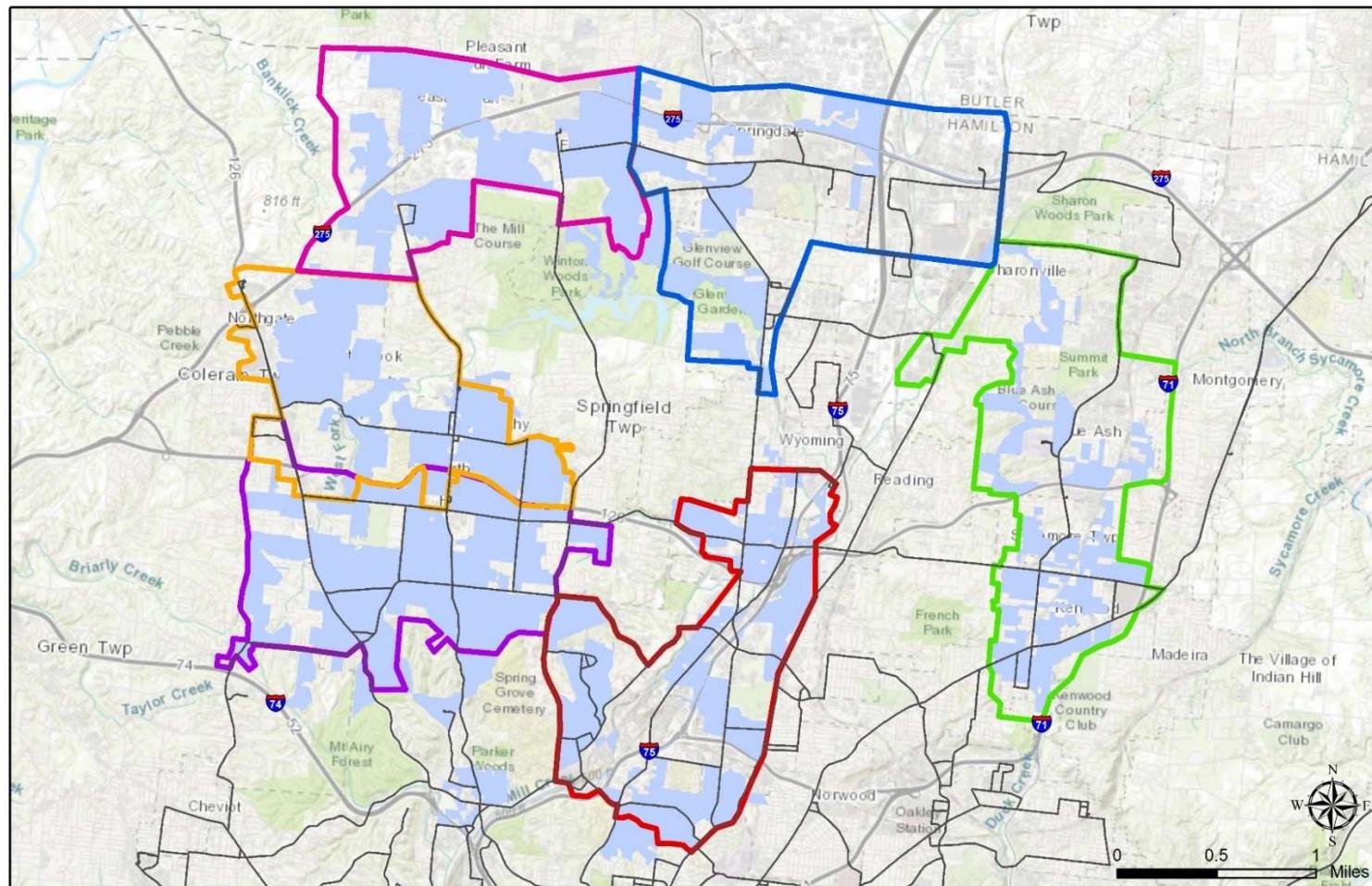
The spatial optimization model examined Census block level data to identify, concentrate, and connect Census blocks with high mobility need. The intent of the model was to create contiguous groupings of Census blocks with high mobility needs by optimizing block groupings based on variables of either 4, 5 or 6 zones and the allowable size of the zones (5, 6, 7, 8, 9, or 10 square miles). The optimization equation and a sample output of the model is illustrated below.

Neighborhood identification spatial optimization model

$$\begin{aligned}
 & \text{Maximize} && \sum_i \beta_i X_i \\
 & \text{Subject to} && \sum_i V_i = p \\
 & && \sum_{j \in \Phi_i} Y_{ij} - \sum_{j \in \Phi_i} Y_{ji} \geq \alpha_i X_i - \tau V_i \quad \forall i \\
 & && \sum_{j \in \Phi_i} Y_{ij} \leq \tau X_i \quad \forall i \\
 & && V_i \leq X_i \quad \forall i \\
 & && X_i \in \{0,1\} \quad \forall i \\
 & && V_i \in \{0,1\} \quad \forall i \\
 & && Y_{ij} \geq 0 \quad \forall i, j
 \end{aligned}$$



