Kane County

RANDALL/ORCHARD CORRIDOR BUS RAPID TRANSIT FEASIBILITY STUDY

Final Report

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1 INTRODUCTION

Kane County embarked on this study to assess the future viability of implementing Bus Rapid Transit (BRT) in the Randall/Orchard Road Corridor. The corridor has traditionally served automobile travel, which is the dominant means of accessing businesses and services along the corridor. There currently is only limited transit service in the corridor. Kane County envisions the incremental implementation of high quality transit service as an integral part of transforming the Randall/Orchard Road corridor from an auto-dominated commercial corridor to a pedestrian-friendly, multi-modal corridor while promoting economic development and realizing benefits such as environmental and public health improvements. The envisioned BRT service would be part of a regional rapid transit network including express bus[1] service on I-90 between IL 72 and Schuamburg.

Incremental or phased implementation of BRT, along with transit-supportive land use and development, is among several options for reducing vehicle travel demand that have been recommended by past long-range plans in Kane County. One motivation is the projected severe traffic congestion that would remain by 2040 even after nearly $3 billion of arterial roadway projects, far in excess of available funding.[2] Around the U.S., jurisdictions are recognizing the need to adapt transportation corridors for a broader conception of local and regional mobility and pursuing transit system development as a key element of such efforts.

This is not a planning study or engineering plan for a specific BRT project, but rather a "what-if" examination of what changes would be needed in the corridor to support BRT and what benefits could be expected from incorporating this mode of transit along Randall and Orchard Roads. This report is organized as follows:

- **Chapter 1 – Introduction.** Provides a brief overview of BRT and the benefits of BRT. The BRT Primer (Appendix C) provides a detailed discussion of BRT characteristics.
- **Chapter 2 – Randall/Orchard Corridor Conditions.** Provides an overview of the corridor and its compatibility with BRT, and identifies future conditions needed to successfully accommodate BRT in the 2040 time frame.
- **Chapter 3 - Conceptual Randall/Orchard Corridor BRT.** Identifies a conceptual BRT alignment and station areas.
- **Chapter 4 – BRT Benefits.** Examines the potential benefits attainable from investing in BRT and fostering supportive land uses, including congestion, time and monetary, energy usage, environmental, public health and economic benefits of the identified BRT service and station area developments.
- **Chapter 5 – Conclusions and Next Steps.**
- **Appendices A and B** – List of Acronyms and Glossary.
- **Appendix C – BRT Primer.** The BRT Primer was developed to provide the Randall/Orchard Road BRT Task Force with background and context for the corridor visioning workshop (described in Chapter 3).

[1] BRT services planned by PACE are branded as Arterial Rapid Transit (ART)

[2] Kane County 2040 Transportation Plan

BRT OVERVIEW

General Characteristics of BRT

Bus Rapid Transit (BRT) is a high-quality transit service that integrates a variety of strategies aimed at improving transit travel speed, reliability, passenger comfort, and transit identity over traditional fixed-route bus service. These strategies include:

- **Dedicated running ways and/or transit signal priority (TSP).** Roadway and intersection improvements allowing transit vehicles to bypass congestion.
- **Enhanced stations.** High amenity stations including customer convenience, quick passenger loading and unloading, and BRT service branding elements.
- **Specialized vehicles.** Unique buses with customer amenities, high passenger-carrying capacity, and stylized to promote BRT service.
- **High quality transit service.** Service that is competitive with automobile travel including reduced transit travel times, long spans of service, high frequency of service, and connections to destinations off of the BRT corridor.
- **Enhanced fare collection systems.** Innovative fare collection tools and methods that streamline the time needed to collect fares, reducing passenger boarding times and therefore limiting delays at stops.
- **BRT branding.** Unique designs and promotion to separate BRT from local bus service and highlight it as quality service.

Source: Lane Transit District

BRT systems throughout North America employ a broad spectrum of these strategies based on available resources, corridor constraints and benefits desired. BRT systems are commonly differentiated by the range of strategies employed, falling into one of two primary categories: Full BRT and Rapid Bus. Full BRT employs many or all of the enhanced characteristics, most notably an exclusive or even segregated running way, while Rapid Bus is typically less capital-intensive, applying only targeted strategies. For a frame of reference, Pace's plans for Arterial Rapid Transit will operate more like Rapid Bus.

BRT has operating costs on par with local bus service. Operator labor costs may be slightly higher if high-capacity or sophisticated vehicles are used, or if senior operators are assigned to BRT services. These potential increases are typically offset by increased ridership (lowering the cost per rider) and by improved reliability (eliminating costs to run extra buses due to poor schedule adherence stemming from congestion). As with local service, BRT operations are typically funded from local revenues (primarily sales tax and fares in Kane County).

Capital costs for BRT service vary based on the strategies used. Dedicated running ways, high-end vehicles, sophisticated fare systems and full-featured stations have significant one-time costs associated with them. Capital costs are often offset by federal grants, but a number of systems typically compete for these funds.

Conditions for Successful BRT Projects

Successful BRT systems are often associated with the following four conditions:

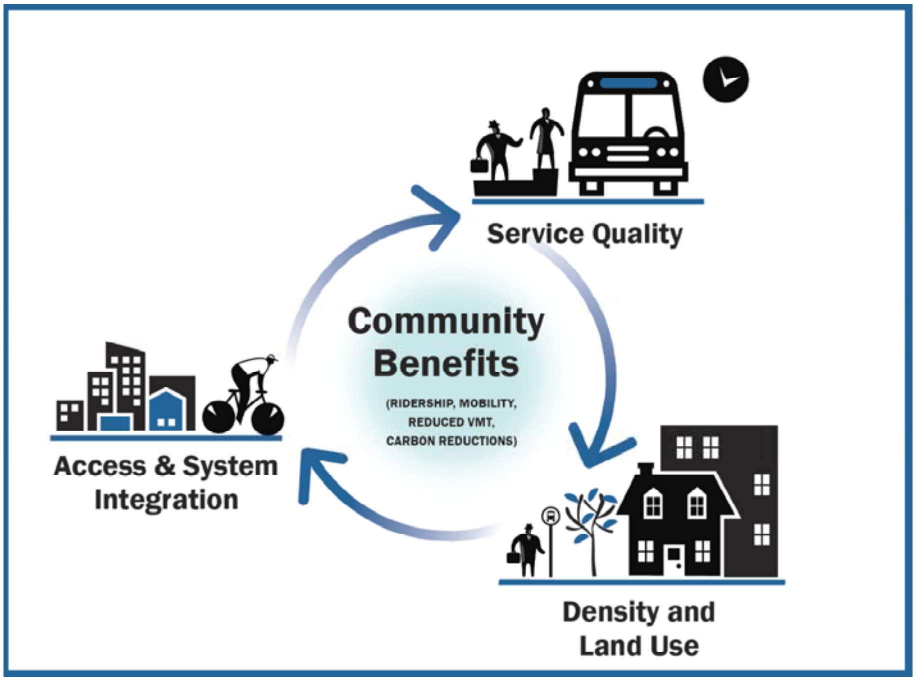
- **Transit supportive land uses.** Mixed-use developments (commercial, residential, and other uses) to support high levels of dwelling units, employment opportunities, and personal trip destinations near BRT station areas. Greater pedestrian and bicycle connections are offered within station areas.
- **Branding and marketing plan**. A coordinated program to brand BRT service and all of its physical elements (vehicles, stations, signage, etc.) to differentiate BRT from traditional bus service and promote it as a convenient and fast alternative to driving alone.
- **Multimodal connectivity**. Accessibility to BRT from all modes of travel including: good transit connections between BRT stations and other destinations located off of the BRT corridor, and convenient and safe bicycle / pedestrian paths and amenities.
- **Competitive with automobile travel**. Investments in transit speed and reliability to ensure that BRT vehicles can bypass congested roadways and intersections while also accessing desired destinations.

The element of reduced travel time is essential and is needed to attract riders from competing modes of travel. This is captured in the “rapid” component of bus rapid transit and the term is often reflected in the branding created for BRT systems. Reductions in transit travel time typically require a number of the previously described strategies including limited station spacing along with dedicated lanes, TSP, and streamlined fare collection.

As illustrated in the graphic below, the success of BRT or any other transit system along the Randall/Orchard Road Corridor is contingent on:

- Evolving from mostly single-use development to mixed-use residential and employment activities at sufficient intensities around identified station nodes to support frequent transit service.
- Establishing land use policies and guidelines to ensure consistent, transit-supportive development along the corridor.
- Integrating BRT service with local transit routes that serve the east-west corridors connecting Randall Road with residential areas and the downtowns of Fox Valley municipalities.

Figure 1-1 Transit, Land Use, and System Integration



There is a mutually supportive relationship between land use, access and system integration, and service quality from which community benefits from transit are derived.

Transit supportive land uses are the most critical condition. Research and experience have shown that increased development activity and providing access to quality transit service results in a greater use of transit, pedestrian, and bicycling modes of travel. In addition, average trip lengths in these mixed-use, Transit Oriented Developments (TODs) decrease for all modes, including auto travel. For BRT systems, transit-supportive developments are best focused around each station. These station areas are typically developed radially a half-mile around the station – the distance potential riders will typically walk for high-quality transit service.

Station area developments are best thought of as having a unique character or focus. A station typology, as shown in Figure 1-2, helps define the vision for each station area and helps balance the types and scale of uses throughout the many stations planned along a BRT corridor.

Figure 1-2 BRT Station Typology

Station Typology	Station Area Description
Core	• CBD-like land uses and development patterns • Able to sustain job and housing growth • Well-connected multimodal street grid and inviting pedestrian environment • High transit connectivity, including at least two high capacity transit (HCT) modes (e.g., Rail or BRT)
Mixed Use Employment Center	• Adequate mix of zoning capacity to support vibrant mixed use • Provides a regional employment base or draw, typically functions as a distinct residential or employment district • Bicycle and pedestrian friendly streetscape • At least 2 modes of 18 – 24 hour transit service
Mixed Use Residential Village	• Some but not all have zoning capacity necessary to achieve social and environmental goals • Smaller centers within the urban area, and no regional draws • Some but not all have high street connectivity • Secondary modes of frequent, high-quality transit service are not readily available and residents of the village station area make up the ridership base
Commuter	• Lack of zoning capacity, street connectivity or civic amenities • Peripheral station areas; often serve as transit line terminus or stop along the corridor • Often placed along freeway corridors or areas that make residential development difficult or unattractive • Park and rides are the key multimodal facility and feeder service is the key connective service into HCT
Destination	• Refers to an attraction that creates a large, single user base (such as hospitals, universities, large employment campuses) • Large variance in physical character and performance (density and zoning capacity) • Street connectivity varies by the type of attraction • Transit service varies by use (i.e., service to universities often looks like a bell curve, including strong midday demand, while employment campuses have frequent peak-hour transit service but lower midday demand)

Benefits of BRT

Transit agencies and communities in North America implement BRT to satisfy goals for mobility and greater level of service, as well as to leverage broader policy goals such as economic development, increased sustainability, and promotion of livable communities. Experience and research have demonstrated not only substantial time savings and increases in transit ridership relative to conventional bus service, but also highlight a number of community benefits associated with the implementation of BRT service including:

- **Congestion mitigation**. Increased ridership on BRT lines promotes the shifting of some trips from automobile use to transit, freeing up roadway capacity for other drivers and for the movement of freight. Similarly, development of transit-supportive land uses results in shorter trips for all modes – reducing vehicle miles traveled (VMT) per capita.
- **Cost effectiveness**. Higher capacity BRT vehicles lower the operating costs per rider.
- **Economic Development**
  - **Increased economic productivity**. Personal and employee time savings resulting from time not spent idly in traffic.
  - **Improved economic opportunities.** Increased mobility options expand employment opportunities and reduce commuter transportation costs.
  - **Revitalization**. TOD development around stations can revitalize aging commercial areas creating economic opportunities and enhancing tax revenues for local jurisdictions.
  - **Increased land values**. Investments in high-capacity transit stations and other infrastructure improve access, attract development, and increase land values.
  - **Job creation.** Capital investments in BRT infrastructure support local construction, planning and design jobs.
- **Air quality**. By shifting trips to transit and shortening trip lengths, the combination of BRT and transit supportive land uses reduces tail pipe emissions per capita, improving air quality and reducing greenhouse gas (GhG) emissions.
- **Community Health**. BRT and stations areas incorporating TOD concepts support active living goals by encouraging bicycling and walking to reach transit or for entire trips.

Based on the desired benefits, Bus Rapid Transit can employ a variety of technology and amenity packages ranging from Rapid Bus to Full BRT components. Whatever transit strategies are employed to serve the Randall/Orchard Road Corridor, BRT, in conjunction with coordinated land use planning, can help build thriving, livable communities in Kane County.

2 RANDALL/ORCHARD CORRIDOR CONDITIONS

This chapter provides an assessment of the Randall/Orchard Road corridor as relates to the long-term vision for BRT service along the corridor. BRT is envisioned as a mechanism for transforming Randall/Orchard Road from an auto-dominated commercial corridor to a pedestrian-friendly, multi-modal corridor and promoting economic development in the corridor. The assessment discusses constraints and opportunities for BRT-supportive development, which are summarized in a table at the conclusion of the chapter.

Corridor Overview

The Randall/Orchard Road corridor runs for approximately 31 miles between the north and south boundaries of Kane County, between about one and three miles west of the downtowns of Fox Valley municipalities. Figure 2-1 highlights the corridor on a map. By car, travel time along the corridor is slightly more than an hour from end-to-end under normal driving conditions. Both Randall Road and Orchard Road are classified as Strategic Regional Arterials (SRAs)[3] and there is significant demand for access to destinations along the corridor, segments of which carry up to 60,000 vehicles per day.[4] Land use along the corridor is a mixture of suburban and rural character with primarily retail and commercial uses directly along the corridor and pockets of undeveloped and/or agricultural lands. There is significant residential development along the corridor, consisting primarily of low-density single-family dwellings. There are several concentrations of major employers and industrial parks. Medical institutions are a major presence in Kane County. In particular, Sherman and Delnor Hospitals are two major medical facilities located directly on Randall Road, and Provena St. Joseph Hospital and Provena Mercy Medical Center are near the corridor.

Transportation and Access

Overall, the existing character of the corridor and development along it pose significant challenges to developing it as a transit corridor. Since BRT service has fewer stops than local bus service, integrating high-quality pedestrian and bicycle networks into new BRT stations is a critical element of successful BRT implementation. The difficulty of making pedestrian and bicycle connections along and across the Randall/Orchard Road corridor is one of the major impediments to transit service today.

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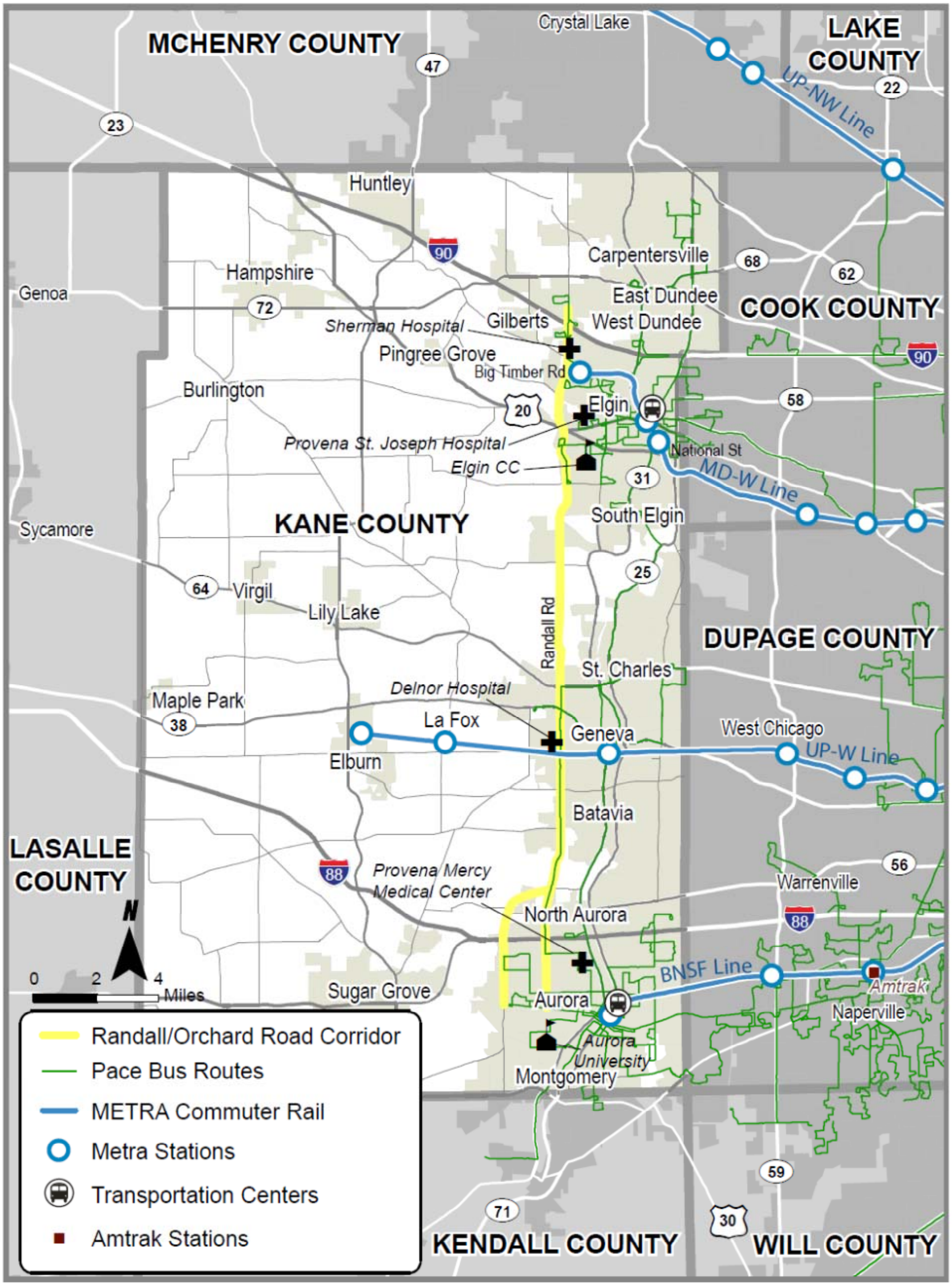
[3] The Illinois Department of Transportation (IDOT) defines Strategic Regional Arterials as part of a "network of highways designed to accommodate long distance regional traffic, to complement a region's major transit and highway facilities," differentiated by urban, suburban, or rural environments. IDOT emphasizes the "need for cooperation among local governments and regional transportation agencies in coordinating land development" along SRAs and that "land use planning techniques can also encourage use of alternative modes of transportation, with policies favorable to mixed-use development." Source: IDOT, Bureau of Design & Environment Manual - 2002 Edition, Chapter 46.

[4] Kane County 2040 Transportation Plan

Figure 2-1 Corridor Area Map



Source: Kane County, ESRI, Census 2000

Expansive Corridor Cross-Section. Randall Road has four travel lanes (two in each direction), with six lanes along some stretches, and is highly variable in width. Pavement width (excluding shoulders) varies from 52 feet (4-lane section with 4-foot striped median) to up to 112 feet (6-lane section with dual left-turn lanes, a 4-foot barrier median, and right-turn lanes).

Inconsistent or Missing Sidewalk Infrastructure. Sidewalks conditions along Randall Road vary. Sidewalks often do not exist or are discontinuous, may be deeply setback from the roadway, or do not provide a complete path to transit stops or intersections, including curb ramps at each street corner. The most comfortable walking environments use street trees or on-street parking to create a buffer or physical separation between pedestrians and vehicles; these features also serve a traffic calming function, discouraging excessive driving speeds. Although the corridor lacks these features, there is generally right-of-way between existing sidewalks and the curb that could be used to plant trees or provide landscaping that would create this separation. Pace has received an $800,000 Federal Transit Administration (FTA) grant to fund infrastructure improvements such as bus shelters, bus pads, and sidewalks for Pace Route 529 along Randall Road.

Figure 2-2 Disconnect between Sidewalks and Transit

A deeply setback sidewalk along Randall Road does not serve the intersection or existing transit stop.

Source: Nelson\Nygaard

Large Setbacks. Buildings along the Randall/Orchard Road corridor are typically separated from the roadway by parking lots or green space. Large setbacks increase walking distances from transit stops, green space or landscaped areas that lack sidewalks or other walking paths impede accessibility, and traversing a vast expanse of parking on foot can be an unpleasant walk. In contrast, building up to the sidewalk line with windows and doors that face the street makes walking along the corridor more interesting, engaging, and safe. However, the existing setbacks may provide an opportunity for linear infill development along the corridor and to develop pedestrian and transit infrastructure in conjunction with a transit project.

Figure 2-3 Examples of Large Setbacks along Randall Road

Large setbacks for major institutions that are potential transit node anchors and much of the existing retail development are a barrier to existing local bus service but could provide right-of-way for future transit and pedestrian infrastructure.

Source: Nelson\Nygaard

Challenging Crossings at Signalized Intersections. Crossing a corridor as wide as 112 feet on foot within the duration of a traffic signal cycle can be challenging to pedestrians, especially if they have any impairment affecting their walking speed. Many signalized residential intersections lack crosswalks altogether. At commercial intersections with crosswalks, the curb design can significantly extend the crossing distance, such as to 160 feet at Bricher Road near Geneva Commons, as shown in Figure 2-4. Assuming a pedestrian walking speed of 3 to 4 feet per second, about 40-55 seconds would be required to cross Randall Road at this location. Pedestrian bulbouts and median refuges are examples of crosswalk design solutions that reduce the required pedestrian crossing distance and exposure to motor vehicles.

Figure 2-4 Crossing Distance, Randall Road at Bricher Road

Intersection design features such as curb extensions (bulbouts) or median refuge islands improve pedestrian safety by reducing pedestrian crossing distances and time in the intersection exposed to motor vehicle traffic.

Source: Google Maps

Lack of Street Crossings between Intersections. The distance between signalized intersections ranges from 0.2 to 0.4 miles through commercial areas (such as in Batavia or St. Charles) to a half mile or more (such as near Delnor Hospital and Geneva Commons). These distances are too long to allow transit riders to conveniently cross Randall Road at signalized intersections alone and there are no marked crossings between intersections. The County's typical access spacing for an SRA is 0.25 to 0.33 miles in commercial areas and 0.33 to 0.5 miles in residential areas.[5]

Figure 2-5 Long Intersection Spacing

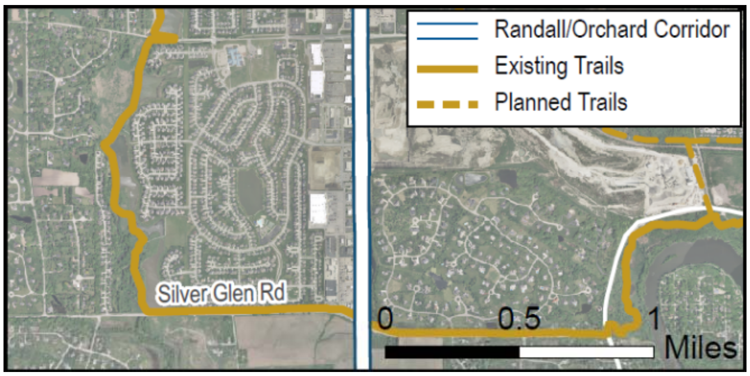
Along Randall Road in St. Charles, the intersection spacing of approximately a third of a mile between Main St. (IL 64) and both Dean Street to the north and Oak Street to the south is typical of the corridor.