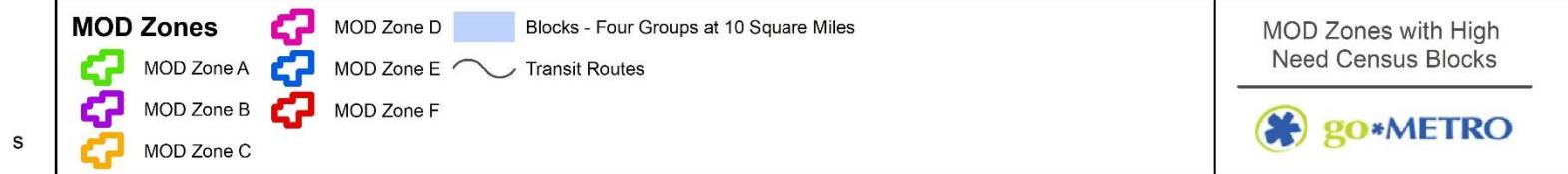
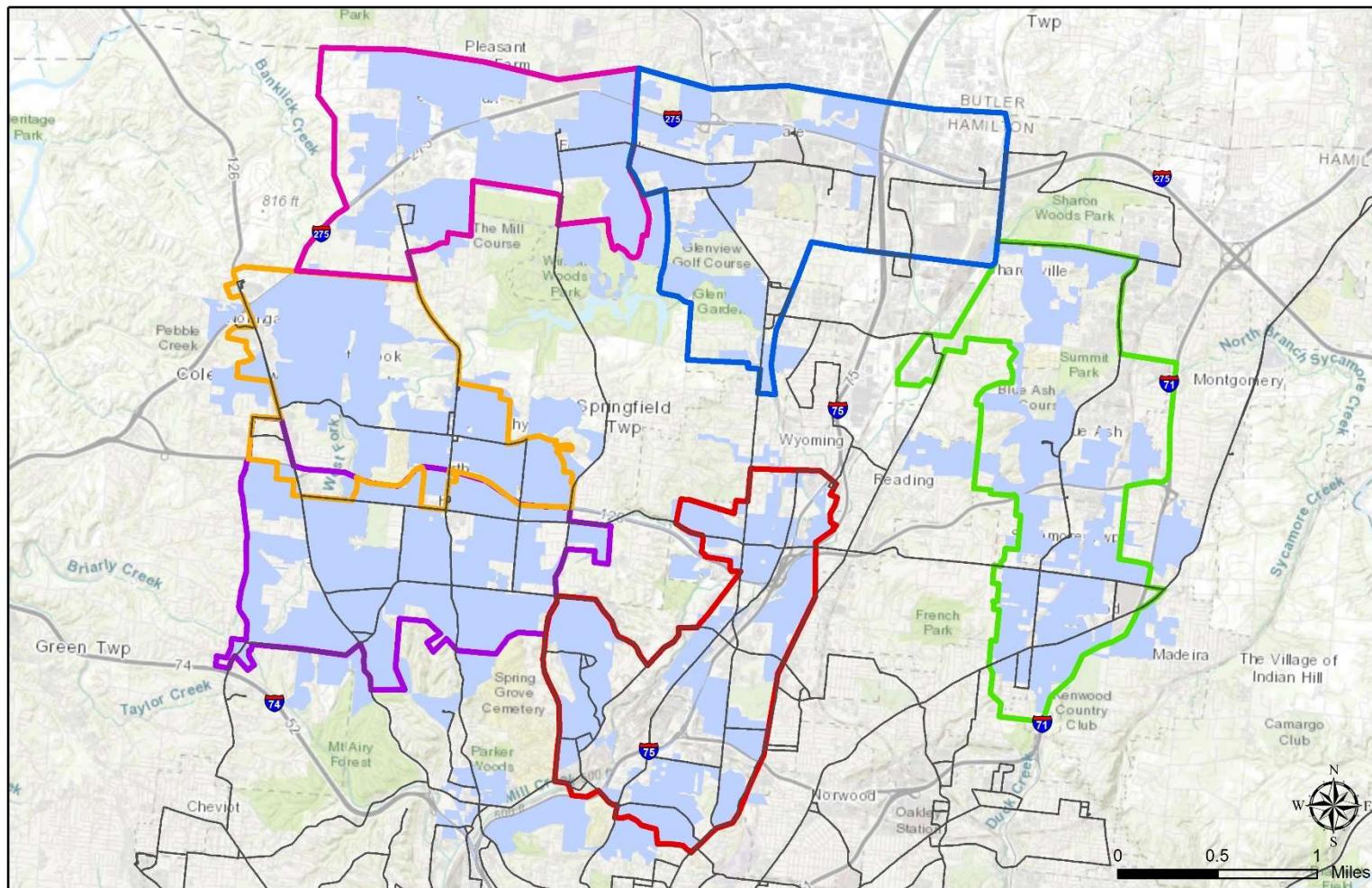
The optimization model captures identified transit need by Census block within the candidate MOD zones as well as the Census blocks directly outside the candidate MOD zones. This analysis identified the high aggregated need blocks derived from minority population, older adult (65+) population, younger adult (15-24) population, zero vehicle households, and households in poverty. Aggregate mobility need was identified in blocks based on these population and household characteristics and measured as a percentage of need compared to the total population and households within each Census block. Any Census blocks beyond the zone were apportioned to the area within the zone. This was also the process for any Census blocks that were split by the zone boundary. The following maps present the concentrations of high need Census block as continuous and contiguous groupings of blocks based on altering the variables of number of groups 4, 5, or 6 and size of each group. (5, 6, 7, 8, 9, or 10 square miles). The optimal model was determined to be six zones with an average area of eight (8) square miles. The shaded areas reflect the contiguous groupings of higher mobility need Census blocks.