Source: Nelson\Nygaard

[5] Kane County Division of Transportation, Permit Regulations and Access Control Regulations, 2004

Lack of Pedestrian Connectivity to/from Adjacent Residential Developments. Residential developments along the corridor assume auto-oriented access to the corridor and do not have pedestrian connections to Randall Road. These developments often "turn their backs to the corridor," are separated from the corridor by fences, and/or do not have a strong internal street grid. These characteristics lead to indirect pedestrian routes and longer walking trips than most transit riders would be willing to make. The generally long stop spacing of BRT compared to local buses exacerbates both the lack of connectivity and lack of street crossings, since BRT would likely not be able to stop at each east-street connecting to the corridor. In Figure 2-6, the development east of Randall Road lacks good pedestrian access to the corridor, while west of Randall Road the development provides both a street connection and pedestrian cut-throughs from the cul-de-sacs just north of Silver Glen Road.

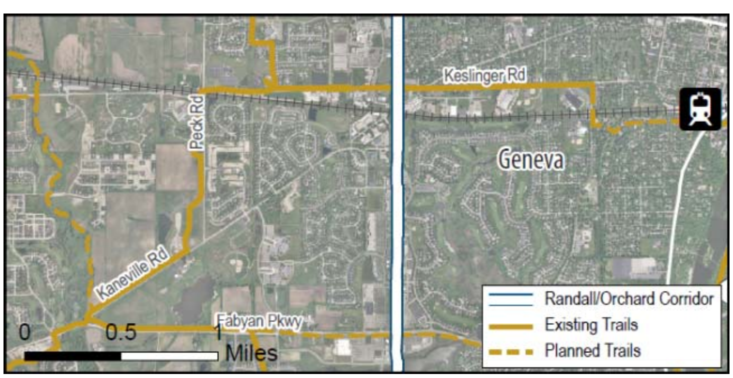
Figure 2-6 Pedestrian Connectivity from Residential Developments



Data Source: Kane County

Regional Trail System Parallel to the Corridor. The regional trails adjacent to the Randall/Orchard Road corridor present an excellent opportunity for accommodating bicycle and pedestrian access to the corridor, particularly given challenging on-street bicycle and pedestrian conditions in many locations. One example can be seen in Figure 2-7, where the existing and planned (dashed line) trails could serve a feeder function to BRT stations along Randall Road (the corridor maps included at the end of this document illustrate trails for the entire corridor). However, to provide safe transportation to and from Randall Road, these trails may require safe street crossings, additional wayfinding, and completing planned and other missing segments. In addition, regional trails would require complementary bicycle and pedestrian facilities along and across the corridor to provide local access to transit stations and other destinations.

Figure 2-7 Regional Trail Connection Example



Data Source: Kane County

LAND USE

The connection between transit and land use refers to the mutually supportive relationship between quality of transit service, land use (density and form), and pedestrian and bicycle access to transit, illustrated in Figure 1-1 (above). Retail and employment destinations and several major institutions located along the Randall/Orchard Road corridor make it a major attractor for employees and residents accessing services. However, low-density and auto-oriented land use patterns limit the current ability to provide effective transit service. Transit accessibility to existing development along the corridor is limited by curvilinear and loop street patterns and lack of direct connections to Randall Road that increase walking distances to/from transit in the case of residential subdivisions, and by large setbacks in the case of commercial development. Although the uneven distribution of development and challenging pedestrian accessibility along the corridor is an impediment to local fixed-route bus service under existing conditions, the availability of large expanses of undeveloped land around potential station areas, along with redevelopable parcels, creates a future opportunity to increase development densities and improve pedestrian and bicycle access in the medium to long-term.

The success of BRT or any other transit system along the corridor is contingent on:

- Evolving from mostly single-use development to mixed-use residential and employment activities at sufficient levels around identified station nodes to support frequent transit service.
- Establishing land use policies and guidelines to ensure consistent, transit-supportive development along the corridor.
- Integrating BRT service with local transit routes that serve the east-west corridors connecting Randall/Orchard Road with residential areas and the downtowns of Fox Valley municipalities.

Low-rise multifamily homes (as shown above) and single-family homes on narrow lots can lead to modest density increases. Together with two- to four-story mixed use buildings, this type of development can increase density to rates supportive of high quality bus service.

Source: Nelson\Nygaard

BRT AND THE IMAGE OF RANDALL ROAD

Branding and marketing are critical to the success of transit in attracting "choice" riders – those who own or otherwise have access to a vehicle for making any particular trip. The marketing of a BRT service could capitalize on several elements of Randall Road's image. Most importantly, Randall Road provides access to commercial and institutional (particularly medical) destinations that Kane County residents *want* to access. People live along and access the corridor from clusters of development around the corridor. Randall Road is also a direct north-south route through the County, running a few miles or less from Fox Valley town centers and Kane County's Metra stations. Congestion along the corridor, a result of the desirability of destinations along and near the corridor, is also synonymous with its image. The Kane County 2030 Transportation Plan projects that Randall Road will see significant growth in traffic and segments with "extreme congestion" by 2030. Competitive and reliable travel times are key factors in enabling transit to compete with automobile travel and make transit attractive to commuters. To successfully market itself as an alternative to driving, BRT will need to be implemented with transit priority features and running way options that allow it to bypass traffic congestion, stay on schedule, and provide competitive travel times with automobiles.

While the above aspects of the corridor lend themselves to marketing BRT service, Randall Road is also known for poor walking conditions, which detract from the image of a transit corridor and would need to be addressed through design of BRT service and its marketing. Given that many Kane County residents do not look toward transit as a personal option, creating a positive image for BRT and marketing it as a premium service will also be essential for changing existing attitudes and attracting riders. A successful marketing strategy will also ensure that all aspects of the BRT system are easy for passengers to navigate, particularly first-time riders, including transfers to connecting transit services. The distinct identity of BRT should be evident in passenger information, yet its schedules and route maps should also be integrated and coordinated with all connecting transit routes and systems.

TRANSIT ACCESS AND INTEGRATION

This section addresses opportunities and constraints affecting access to BRT service along the Randall/Orchard Road corridor and integration of BRT with bus and Metra service and stations in Kane County.

Direct Connections to Major Activity Centers

Major activity centers in Kane County that could feasibly be served by a Randall/Orchard Road corridor BRT service are those that are located directly along the corridor or could anchor one end of the route. If BRT service branches[6] off of the corridor to reach an endpoint, activity centers could also be served enroute to the endpoint. A major strength of BRT relative to rail modes is its flexibility, allowing buses to provide direct service to multiple locations near either end of the route while providing the highest frequency service along the core of the route. Examples of such locations include:

[6] Branching is a strategy that allows transit lines with different endpoints to use the same route for the bulk of their run when there are multiple options for endpoints.

- **Existing Transportation Centers.** The transportation centers in downtown Aurora and downtown Elgin are key locations for connecting to both local bus and Metra commuter rail service; it would be important to integrate BRT with both transportation centers as part of a branch and/or with connecting transit service.
- **North Kane County.** In the northern part of the county, other activity centers and potential options for routing BRT service include Algonquin, Upper Fox Valley municipalities, and Huntley. From Algonquin, an extension into McHenry County would be possible and is included in Pace's map of long-term Arterial Rapid Transit (ART) corridors. Sherman Hospital is a key activity center located along the corridor. Elgin Community College is also a significant activity center but would need to be served as part of a branch.
- **South Kane County.** In the southern part of the county, activity centers and possible BRT routing options include Montgomery, along a proposed extension of the Metra BNSF line to Oswego (in Kendall County), Sugar Grove, and other locations in Kendall County. Negotiation of costs would be necessary for any extension into Kendall County, since it is currently not part of the six-county RTA service area.
- **Middle of the Corridor.** The middle part of the Randall/Orchard Road corridor is the core of the route, making it less feasible to provide direct BRT service to activity centers that are not located directly on Randall Road, including the downtowns of St. Charles, Geneva, and Batavia, which are located east of Randall Road, and the Kane County Judicial Center located west of Randall Road. Delnor Hospital is a major activity center located on the corridor, and could be served directly.

Connecting Transit Service

Other transit service would connect BRT stations to activity centers that cannot be served by BRT directly. Existing Pace bus routes in Kane County are illustrated in Figure 2-1 (above). The only existing transit connections between Fox Valley municipality downtowns and Randall Road are in Aurora, St. Charles/Geneva, and Elgin. Current service levels in the St. Charles/Geneva area lack the frequency and hours of service to integrate with BRT along the Randall/Orchard Road corridor, although the quality of service could be improved by 2040. BRT would likely increase demand for service both on existing transit corridors and other east-west corridors that connect to Randall Road but are not served by transit. In the Fox Valley, examples of these corridors are in Batavia, South Elgin, and Carpentersville. Although there is no existing fixed route bus service west of Randall Road, similar demand could be expected in municipalities such as Huntley and Sugar Grove. Frequent east-west circulator service connecting BRT stations along Randall Road with established downtowns, including the Geneva Metra station, would be one approach to meeting the connectivity needs that would accompany BRT service on the Randall/Orchard Road corridor. In addition, BRT on the corridor could connect with potential future BRT service on I-88 and I-90. BRT service on I-90 (between IL 72 and Schaumburg) is planned to begin operations by 2016.

Metra

The three Metra lines serving Kane County, shown in Figure 2-1 (above), attract significant regional travel demand, however the Metra stations/lines are not well connected to one another by transit service. A north-south BRT line connecting the Metra stations would improve regional transit access, however Randall Road is west of the existing stations on the BNSF and MDW lines and between the Geneva and La Fox stations on the UPW line. The following are opportunities and constraints for integrating BRT service along the Randall/Orchard Road corridor with existing Metra stations in Kane County:

- **BNSF Line.** Randall Road is slightly less than 2.5 miles west of the Aurora Transportation Center (ATC), the current terminus of the BNSF line; Orchard Road is about 3.5 miles west of the ATC. As discussed above, since Aurora is near the southern end of corridor, ATC could be a logical termination point for BRT service.
- **UPW Line.** Along the UPW Metra line, Randall Road is over 1.5 miles west of the Geneva Metra station and over 3.5 miles from the La Fox Metra station. Since the Geneva Metra station is located in the middle of the Randall/Orchard Road corridor, it would likely be infeasible for BRT to serve it directly but could be linked via connecting transit service.
- **MDW Line.** The Big Timber Road station on the Metra MDW line is the closest station to Randall Road, slightly less than a 0.5-mile straight-line distance, presenting both an opportunity for development around of significant node with both BRT and Metra service and a constraint in that the walking distance between the existing Metra station and a BRT station directly on Randall Road may preclude an easy transfer between the two services. The Elgin Transportation Center is about 3 miles from Randall Road, but as discussed above would be logical to integrate with BRT service, as a possible station or endpoint for a branch of BRT service and/or via convenient connections with other transit routes.

Municipalities in Kane County have been working on station area plans in anticipation of future Metra Commuter Rail extensions (of which some are included in the CMAP Go To 2040 plan while others are not). If these extensions are developed, they could present future opportunities to integrate BRT along the Randall/Orchard Road corridor with Metra. These opportunities include jointly developing BRT and Metra stations along the potential extensions. In addition, along the existing UPW line it may be possible to develop a Metra station along Randall Road (between the downtown Geneva and La Fox stations) in conjunction with a BRT Randall/Orchard Road BRT project.