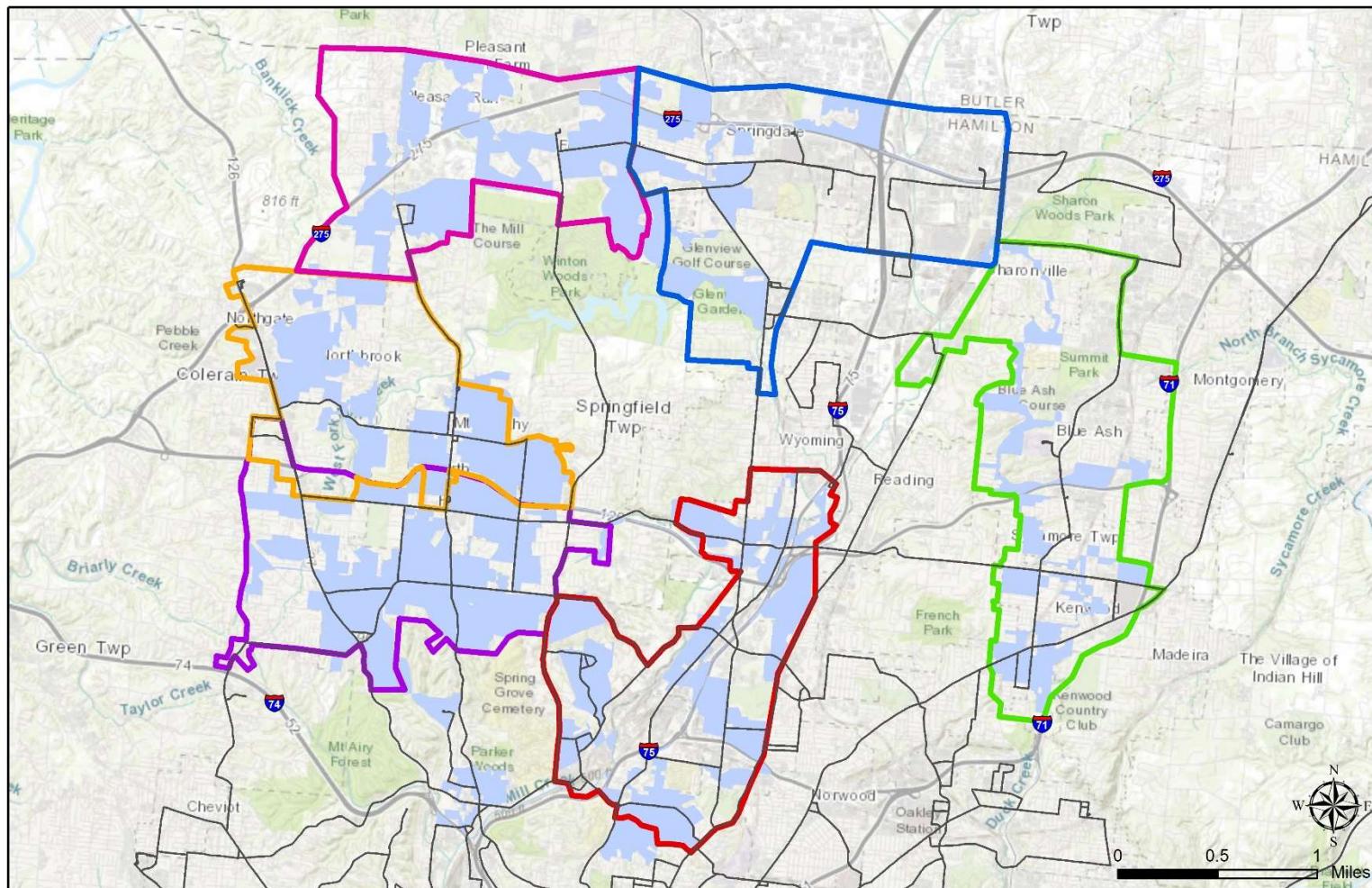

**MOD Zones**

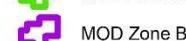
 MOD Zone A	 MOD Zone D	Blocks - Four Groups at 8 Square Miles
 MOD Zone B	 MOD Zone E	Transit Routes
 MOD Zone C	 MOD Zone F	

MOD Zones with High  
Need Census Blocks





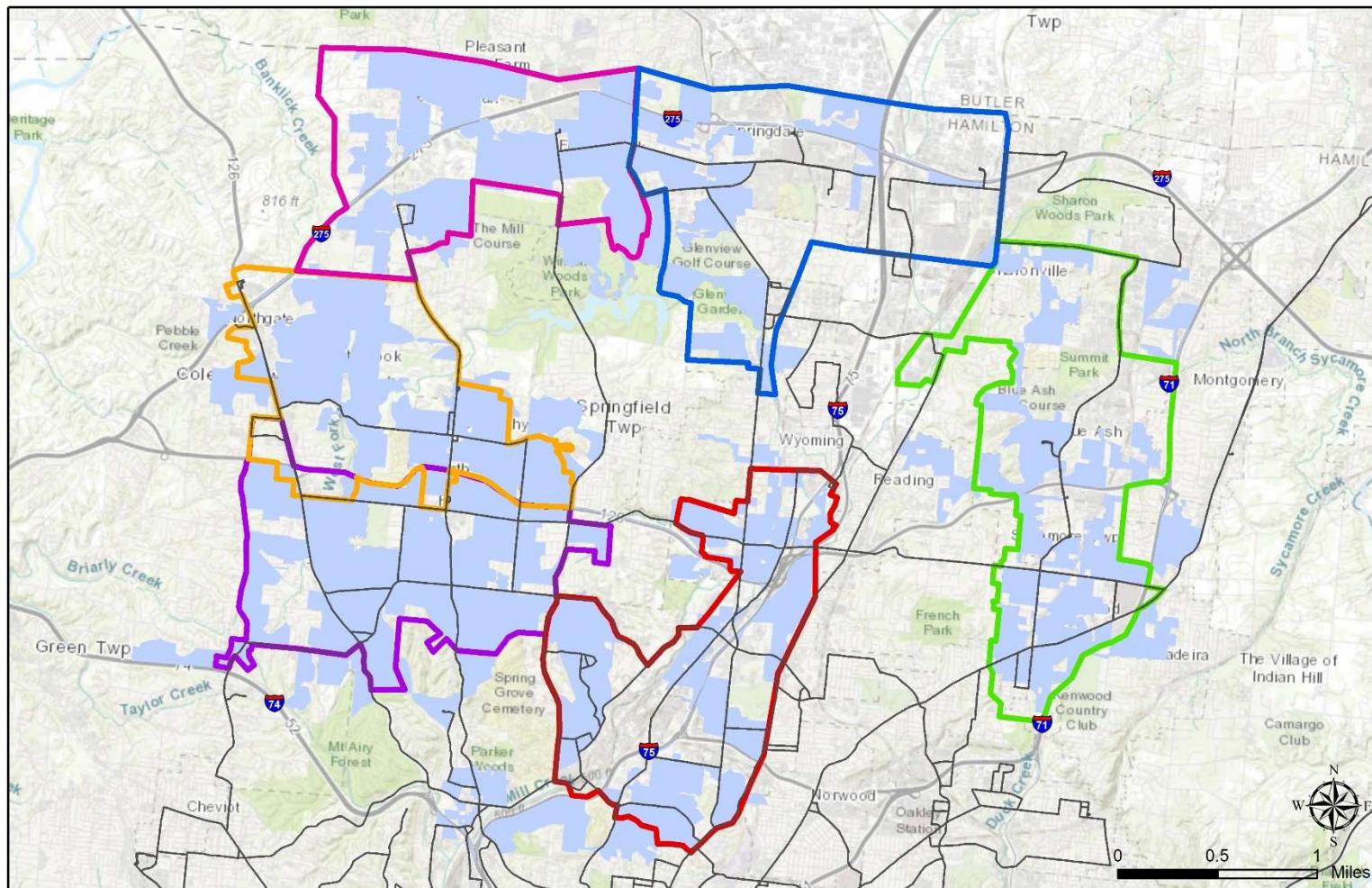

**MOD Zones**

-  MOD Zone A
-  MOD Zone B
-  MOD Zone C

-  MOD Zone D  Blocks - Five Groups at 5 Square Miles
-  MOD Zone E  Transit Routes
-  MOD Zone F