Bicycle and Pedestrian Access

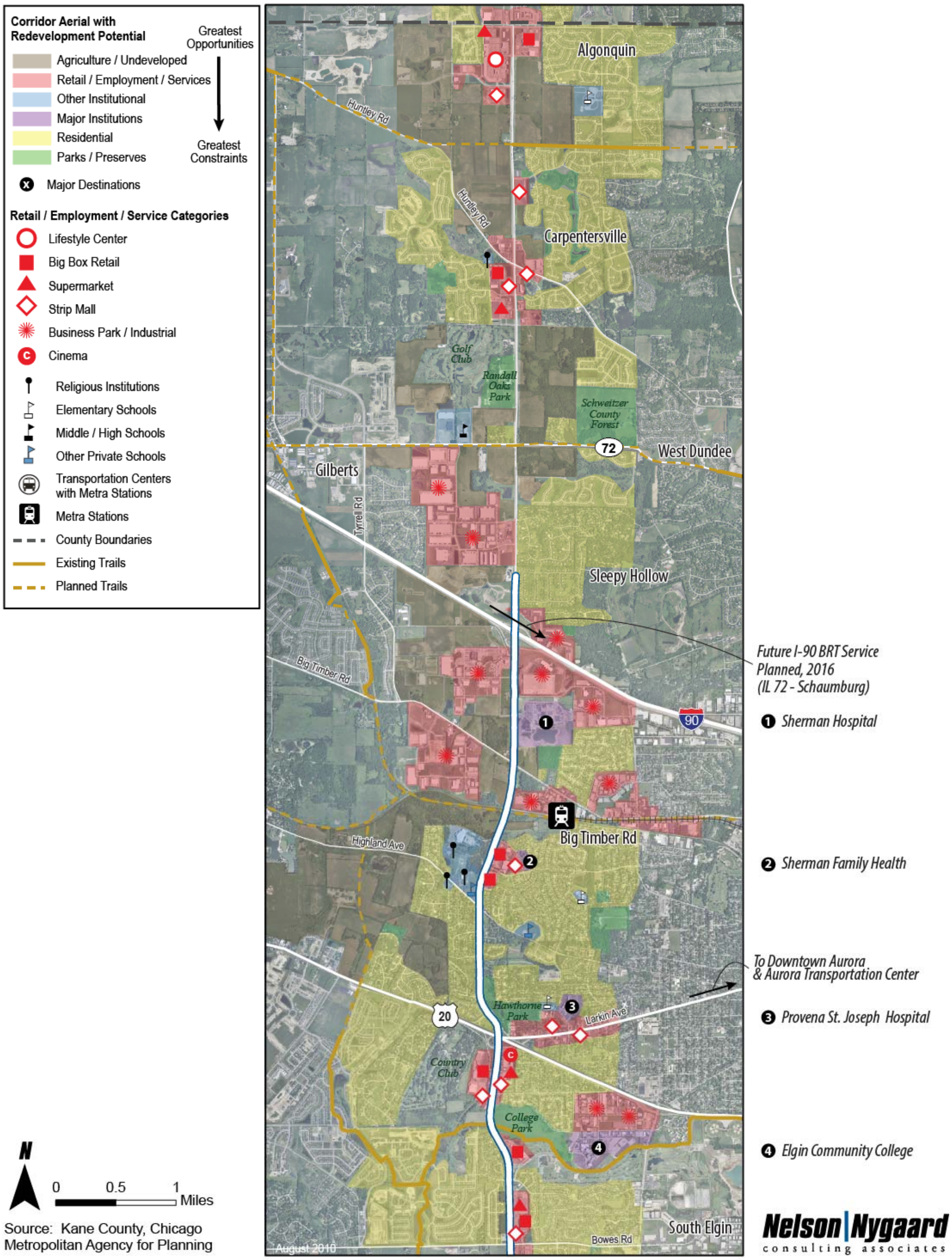
As discussed above, current conditions for bicycling and walking along the Randall/Orchard Road corridor are a major constraint for the success of BRT. In addition to improving pedestrian infrastructure (e.g., sidewalks and crossings) along the corridor and in station areas, developing continuous, alternative bicycle and pedestrian facilities connecting station areas and associated land uses along the corridor present a key opportunity for BRT. The existing and planned regional trail system in Kane County could be integrated with BRT service on the Randall/Orchard Road corridor to serve short-to-medium distance connections, and would tie-in to the County's goal of encouraging "active" transportation and helping residents realize the public health benefits of walking and bicycling. While pedestrian access to transit is generally considered to fall within a range of 0.25 to 0.5 miles, bicycle access trips can range from 1.5 to 3 miles. High-quality facilities such as trails can further extend this range. Complete aerial photographs of the corridor that illustrate the countywide trail system are provided below.

CORRIDOR OPPORTUNITIES AND CONSTRAINTS

The following maps, dividing the corridor into thirds (north, center, and south), illustrate existing land uses on aerial photos of the corridor. The overlays on the aerial photos illustrate the high-level land uses along the corridor, with an emphasis on identifying opportunities and constraints with respect to the location of potential BRT stations area developments:

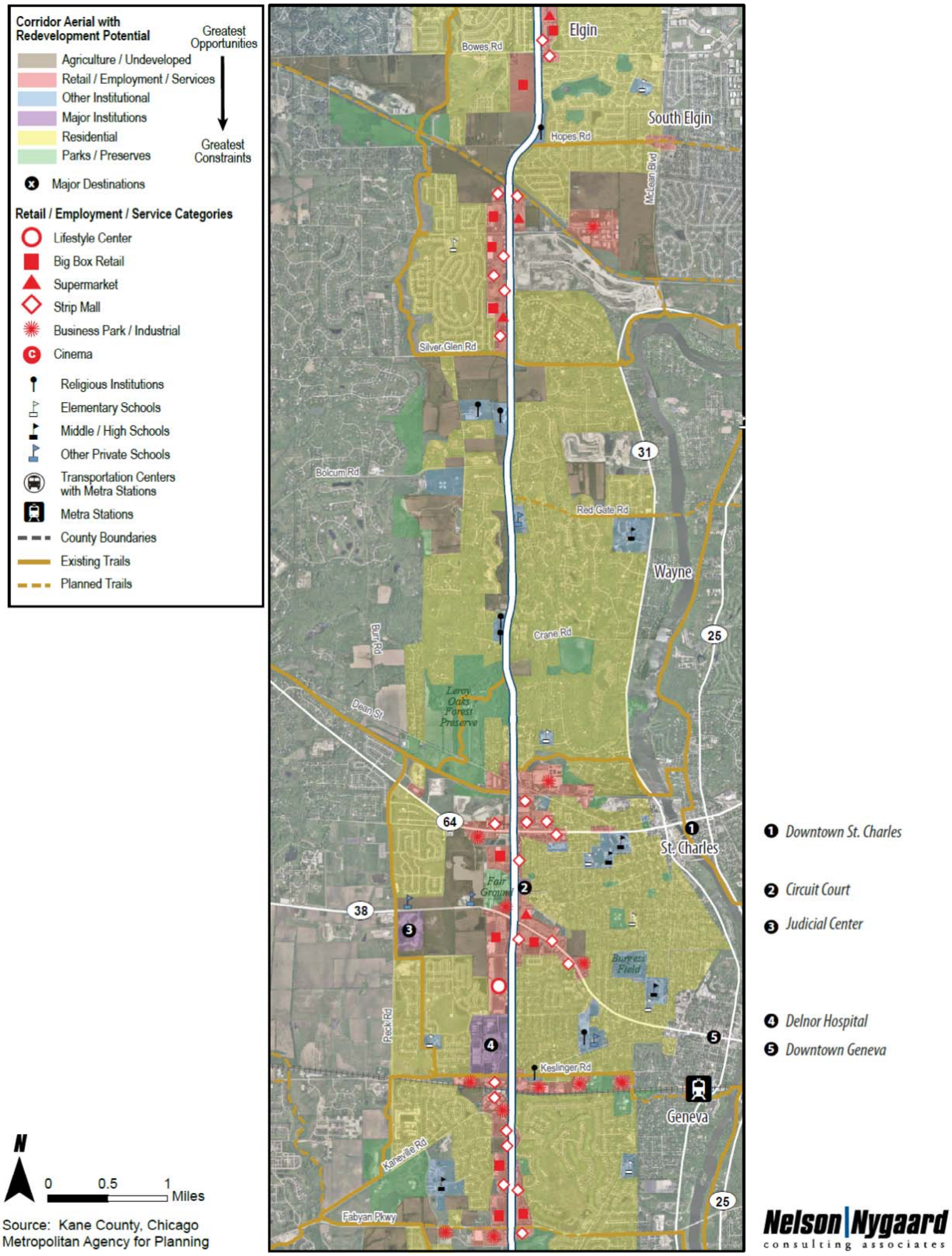
- Undeveloped land and retail, employment, or services uses generally offer the greatest potential for development/redevelopment in conjunction with a BRT station area. Parcels with big box retail development may have consolidated ownership and thus provide better opportunity for redevelopment, while aging strip malls have a high redevelopment potential but may require dealing with a larger number of owners (although this level of analysis is beyond the scope of these maps).
- Major institutions, while themselves generally not opportunities for development, represent opportunities as potential anchors for development around BRT stations and for possible intensified densities. Hospitals and higher education institutions are examples of such institutions.
- Enduring public/private institutions (including schools and religious institutions) that do not turn over frequently are generally an established fixed land use, and typically do not generate significant transit ridership.
- Relatively low-density residential areas and parks/preserves are typically not considered for redevelopment but should be further studied for options to improve pedestrian access to the corridor (such as connections to the corridor for non-motorized travel).

Figure 2-8 Corridor Aerial and Map (North)



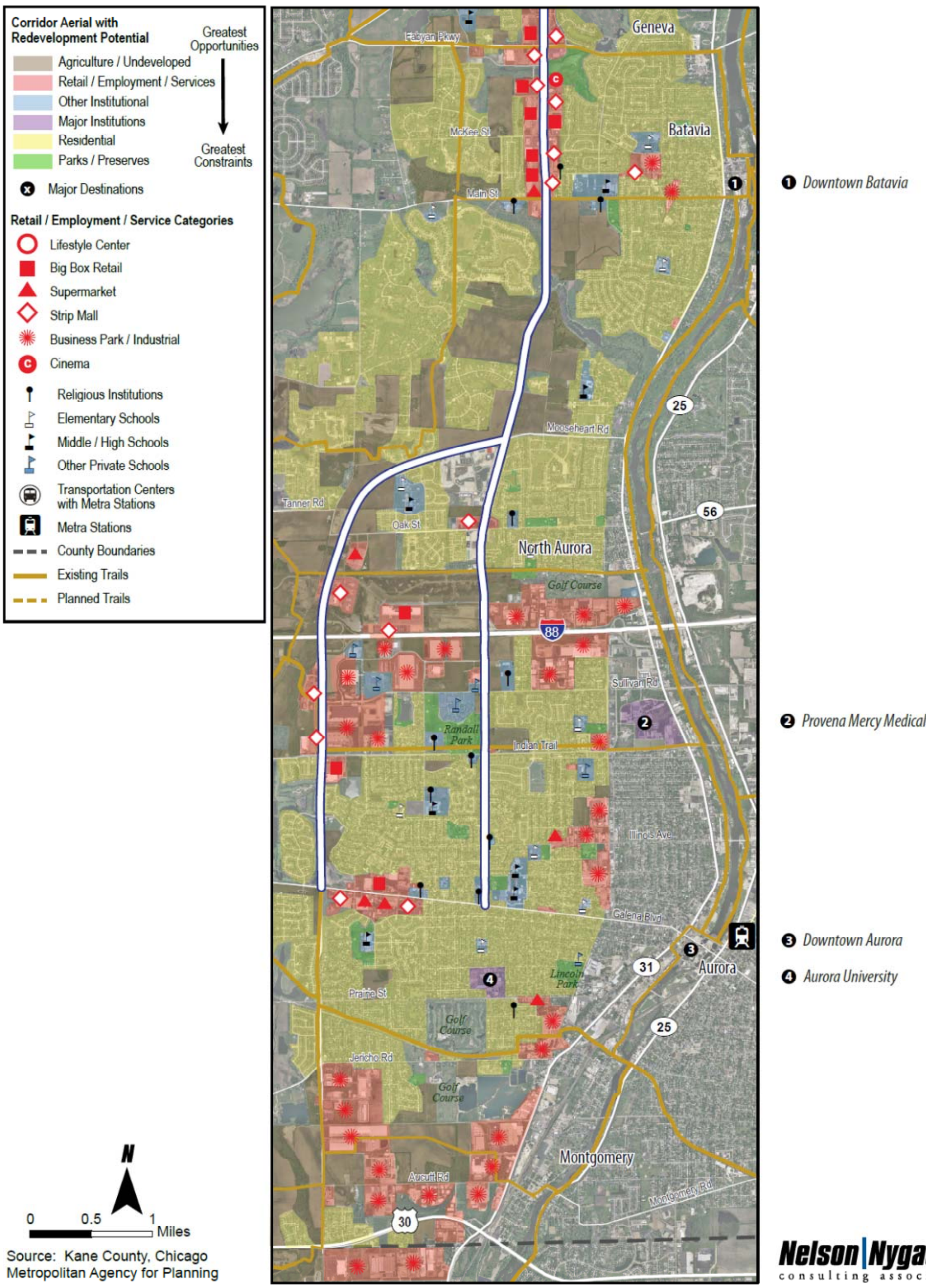
Source: Kane County, Chicago Metropolitan Agency for Planning

Figure 2-9 Corridor Aerial and Map (Central)



Source: Kane County, Chicago Metropolitan Agency for Planning

Figure 2-10 Corridor Aerial and Map (South)



Source: Kane County, Chicago Metropolitan Agency for Planning

SUMMARY OF OPPORTUNITIES AND CONSTRAINTS

Figure 2-11 summarizes the major opportunities and constraints related to development of BRT along the Randall/Orchard Road corridor, as discussed in this chapter.