MOD Zones with High  
Need Census Blocks




**MOD Zones**

- MOD Zone A
- MOD Zone B
- MOD Zone C



MOD Zone D

Blocks - Five Groups at 8 Square Miles



MOD Zone E

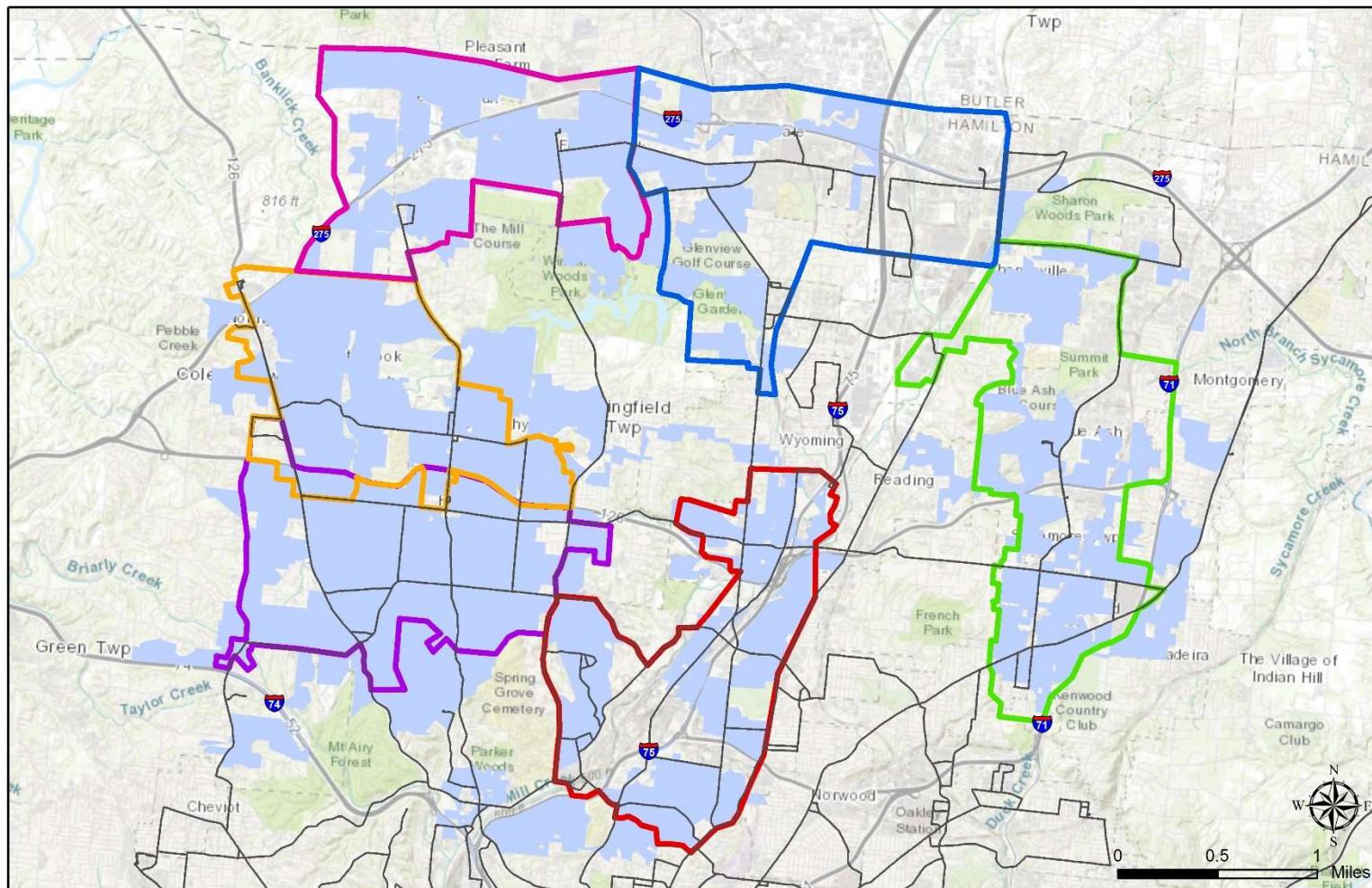
Transit Routes



MOD Zone F

MOD Zones with High  
Need Census Blocks




**MOD Zones**

-  MOD Zone A
-  MOD Zone B
-  MOD Zone C

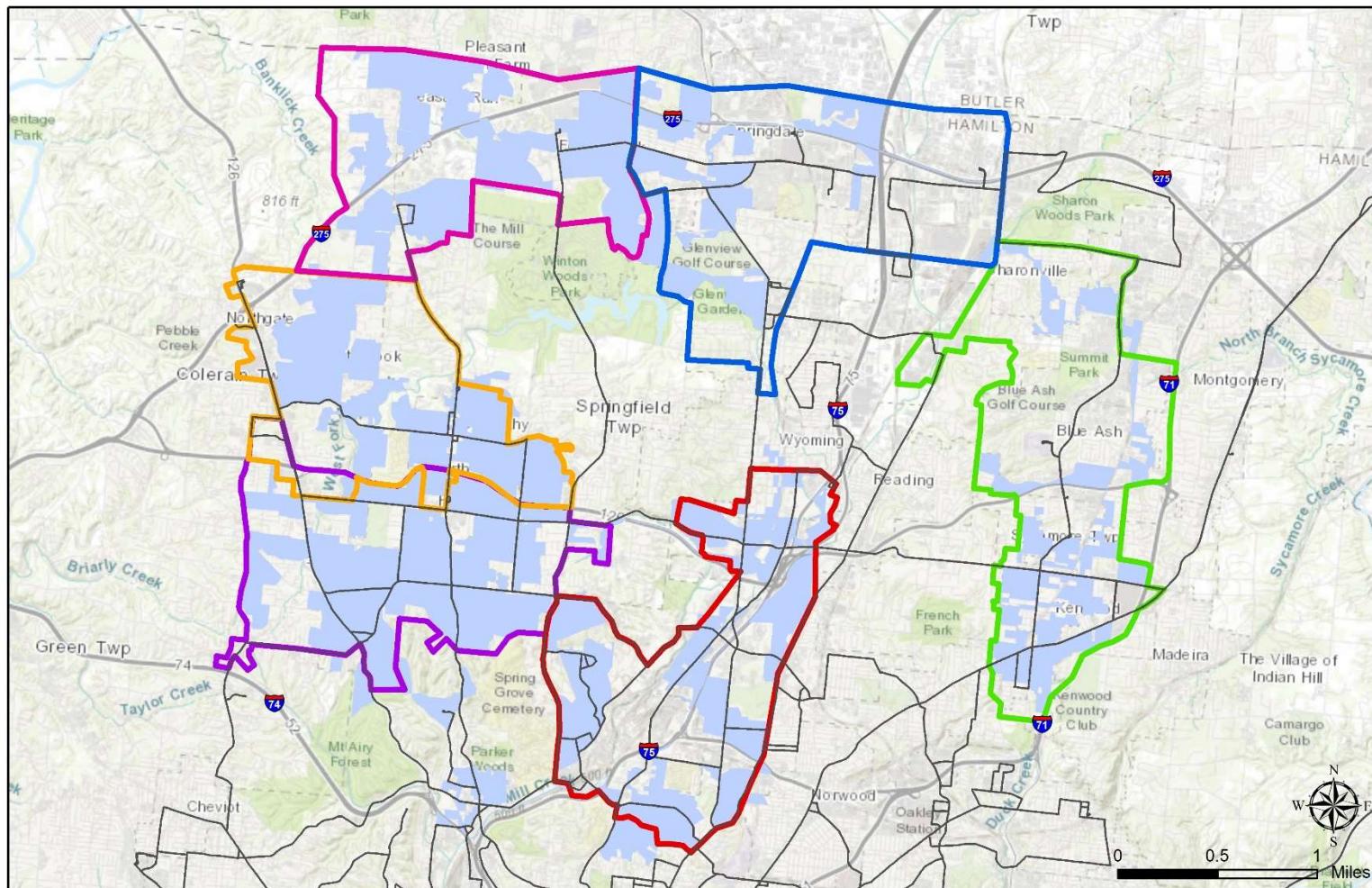
 MOD Zone D  Blocks - Five Groups at 10 Square Miles

 MOD Zone E  Transit Routes

 MOD Zone F

MOD Zones with High  
Need Census Blocks



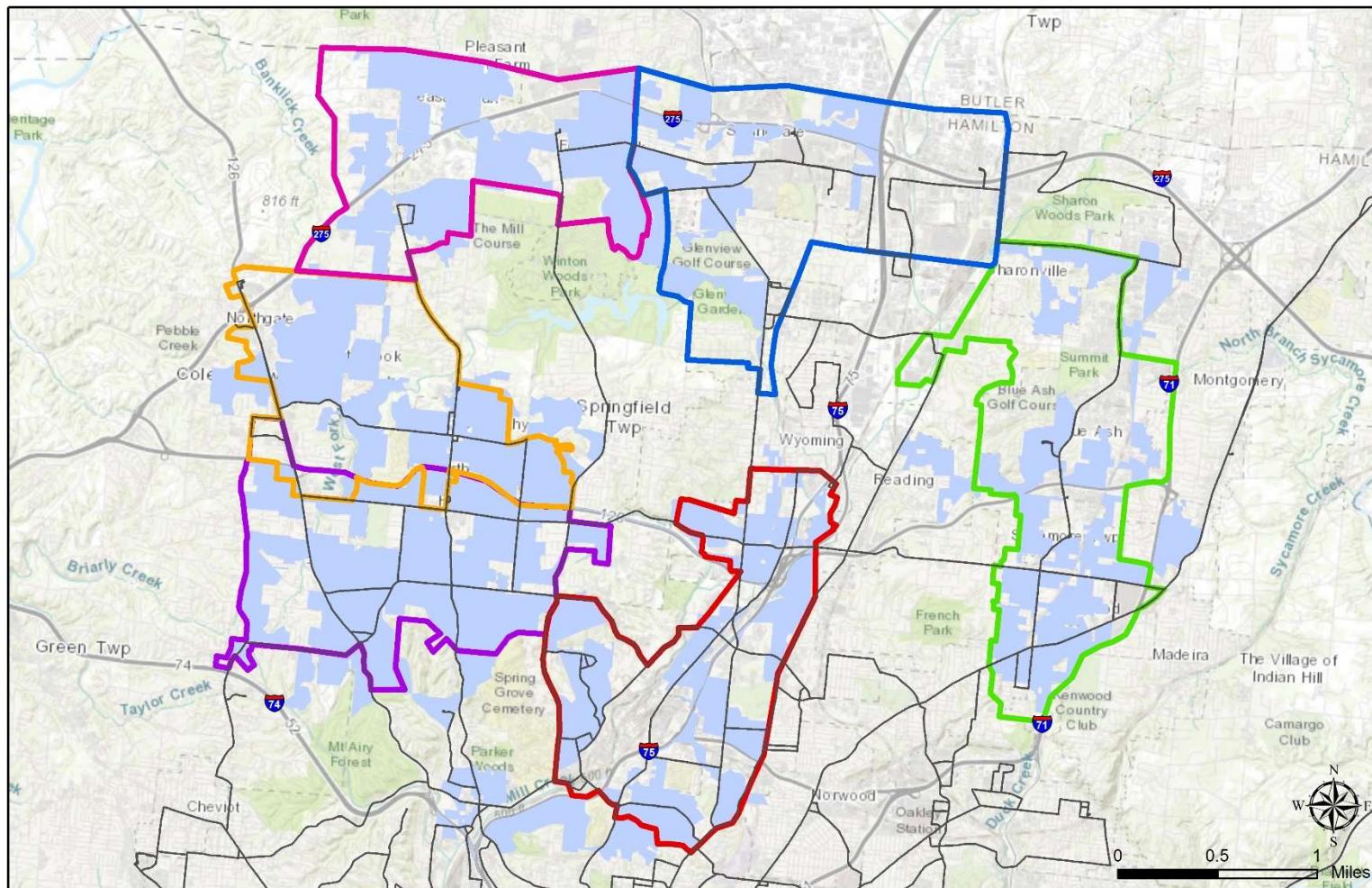

**MOD Zones**

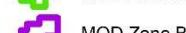
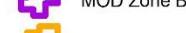
-  MOD Zone A
-  MOD Zone B
-  MOD Zone C

-  MOD Zone D  Blocks - Six Groups at 5 Square Miles
-  MOD Zone E  Transit Routes
-  MOD Zone F