Figure 2-11 Major Corridor Opportunities and Constraints

Opportunities	Constraints
• Higher density, potentially transit-intensive major institutions along or near the corridor (e.g. hospitals, community colleges) that can anchor a major transit node. Potential destinations include: o Sherman, Delnor and Mercy Hospitals – growing 24 hours per day, 7 days per week, 365 days per year service centers. o Elgin Community College, Aurora University, and Waubonsee Community College (including satellite campuses). • Underdeveloped commercial strips without a major anchor can be more easily assembled into larger redevelopment. • Large retail developments with limited lifetimes that can be developed or repurposed. • Significant undeveloped or agricultural land could support future development, while higher-density development along the corridor could enable greater preservation of agricultural land and open space outside of the corridor. • Significant right-of-way exists to develop transit and pedestrian infrastructure along the corridor. • Regional trails along the corridor provide alternative access to the street network. • Connections to two major interstates with BRT potential, including planned BRT on I-90 by 2016 • Proximity to Metra stations and urban areas. • Increased congestion and higher energy prices in the future would incentivize use of BRT/transit.	• Existing pedestrian infrastructure that is not supportive of transit, e.g., building fronts setback from the corridor, large parking lots oriented to the corridor, lack of sidewalks and pedestrian crossings. • Low-density residential developments poorly connected with the corridor. • Relatively long signalized intersection spacing and no/few crossing opportunities between intersections. • Low-density, less transit-intensive public or private institutions (primary schools, religious institutions) that are not conducive to redevelopment. • Land use policies and incentives require coordination among multiple jurisdictions along the corridor (also an opportunity).

3 CONCEPTUAL RANDALL/ORCHARD CORRIDOR BRT

INTRODUCTION

This chapter presents a set of conceptual Bus Rapid Transit (BRT) station locations and station area developments along the Randall/Orchard Road corridor. The goal of this chapter is to outline the station location and size/nature of development for each site for use in the analysis of overall BRT feasibility and project benefits. It should be emphasized that the purpose of identifying these conceptual station locations and station area development characteristics is to evaluate the long-term feasibility of BRT for the corridor rather than identifying particular stations for future development. Accordingly, if one or more station locations do not prove feasible or lack community support, they could be replaced with alternate locations, provided that the general requirements for BRT are met.

The conceptual station locations were informed by stakeholder input provided at a visioning workshop conducted for this project. Station locations and development potential were refined based on an analysis of developable/redevelopable lands, population and employment growth targets, and BRT station development principles. To evaluate to what degree these development sites help realize the County's long-range plan for accommodating growth, the project team developed population and employment targets for the BRT corridor based on the County's vision for growth as described in its 2030 Land Resource Management Plan and 2040 Conceptual Land Use Strategy Report. These plans envision accommodating 50% of growth in the county's Sustainable Urban Area in accordance with the Smart Growth and Livability Principles articulated in the 2040 Land Use Strategy and embrace an overarching theme of fostering "Healthy People, Healthy Living, Healthy Communities."

The results of this chapter will be used as an input to transportation analysis (see Chapter 4) of BRT service, including the need for transit priority treatments along the corridor to allow BRT to provide travel times competitive with the automobile. Competitive travel times will be essential to realizing the potential benefits of BRT, including providing residents with travel time savings and additional mobility options that will reduce vehicle miles traveled (VMT) in the county. Reducing VMT translates into benefits from improvements in air quality and community health, reductions in transportation-related energy usage and emissions, land consumption, and economic development and job creation. The transportation modeling results are one of the inputs into the quantitative and/or qualitative assessment of these potential benefits (also described in Chapter 4).

This chapter also provides preliminary estimates of operating costs and capital needs for a BRT alignment serving the conceptual station sites. These estimates are provided for both a Minimum Operable Segment (MOS)—the minimum portion of the corridor that would provide independent utility and benefit—and optional extensions north and south of the MOS to highlight the nature and costs of various service options.

VISIONING WORKSHOP SUMMARY

Twenty seven attendees representing study area municipalities, Kane County Board and staff, Pace, Metra, the RTA and CMAP participated in a corridor visioning workshop held on October 25, 2011. Participants looked forward 30 years and discussed the potential roles Bus Rapid Transit (BRT) and transit-supportive land uses could have in shaping the corridor while addressing issues ranging from traffic congestion to active/healthy lifestyle choices.

Working in small groups and focusing on one of three segments of the Randall/Orchard Road corridor, participants suggested locations for compact mixed-use development around BRT stations and types of development that could be realized at each.

Workshop participants identified 28 potential station locations, including various options for station area development and route termini, with 21 distinct station locations. These locations and the following characteristics are summarized in Figure 3-1, and are illustrated on a map in Figure 3-2.

- **Station Location.** Primarily on Randall/Orchard Roads and at major east-west connections or key activity centers.
- **Station Type**. Including end-of-line termini, stations with station area development, and stop-only locations, i.e., where a stop may be merited due to a major attraction but significant redevelopment may not be possible due to lack of vacant land.
- **Development Area**. Ranging from specific suggestions for station area development fitting in or around existing development to general station area development within a half-mile radius around the preferred station location (Figure 3-3 on page 3-7 provides a diagram). A half-mile is generally regarded as the distance most people are willing to walk to high-quality transit service.
- **Density of Development**. With a predominant preference for medium level densities.
- **Development Typology**. With a preference for mixed-use retail development along with some mixed-use commercial/employment development.
- **Connections**. Including both nearby activity centers which may merit short-trip shuttles and key destinations which may merit traditional public transit connecting service.

Figure 3-1 Visioning Workshop Identified Potential Station Locations

Map ID	Location	Station/Stop[1]	Gross Area[2]	Development Typology	Density	Identified Connections	Notes	Identified by[3]
1	At IL-62	Terminus						N-2
2	I-90 @ IL-47	Terminus		Park-and-Ride				Various
3	At I-90	Station or Terminus	*500*	Commuter				N-2
4	In front of Sherman Hospital	Stop-only						N-1
5	At Big Timber	Station	*500*	Destination		Sherman		N-2
6	At Milwaukee District / West Line RR (Randall and Big Timber Road or diversion to station)	Stop-only						N-1
7	At US-20	Station	*500*	Mixed Use Residential		St. Joseph, ECC		N-2
8	South of US-20	Station	108	Mixed Use Employment (Office and possible Medical)	Medium	ECC		N-1
9	At Bowes	Station	*500*	Mixed Use Residential		ECC		N-2
10	Southwest of Randall & Bowes	Station	69	Mixed Use General	Medium		New WalMart Site	N-1

[1]Indicates if location was identified for a developed station, mid-corridor stop-only or an end-of-line terminus.

[2]Indicates total area of potential station area development in acres as identified by workshop participants. 500 in italics indicates that participants identified a generic half-mile radius station area around a station location. A half-mile is regarded as the distance most people are willing to walk to access high-quality transit service.

[3]Workshop table number that identified location

Map ID	Location	Station/Stop[1]	Gross Area[2]	Development Typology	Density	Identified Connections	Notes	Identified by[3]
11	At McDonald (east of Randall)	Station	127	Mixed Use Employment (Office/Retail)	Medium-High		Medium density (17 units/acre) residential and medium to high density office/commercial	N-1
12	At McDonald	Station	*500*	Mixed Use Employment(office)				N-2
13	At Silver Glen	Station	*500*					N-2
14	At IL-64	Station	*500*	Mixed Use Retail	Medium			C-1
15	At IL-38	Station	271	Mixed Use Retail	Medium to High	Judicial Center		C-1
16	At IL-38	Station	297	Mixed Use Retail	High			C-2
17	South of Williamsburg (at Delnor)	Station	20	Destination	Medium		Bridge Delnor & Geneva Commons on West side of Randall	C-1
18	0.2 mi north of Keslinger (at Delnor)	Station	166	Destination	Medium			C-2
19	At Fabyan	Station	119	Mixed Use Retail	Medium			S-1
20	At McKee	Station	156	Mixed Use Retail	Medium			C-2
21	At McKee	Station	125	Mixed Use Retail	Medium to High		Mill to Wilson E&W of Randall	C-1

[1]Indicates if location was identified for a developed station, mid-corridor stop-only or an end-of-line terminus.

[2]Indicates total area of potential station area development in acres as identified by workshop participants. 500 in italics indicates that participants identified a generic half-mile radius station area around a station location. A half-mile is regarded as the distance most people are willing to walk to access high-quality transit service.

[3]Workshop table number that identified location

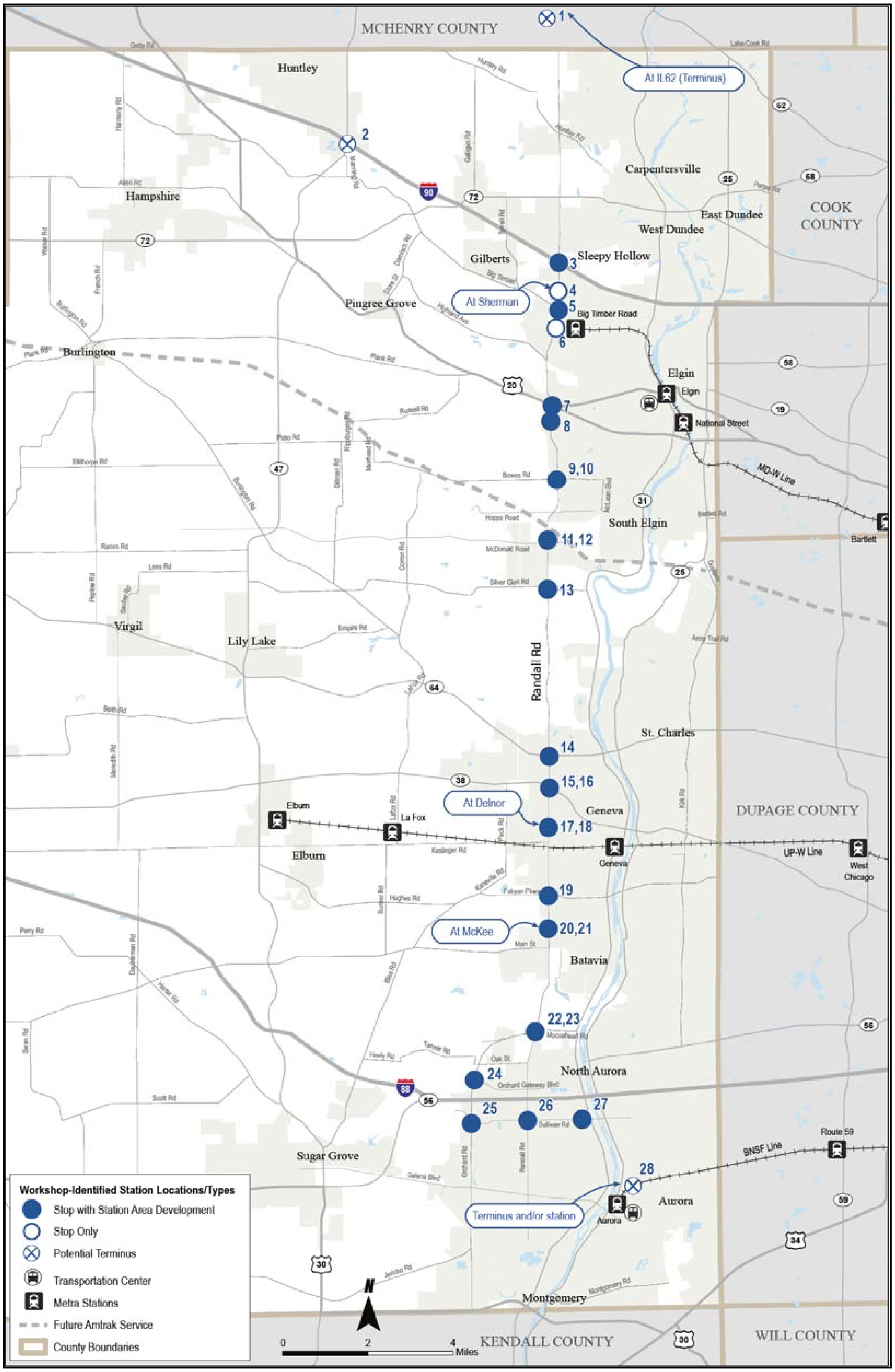
Map ID	Location	Station/Stop[1]	Gross Area[2]	Development Typology	Density	Identified Connections	Notes	Identified by[3]
22	At Orchard (northeast of intersection)	Station	105	Destination (Entertainment / Hospitality)	Medium			S-1
23	At Orchard (southwest of intersection)	Station	191	Mixed Use Employment (commercial)	Medium			S-1
24	At Orchard Gateway	Station	762	Mixed Use Employment (Office/Retail)	Medium			S-1
25	At Sullivan	Station	196	Mixed Use Employment (Office/Retail)				S-1
26	Sullivan at Randall	Station	181	Mixed Use Employment (Institutional Retail)			Mathematics & Science Academy	S-1
27	Sullivan at Provena	Station	133	Destination				S-1
28	Aurora Transportation Center	Station or Terminus	*500*	Commuter/P&R	High			S-1