MOD Zones with High  
Need Census Blocks




**MOD Zones**

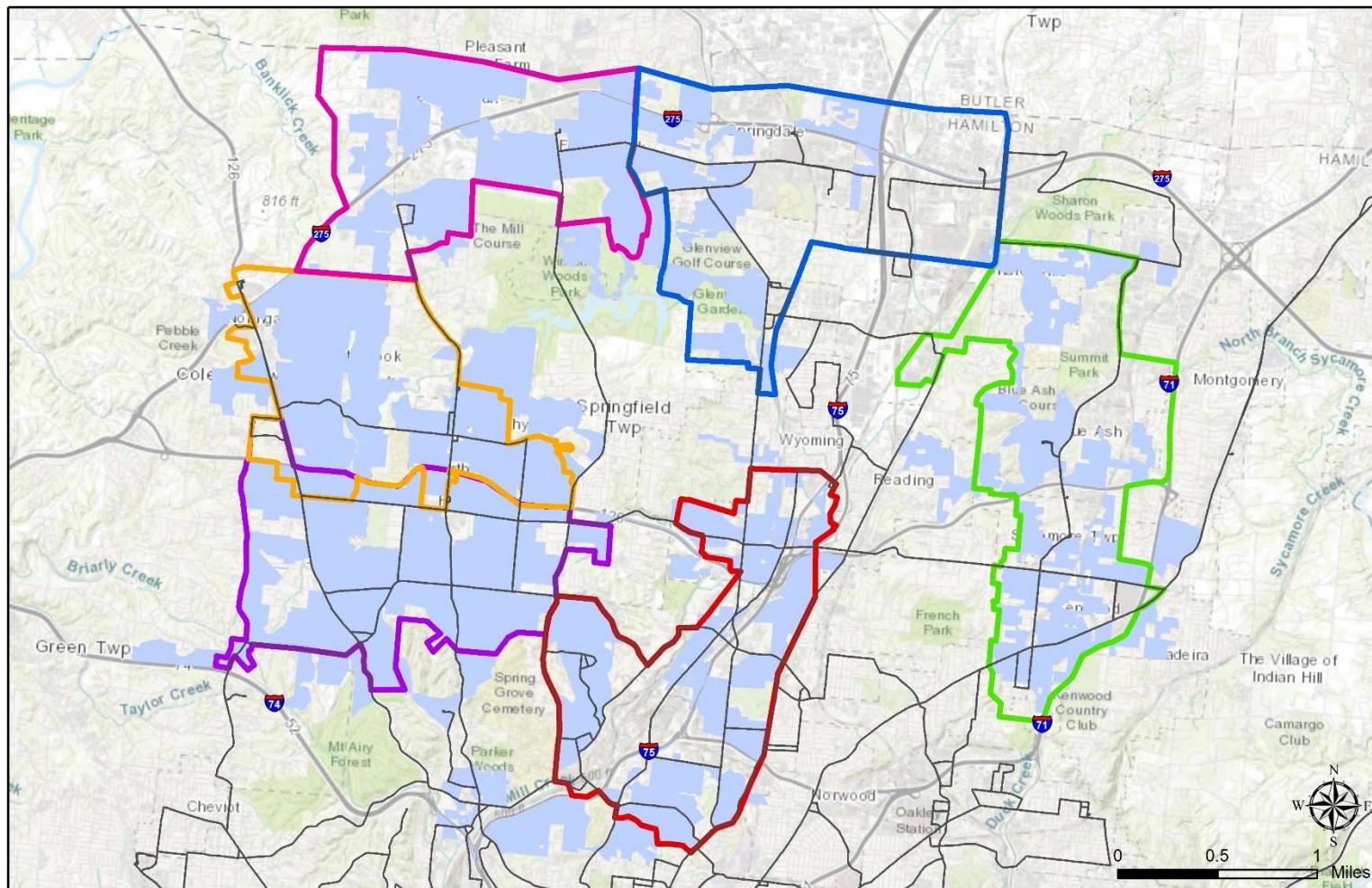
-  MOD Zone A
-  MOD Zone B
-  MOD Zone C

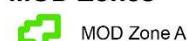
 MOD Zone D  MOD Zone E  MOD Zone F  Blocks - Six Groups at 6 Square Miles

 Transit Routes

MOD Zones with High Need Census Blocks




**MOD Zones**

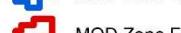
-  MOD Zone A
-  MOD Zone B
-  MOD Zone C

 MOD Zone D

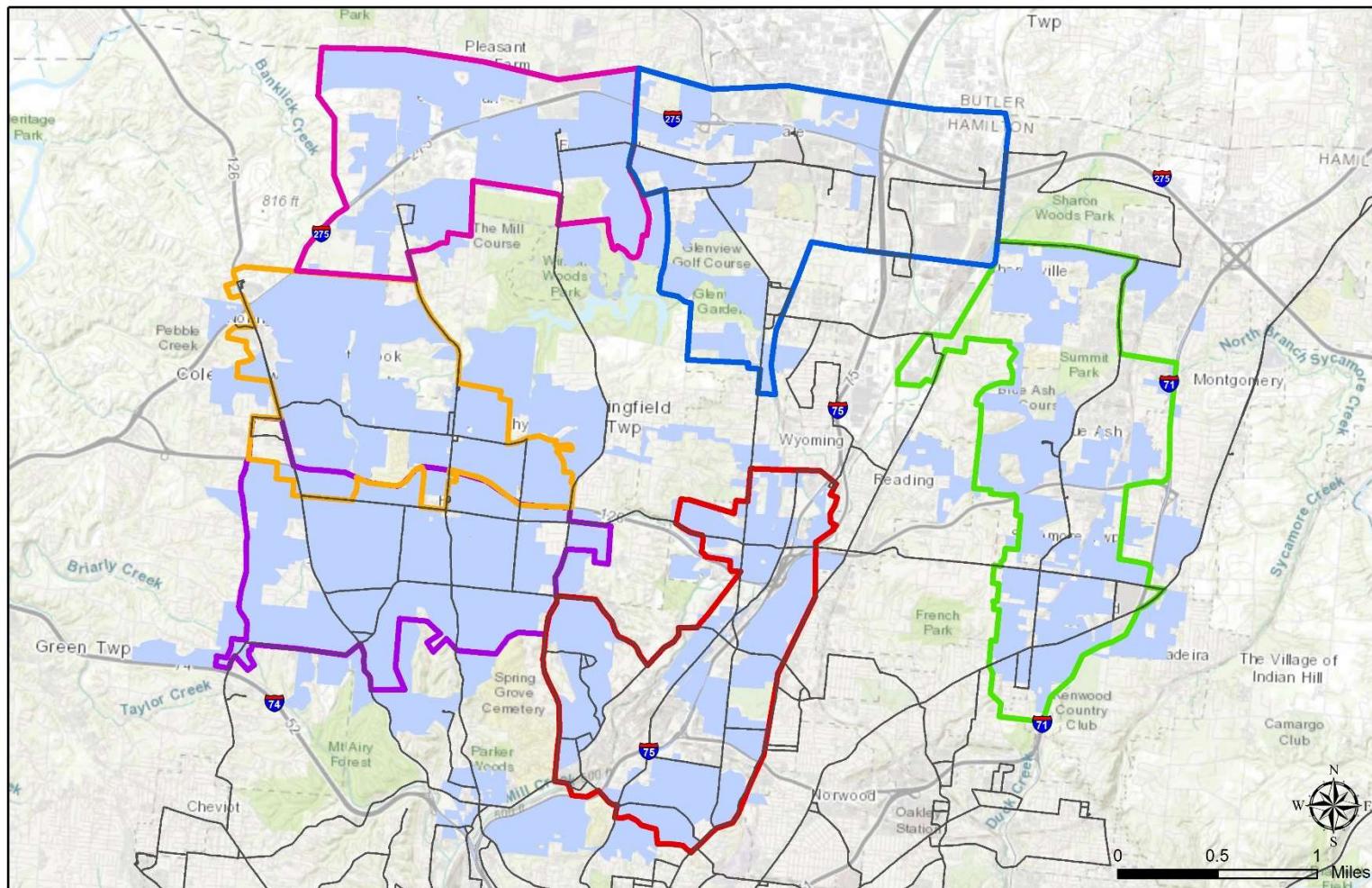
Blocks - Six Groups at 7 Square Miles

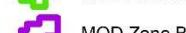
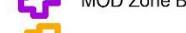
 MOD Zone E

Transit Routes

 MOD Zone F

 MOD Zones with High  
Need Census Blocks



**MOD Zones**

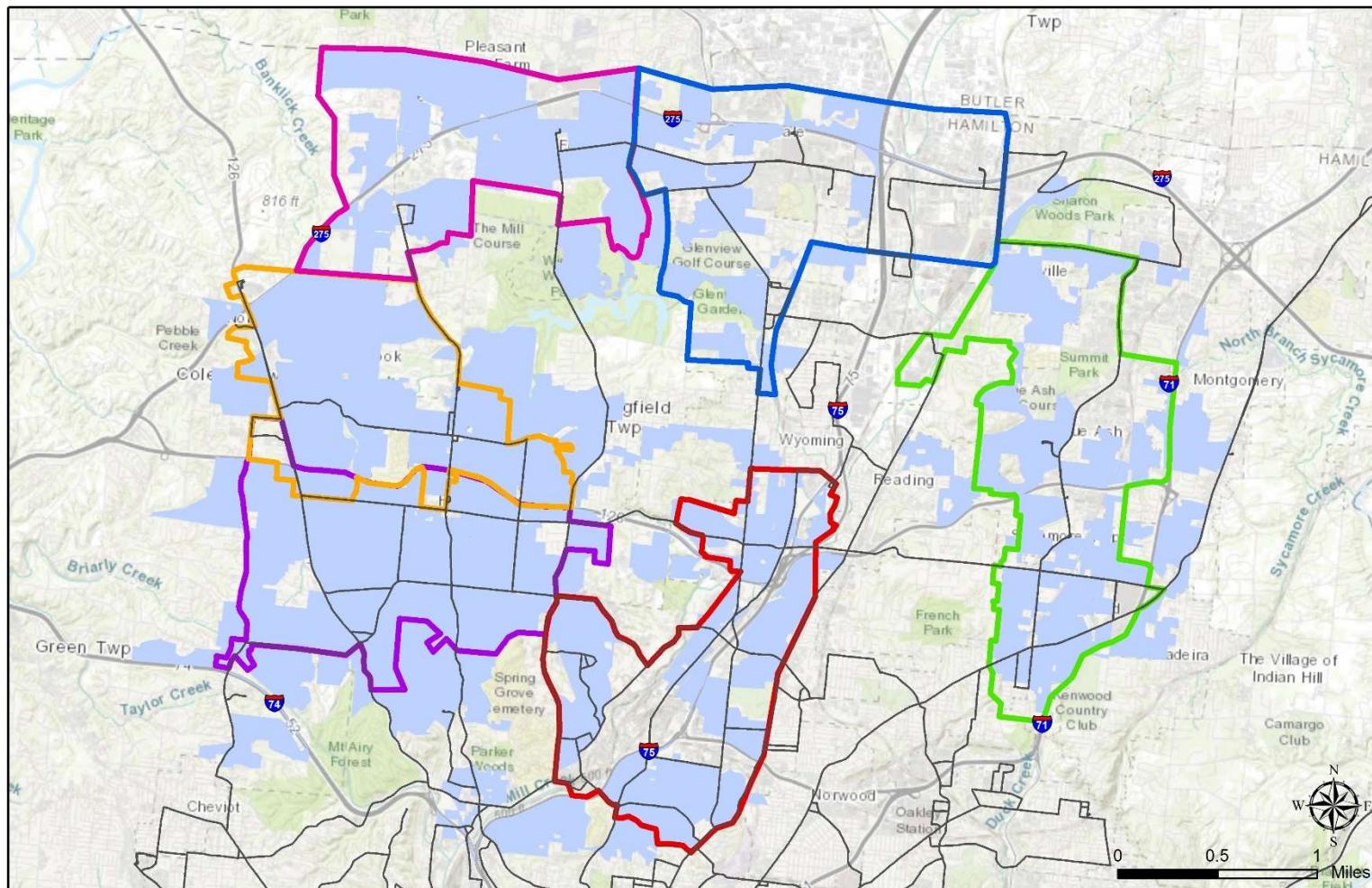
-  MOD Zone A
-  MOD Zone B
-  MOD Zone C

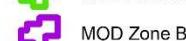
 MOD Zone D    Blocks - Six Groups at 8 Square Miles

 MOD Zone E    Transit Routes

 MOD Zone F

 MOD Zones with High  
Need Census Blocks



**MOD Zones**

-  MOD Zone A
-  MOD Zone B
-  MOD Zone C

-  MOD Zone D  MOD Zone E
-  MOD Zone F
-  Blocks - Six Groups at 9 Square Miles

MOD Zone D  Blocks - Six Groups at 9 Square Miles

MOD Zone E  Transit Routes

MOD Zones with High  
Need Census Blocks