[1]Indicates if location was identified for a developed station, mid-corridor stop-only or an end-of-line terminus.

[2]Indicates total area of potential station area development in acres as identified by workshop participants. 500 in italics indicates that participants identified a generic half-mile radius station area around a station location. A half-mile is regarded as the distance most people are willing to walk to access high-quality transit service.

[3]Workshop table number that identified location

Figure 3-2 Workshop-Identified Station Locations and Types

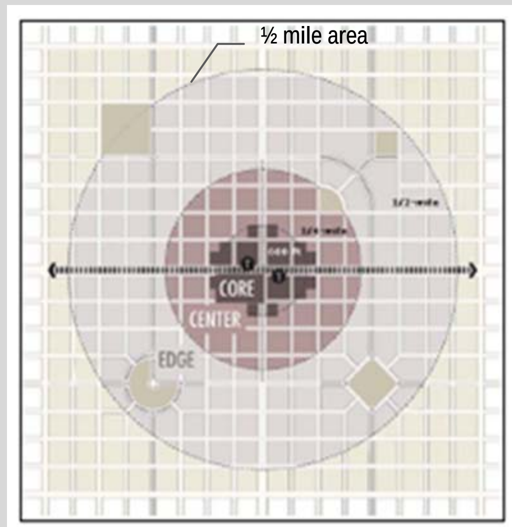


PRINCIPLES AND METHODOLOGY

Participant inputs from the workshop were synthesized into a set of conceptual station locations. The station location and development characteristics were chosen to ensure: enough capacity to accommodate the identified population and employment growth and compliance with the BRT design principles and best practices for Transit-Oriented Development (TOD). The BRT design principles were articulated in the BRT Primer developed in the initial phase of this study as four conditions for successful BRT projects, summarized as follows:

1. **Transit-Land Use Connection.** There is a mutually-supportive relationship between land use, transit service quality, and transit accessibility. Density is the primary factor in transit ridership. Increases in residential and employment density, with a diversity of land uses and housing types, expand BRT's ridership base and support the local retail market.
2. **Branding and Marketability.** Consumers should perceive BRT as a high-quality service. Vehicles should enhance the service's image and be clearly differentiated from traditional bus service. Station areas should create a distinct sense of place and create a livable community by integrating public space, active retail frontages, and pedestrian amenities.
3. **Multimodal Connectivity around Stations.** Safe and convenient multimodal connections from stations to major activity centers and destinations are a key to increasing ridership and attracting riders from other travel modes. Pedestrian and bicycle connections support internal circulation and access to transit. Efficient, convenient and intermodal connections and transfers to feeder services should be available.

Figure 3-3 Half-Mile Development Area



Dallas Area Rapid Transit (DART) targets a 600-foot station core for the highest intensity of development, a ¼-mile station center for intermediate intensity development, and the ½-mile station edge (area) for lower development intensity, but greater than the surrounding community average.

Source: DART TOD Guidelines Handbook, 2008. http://www.dart.org/about/todpolicy.asp

4. **Competitiveness with Automobile Travel.** Travel time is the single most important factor in encouraging ridership among "choice" riders, who have access to an automobile for their trip. BRT stops/stations should be spaced a minimum of a half-mile apart, although stations are typically a mile or more apart. Service design should seek to balance speed to maintain competitive travel times (longer stop spacing) with the maximum distance customers are willing to walk, generally considered to be up to a half-mile for frequent, high-quality service (shorter stop spacing).

Using these conceptual station areas, population and employment potential was assessed. The methodology follows these general steps:

- Estimate potential population and employment that can be accommodated within each station area (illustrated in the diagram at right) including:
  - Estimate the quantity of land available (gross acres) for long-term development/redevelopment within each station area

- Estimate net buildable acres, excluding site area used for transportation right-of-way and other non-building purposes.
- Develop assumptions for development scale and land use mix, for both residential and non-residential uses.
- Estimate the quantity of residential and non-residential development.
- Estimate the number of jobs supported by non-residential uses.

- Compare the estimated population and employment figures to projected growth in Kane County by 2040 and to the population and employment targets for the Randall/Orchard corridor. These figures will be utilized in the next phase of the study to model BRT operating characteristics and system benefits.

Key Assumptions

Based on industry standards and TOD case studies, the following assumptions were used to determine the development potential at conceptual sites and to evaluate this potential against future population and employment growth projections.

Net Buildable Area

For each site, the gross area available for development was determined by correlating workshop identified boundaries, natural boundaries, long-term existing developments and other constraining factors. It was assumed that existing residential development and major institutional buildings would not be redeveloped in this time frame and therefore these uses were excluded from the gross area available for development/redevelopment.

Based on an examination of socioeconomic projections for general land use plans and for typical TOD developments, 75% of the gross area was considered available for actual development, i.e., net buildable area. The 25% reduction in the gross area accounts for roads, right-of-way (e.g., on-street parking), utility easements, station platforms and other infrastructure, etc. Five percent of the net buildable area was assumed to be used for public uses and open space. The amount of space required for surface parking and additional public and open spaces is taken into account separately in the average residential densities and the floor area ratio (FAR) for non-residential development.

Scale of Development

To determine the number of residents and/or jobs accommodated at each site, the net developable area was programmed for discrete uses. Residential development is characterized by the number of dwelling units per acre, as shown in Figure 4. The mid-level density of 14 dwelling units per acre represents the rough minimum average density needed to support BRT service along a corridor. At the low end, 7 dwelling units per acre is comparatively high for Kane County, but is a minimum level of density to support basic transit service and may be appropriate as a transition between new, higher-density development and existing residential development along the corridor. Some development at higher densities will be appropriate around some stations and will be necessary to achieve the average density needed to support BRT along the corridor and accommodate the County's desired share of projected growth within the corridor. The images in Figure 3-4 provide examples of development at each of these density levels.

Figure 3-4 Transit Oriented Development Residential Density Examples

Intensity of Development	Dwelling Units per Acre	Out-of-County Examples		Kane County Examples
		Birds Eye View	Zoomed In View	
Medium-Low	6-10	 Longmont, CO. 8.8 DU/Acre		 South Elgin, 8 DU / Acre
Medium-High	12-16	 Shaker Heights, OH. 15.2 DU/Acre (219 units, 14.4 acres)		 Batavia, 14 DU / Acre
High	18-22	 San Jose, CA. 21.0 DU/Acre (98 Units, 4.6 acres)		 Elgin, 19 DU / Acre

Sources: Out-of-county examples from Lincoln Institute of Land Policy, Visualizing Density, http://www.lincolninst.edu/subcenters/visualizing-density/gallery/index.aspx. Kane County examples from Kane County, The Suburban Challenge: Making the Land Use/ Transportation Connection, Presentation to the Congress for New Urbanism Illinois State Conference, 9/28/2007.

The scale of non-residential development is represented using floor area ratios (FAR)—the ratio of total building floor area to the net buildable site area. Figure 3-5 provides examples of how a 10,000 square foot site could be developed with alternative building footprints at different FARs. The un-built portions of a site may be used for parking or public space. Figure 3-6 lists a range of floor area ratios for different land use categories, including both values typical of suburban developments and assumptions for higher FARs. The "low-medium" values are applied for most uses when assessing initial development potential. The employee capacity of a site is then determined based on the floor space needed per employee, listed in Figure 3-7.

Figure 3-5 Floor Area Ratios

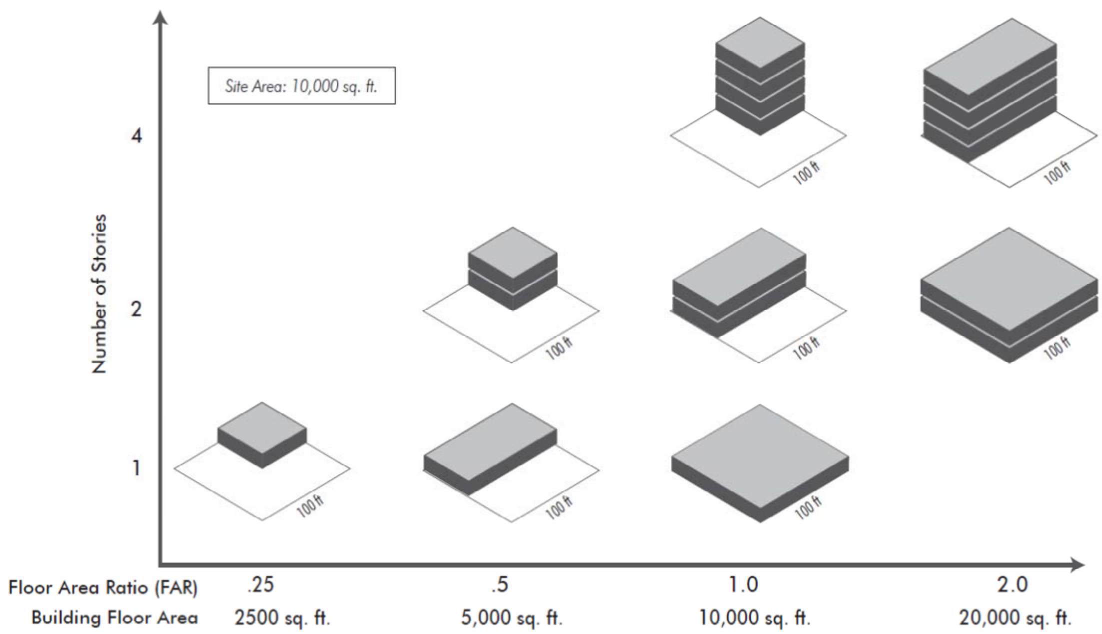


Figure 3-6 Non-Residential Floor Area Ratios (FAR)

Use	Intensity of Development		
	Typical Suburban	Low-Medium	Medium-High
Office	0.5	0.75	1.5
Industrial	0.25	0.35	0.6
Medical or Education	0.5	0.75	1.5
Retail / Services	0.25	0.35	0.7

Figure 3-7 Employment Land Use Requirements

Commercial Use	Square Feet per Worker
Office	525
Health Care	540
Education	854
Service	1,160
Retail	1,250
Industrial	1,700

Source: Department of Energy, Energy Information Administration, Commercial Buildings Energy Consumption Survey (CBECS), 2003 (Released 2006), Table B1. Values are median, which is slightly more conservative than the mean value.

Station Typology

Each conceptual station area was assigned one of the station types identified in Figure 3-8. Each station area was then assigned the specified mix of land use types and intensities of development detailed in Figure 3-9. Although not listed in the Station Typology summary table, a FAR from Figure 3-6 above was assigned for each non-residential use at each station to approximate intensity of development, measured in total building area. Most FARs were based on the "low-medium" category, however a "medium-high" FAR was applied for one or more uses at stations identified for "medium to high" density. For each station type, it is assumed that 5% of net buildable land would be used for public uses, e.g., plazas or open space. However some station types, such as "Destination," would likely provide public spaces as part of site development. For example, where a higher FAR is applied and higher density development occurs, the expectation is that part of the buildable site area would be used for this purpose.

Figure 3-8 Station Types and Characteristics

Station Type	Mixed Use Employment	Mixed Use Retail	Mixed Use Residential	Destination
Characteristics	▪ Able to sustain job growth ▪ Provides a regional employment base or draw ▪ High transit connectivity	▪ Able to sustain housing growth ▪ Smaller centers without regional destinations ▪ Moderate transit connectivity	▪ Able to sustain housing growth ▪ Smaller centers without regional destinations ▪ Moderate transit connectivity	▪ Anchored by major destination ▪ Provides a regional employment base or draw ▪ High transit connectivity
Commercial Uses	Small and large scale office, light manufacturing	Some small scale office	Some small scale office	Some small scale office
Residential Uses	Compact development (condos and apartments) and townhomes	Compact development (condos and apartments), townhomes and single family	Compact development (condos and apartments), townhomes	Compact development (condos and apartments)
Retail Uses	Neighborhood markets, convenience	Neighborhood markets, convenience	Regional retailers, neighborhood markets, convenience	Regional retailers, neighborhood markets, convenience
Employment Centers	Job clusters and individual businesses	Individual businesses	Individual businesses	Job clusters and individual businesses
Institutional Uses	Neighborhood libraries, post offices and clinics	Elementary through high schools, neighborhood libraries, post offices and clinics	Neighborhood libraries, post offices and clinics	Government, hospitals, universities/colleges, libraries, post offices
Entertainment Uses	Small venues	Small venues	Small venues	Large and small venues

Figure 3-9 Station Typology and Land Use Mix

	Typology #	1	2	3	4	5	6	7
	Land Use	Mixed Use Employment (Office / Industrial)	Mixed Use Employment (Office / Institutional)	Mixed Use Employment (Office / Retail)	Mixed Use Employment (Institutional / Retail)	Mixed Use Retail	Mixed Use Residential	Destination (Entertainment / Hospitality)
Non-Residential	Office	20%	15%	25%		15%	10%	
	Industrial	20%						
	Medical or Education		20%		20%			
	Retail / Services	10%	15%	20%	25%	30%	15%	40%
	TOTAL	50%	50%	45%	45%	45%	25%	40%
Residential	High	15%	15%	15%	15%	20%	30%	25%
	Medium-High	25%	20%	25%	30%	25%	35%	30%
	Medium-Low	5%	10%	10%	5%	5%	5%	0%
	TOTAL	45%	45%	50%	50%	50%	70%	55%
Public Space		5%	5%	5%	5%	5%	5%	5%
OVERALL TOTAL		100%	100%	100%	100%	100%	100%	100%

Note: Values represent the percent of net buildable area dedicated to a particular land use.

Population and Employment Targets

Figure 3-10 identifies a set of demographic targets for use in evaluating the aggregated population and employment capacities from the various station area developments. The targets are based on the Kane County 2040 growth projections and estimated allocations to the Randall/Orchard Road corridor. A key assumption for this analysis is that 40% of population and employment growth projected to occur within the "Sustainable Urban Area" is targeted for the Randall/Orchard corridor.

Figure 3-10 BRT Corridor Population and Employment Targets

Target Area	Population Growth	Households Growth	Employment Growth	Source/Factor
County wide	269,379	94,383	143,947	Kane County *2040 Conceptual Land Use Strategy*, Chicago Metropolitan Agency for Planning, 2010
Sustainable Urban Area	134,700	47,200	72,000	50% of the county's forecasted population growth should occur in the Sustainable Urban Area. 2030 Kane County Land Resource Management Plan (2004)
Randall/Orchard Corridor	53,900	18,900	28,800	40% of Sustainable Urban Area growth

CONCEPTUAL STATION AREAS

The project team evaluated the 28 different potential station locations/station areas as suggested by the Visioning Workshop attendees. Based upon this evaluation and consideration that stations are typically located at a minimum of 1 mile intervals along successful BRT corridors, the project team defined a set of 13 station locations and/or station area developments as the minimum operable segment (MOS). For transit projects, the MOS is considered to have independent utility and logical termini, meaning that it is able to provide substantial transportation benefit as a complete route. Potential future extensions could be added, providing additional benefits as appropriate. This MOS also identifies potential station locations along such extensions.

Figure 3-11 provides a description of the stations along the MOS as well as on potential extensions beyond it, including:

- Map identifier, corresponding to a map of the stations provided in Figure 3-12.
- Relative location of stop.
- Gross and developable area in acres. As described previously, gross area includes existing commercial buildings, parking, and undeveloped land, but excludes existing residential development and existing major institutional buildings.
- Development typology, corresponding to the types provided in Figure 3-9 with programmed uses.
- Density, describing the general intensity of development programmed at the station.
- Primary connections/links.

Figure 3-11 Conceptual MOS Stations and Potential Stations Outside MOS

Map ID	Station Spacing (Miles)1	Location	Gross Area (Acres)2	Net Buildable Area (Acres)	Station Development Typology	Density	Connections
A	-	IL 72 to I-90 west of Randall	500	375	1: Mixed Use Employment (Office/Industrial)	Medium to High	
B	2.4	Randall at Big Timber Road	150	113	2: Mixed Use Employment (Office/Medical)	Medium to High	Sherman Hospital, Big Timber Metra Station
C	2.7	Randall south of U.S. 20	150	113	6: Mixed Use Residential	Medium to High	Provena St. Joseph Hospital, Elgin C.C.
D	1.6	Randall at Bowes Road	110	83	5: Mixed Use Retail	Medium	
E	1.3	Randall north of McDonald Road	200	150	3: Mixed Use Employment (Office / Retail)	Medium	Future Amtrak Station
F	5.3	Randall at IL 64	140	105	3: Mixed Use Employment (Office / Retail)	Medium	
G	0.7	Randall at IL 38	300	225	5: Mixed Use Retail	Medium to High	Judicial Center
H	1.3	Randall at Keslinger Road	135	101	4: Mixed Use Employment (Institutional / Retail) (Destination)	Medium to High	Geneva Metra, Delnor Hospital
I	1.3	Randall at Fabyan Parkway	180	135	5: Mixed Use Retail	Medium	
J	1.3	Randall at Main Street (Batavia)	180	135	7: Destination (Entertainment/Hospitality)	Medium	
K	2.0	Orchard/Randall at Mooseheart Road	220	165	3/7: Mixed Use Employment / Destination (Entertainment/Hospitality)	Medium to High	
L	2.0	Orchard at I-88 (North) / Orchard Gateway Blvd.	470	353	3: Mixed Use Employment (Office / Retail)	Medium	
M	1.0	Orchard at I-88 (South) / Sullivan Road	175	131	3: Mixed Use Employment (Office / Retail)	Medium	

Map ID	Station Spacing (Miles)1	Location	Gross Area (Acres)2	Net Buildable Area (Acres)	Station Development Typology	Density	Connections
Additional Stations and Potential Terminus Locations Outside MOS							
N	1.4	Sullivan Road at Randall (Math & Science Academy)	181	131	4: Mixed Use Employment (Institutional / Retail)	Medium	
O	1.3	Sullivan Road at Provena Mercy Medical Center	133	75	2: Mixed Use Employment (Institutional)	Medium	
P	2.2	Aurora Transportation Center (ATC)			N/A	N/A	Aurora Metra and Pace
AA	6.7 (rel. to A)	Carpentersville (IL 25)			N/A	N/A	
AB	6.9 (rel. to A)	IL 47 and I-90			N/A	N/A	
AC	6.3 (rel. to A)	IL 62 and Randall Road			N/A		

Notes: (1) Station spacing is calculated between the listed station and the "upstream" station (to the north), with the exception of AA, AB, and AC off of the MOS, where station spacing is relative to station A. (2) Station area development is not assumed at the four potential locations most distant from the north and south endpoints of the MOS (i.e.,P, AA, AB, and AC), however this is not intended to imply that population and employment growth would not occur at these potential locations. (3) Gross areas are based on identified vacant/redevelopable land, within a half-mile radius of the station. A half-mile is generally accepted as the distance most people will walk to high quality transit.

Figure 3-12 Conceptual BRT Station Areas and Alignment

Source: Nelson\Nygaard

Minimum Operable Segment Stations

As discussed previously, nearly 40% of the total projected population and employment growth within the Sustainable Growth Area through 2040 is targeted for the Randall/Orchard corridor—nearly 19,000 households (about 55,000 people) and 29,000 jobs. Figure 13 lists the estimated total households and jobs that can be accommodated at stations on the MOS compared to the growth targeted for the corridor. Based on the assumed land uses, over 17,500 households (about 51,000 people) and over 41,000 jobs could be accommodated in the assumed station areas. This level of development accounts for 93% of targeted residential growth and 143% of targeted employment growth targeted for the corridor. The employment capacity estimated in this scenario exceeds targeted growth because jobs generated by existing land uses would be replaced by new land uses assumed under the BRT development scenario. As previously noted, no existing residential uses were included in the BRT development scenario, therefore all residential growth represents “new” households/population.

Figure 3-13 Total Demographics at Stations on Minimum Operable Segment

	Population	Households	Total Jobs	Jobs by Sector and % of Total				
				Office	Industrial	Hospital	Retail	Services
Conceptual Station Area Demographic Totals	51,266	17,515	41,226	27,128 (66%)	673 (2%)	5,173 (13%)	3,972 (10%)	4,281 (10%)
Targeted Growth	55,261	18,880	28,790					
Percent of Corridor Targeted Growth	93%	93%	143%					

* Total exceeds 100% due to rounding.

Figure 3-14 provides a station-by-station breakdown of demographics for the MOS.

Figure 3-14 Demographics by Station on MOS

				Residential									Non-Residential									
				Net Acres by Intensity per Acre Total Pop. & HH, Pop & HH Density, and % by Station									Retail / Services				Commercial / Institutional				Total Jobs and % by Station	
Map ID	Location	Typology	Net Acres	Net Acres	21 DU	14 DU	7 DU	Total Pop.	Pop / Acre	Total HH	HH / Acre	% of HH	Net Acres	Avg. FAR	Jobs	Jobs/ Acre	Net Acres	Avg. FAR	Jobs	Jobs/ Acre	Total Jobs	% of Jobs
A	IL 72 to I-90	1/Empl	375	169	56	94	19	7,683	46	2,625	15.6	15%	38	0.35	475	12.7	150	0.93	10,007	66.7	10,482	25%
B	Big Timber Road	2/Empl	113	56	17	28	11	2,420	43	827	14.7	5%	11	0.35	143	12.7	39	1.18	3,773	95.8	3,915	9%
C	South of U.S. 20	6/Res	113	79	34	39	6	3,803	48	1,299	16.5	7%	17	0.70	428	25.3	11	0.75	700	62.2	1,128	3%
D	Bowes Road	5/Ret	83	41	17	21	4	1,944	47	664	16.1	4%	25	0.70	627	25.3	12	0.75	770	62.2	1,397	3%
E	N. of McDonald Road	3/ Empl	150	90	30	53	8	4,149	46	1,418	15.8	8%	23	0.00	285	12.7	30	0.00	1,867	62.2	2,152	5%
F	IL 64	3/ Empl	105	63	11	37	16	2,474	39	845	13.4	5%	21	0.35	266	12.7	16	0.75	980	62.2	1,246	3%
G	IL 38	5/Ret	225	113	45	56	11	5,301	47	1,811	16.1	10%	68	0.70	1,710	25.3	34	0.75	2,100	62.2	3,811	9%
H	Keslinger Road	4/Dest	101	51	15	30	5	2,282	45	780	15.4	4%	25	0.70	641	25.3	20	1.50	2,450	121.0	3,092	7%
I	Fabyan Parkway	5/Ret	135	68	27	34	7	3,181	47	1,087	16.1	6%	41	0.35	513	12.7	20	0.75	1,260	62.2	1,773	4%
J	Main Street	7/Dest	135	74	34	41	0	3,734	50	1,276	17.2	7%	54	0.35	684	12.7	0	N/A	0		684	2%
K	Mooseheart Road	3/7 Empl/Dest	165	83	33	41	8	3,888	47	1,328	16.1	8%	50	0.70	1,254	25.3	25	0.75	1,540	62.2	2,794	7%
L	I-88 (North)	3/Empl	353	176	53	88	35	7,583	43	2,591	14.7	15%	71	0.35	893	12.7	88	0.75	5,484	62.2	6,377	15%
M	I-88 (South) / Sullivan	3/Empl	131	66	20	33	13	2,824	43	965	14.7	6%	26	0.35	333	12.7	33	0.75	2,042	62.2	2,374	6%
		TOTALS	2,183	1129	390	594	143	51,266	45.5	17,515	15.5	100%	467	-	8,253	17.7	479	-	32,973	68.9	41,226	100%

CONCEPTUAL BRT COSTS

This section presents preliminary, conceptual costs to construct and operate BRT along the defined MOS. These are order-of-magnitude costs based on experiences with other BRT systems. The vetting of the project through a more formal planning and development process[7] is required to produce refined cost estimates.

Operating Costs

Operating costs are based on the specified alignment and an operating plan that dictates the level of service provided (e.g., frequency of service and hours (span)/days of operation). Fuel and vehicle operator labor cost typical make up a majority of these costs. Insurance, maintenance and support systems/staff also contribute to ongoing operating costs, which are expressed as an average hourly cost of service (a standard practice in the transit industry). The greater the frequency of service and/or the longer the span of service, the higher the operating costs that will be incurred. Figure 3-15 details the attributes of the conceptual operating plan for BRT service in the identified MOS alignment in the Randall/Orchard corridor along with the costs required to operate the service.

Figure 3-15 Conceptual Operating Plan and Operating Cost

	Parameter	Notes
Operating Plan Attributes		
Span of Service	5 AM until Midnight (daily)	
Frequency of Service (Headway, or the amount of time between buses))		
-Weekday peak	10-minute	For six hours per weekday
-Base period	15-minute	E.g., midday or outside of weekday peak
-Nights	30-minute	After 10 PM daily or very early morning
Layover	15%	Operator breaks and schedule recovery time as a percent of running time
Days of Operation per Year	365	251 weekdays, 52 Saturdays, 62 Sundays/Holidays
Hourly Operating Cost	$104	Per Pace 2012 Budget Book
Transit Travel Speeds	Existing corridor speeds	Maintained with transit priority treatments as traffic levels increase. Chapter 4 (see the Microsimulation Modeling [Traffic Operational Analysis] section) discusses where these treatments could be applied.
Estimated Conditions		
Annual Revenue Hours	81,670	
Peak Vehicles in Service	17	Maximum number of BRT vehicles in service during weekday peak period
Annual Operating Cost (MOS)	$8,494,000	In 2012 dollars, for minimum operable segment.

[7] Larger BRT projects are typically planned using the Federal Transit Administration's New Starts Project Planning & Development process which dictates establishment and refining of financial plans. www.fta.dot.gov/12347_5221.html

The conceptual operating plan provides a relatively high level of service. This is required to attract choice riders (those not dependent on transit), especially during non-commute periods. High-quality night and weekend service between station areas is required to realize a reduced dependency on automobile travel in future developments in station areas and along the corridor. To illustrate the sensitivity of operating costs to changes in the operating plan, Figure 3-16 illustrates potential reduction in BRT operating cost from providing a lower level of service.

Figure 3-16 Operating Cost Sensitivity to Operating Plan Parameters

Change From Conceptual Plan	Peak Vehicles in Service	Annual Revenue Hours	Annual Operating Cost (2012 dollars)
None	17	81,670	$8,494,000
Start Night service at 7 PM (i.e., 30-minute headways)	17	76,200	$7,924,000
Start Night service at 7 PM with 60-minute headways	17	71,300	$7,414,000
Operate at 15-minute headways during weekday peak periods	11	72,640	$7,554,000

Capital Costs

Figure 3-17 details some conceptual capital costs required to implement BRT service in the Randall/Orchard Road corridor MOS. These one-time expenses cover the BRT vehicles, improvements to the roadways, development of BRT stations and passenger amenities, and engineering, design work and contingencies. These costs are for BRT operation in general purpose travel lanes with queue jump lanes at key signalized intersections and Transit Signal Priority (TSP)[8] to provide transit travel time improvements. The total implementation costs can be expected to be around $40 million in current (2012) dollars.

Figure 3-17 Conceptual Capital Costs

Element	Unit Cost[1,2]	Units	Quantity	Total Cost
Vehicles				
Stylized Articulated	$927,400	Per vehicle	21[3]	$19,475,000
Subtotal				$19,475,000
Running Way & Intersections				
Queue Jump Lanes[4]	$142,000	per lane	28	$3,976,000
Traffic Signal Controller Upgrade (to support TSP)	$9,800	per pair	14	$137,000
Transit Signal Priority (TSP) upgrades[5]	$87,600	per intersection	14	$1,226,000
TSP System Software	$82,000	Each	1	$82,000
TSP Implementation (Signal timing/implementation only)	$6,200	per intersection	14	$87,000
Subtotal				$5,508,000

[8] The BRT Primer in Appendix C and the Microsimulation Modeling section of Chapter 4 provide further background information on queue jump lanes.

Element	Unit Cost[1,2]	Units	Quantity	Total Cost
Stations				
Station construction: 3 meter (10 ft) wide stations	$231,900	per station	13	$3,015,000
Enhanced shelters	$27,300	each	13	$355,000
Station identification post	$900	per station	13	$12,000
Trash/recycling receptacles at stations	$1,200	per station	13	$16,000
Map at stations	$3,500	per station	13	$46,000
Fare collection- ticket vending machine	$90,000	per TVM	26	$2,340.000
Real-time information display	$8,700	per station	13	$113,000
Security cameras	$9,300	per station	13	$121,000
Emergency callbox	$1,700	per station	13	$22,000
Improvements to pedestrian access ways	$40,600	per station	13	$528,000
Bicycle parking at stations	$9,300	per station	13	$121,000
Subtotal				$6,689,000
E&A				
AA, Concept, Environmental, PE (10% of hard costs)		-		$1,220,000
Final Design (7% of hard costs)		-		$854,000
Design Services Construction (2% of hard costs)		-		$244,000
Administration and Construction Management (15% of hard costs)		-		$1,830,000
Subtotal				$4,148,000
Total Costs				
Total				$35,820,000
Contingency except vehicles (30%)				$3,659,000
TOTAL ESTIMATE				$39,479,000

Notes:
[1]Costs are in 2012 dollars.
[2]Sourced from FTA, Characteristics of BRT, 2009 and The Institute for Transportation, Development Policy (ITDP) Bus Rapid Transit Planning Guide, Sept 2007, and from BRT designs for Seattle and Kitsap County Washington.
[3]Vehicle quantities include spares (20%)
[4]Queue jumps are priced for 750 feet of lane construction (before and after intersection) assuming an existing turn lane is not available. These are priced at $1,000,000 per lane-mile and do not include Right of Way procurement costs. The quantity is based on intersections identified through traffic analysis (see Chapter 4).
[5-] TSP costs assume new buses are equipped with TSP emitters, fiber optic backbone is in place and signal priority receivers are already installed in intersections prior to BRT implementation. Upgrades to system and controller are just for transit priority operation.

POTENTIAL EXTENSION STATIONS

Figure 3-18 lists the estimated total households and jobs that can be accommodated if potential stations are developed outside of the MOS. Overall, over 17,000 households, comprising more than 55,000 people, and over 41,000 jobs can be accommodated. This level of development accounts for 101% of household growth and 154% of employment growth targeted for the corridor.

Figure 3-18 Demographics Including Stations beyond Minimum Operable Segment

	Population	Households	Total Jobs	Jobs by Sector					
				Office	Industrial	Hospital	School[1]	Retail	Services
Targeted Growth	55,261	18,880	28,790						
Demographics at non-MOS Stations	4,418	1,509	3,170	700	0	908	1,004	269	290
Total Demographics (MOS and non-MOS)	55,684	19,025	44,396	27,828	673	6,080	1,004	4,241	4,570
Percent of Total Employment				63%	2%	14%	2%	10%	10%
Percent of Corridor Targeted Growth	101%	101%	154%						

Notes: (1)School jobs are at the Math and Science Academy station location (N).

Figure 3-19 provides a breakdown of demographics for the stations outside the MOS and lists the total demographics for MOS and non-MOS stations.

Figure 3-19 Demographic Breakdown for Potential Extension Stations outside MOS

				Residential									Non-Residential									
				Net Acres by Intensity per Acre Total Pop. & HH, Pop & HH Density, and % by Station									Retail / Services				Commercial / Institutional				Total Jobs and % by Station	
Map ID	Location	Typology	Net Acres	Net Acre s	21 DU	14 DU	7 DU	Total Pop.	Pop / Acre	Total HH	HH / Acre	% of HH	Net Acres	Avg. FAR	Jobs	Jobs/ Acre	Net Acres	Avg. FAR	Jobs	Jobs/ Acre	Total Jobs	% of Jobs
N	Sullivan Road at Randall (Math & Science Academy)	4/Empl	135	66	20	39	7	2,958	45	1,011	15.4	5%	33	0.35	416	12.7	26	0.75	1,004	38.3	1,420	3%
O	Sullivan Road at Provena Mercy Medical Center	2/Empl	71	34	11	15	8	1,460	43	499	14.8	3%	11	0.35	143	12.7	26	0.75	1,608	61.2	1,750	4%
P	Aurora Transportation Center (ATC)	N/A																				
AA	Carpentersville (IL25)	N/A																				
AB	IL47 and I-90	N/A																				
AC	IL62 and Randall (McHenry County)	N/A																				
TOTAL FOR STATIONS OUTSIDE MOS			206	31	54	14	4,418	44.5	1,509	15.2	8%	44	-	558	12.7	53	-	2,612	49.7	3,170	7%	206
MOS + OUTSIDE MOS			2,389	421	649	157	55,684	45.4	19,025	15.5		512	-	8,811	17.2	531	-	35,585	67.0	44,396		2,389

Note: Station area development is not assumed at the four potential locations most distant from the north and south endpoints of the MOS (i.e., P, AA, AB, and AC), however this is not intended to imply that population and employment growth would not occur at these potential locations.

Potential Extension Costs

This section evaluates the impacts on BRT costs from extending service beyond the MOS. Figure 3-20 presents order-of-magnitude operating and capital cost estimates for operating BRT in the identified potential extensions beyond the MOS. The additional capital costs result from serving additional station areas and the need for additional vehicles (peak period) required to maintain the frequency of service over the longer alignment. The additional operating costs result from the need to operate the additional vehicles (all day).

Figure 3-20 Potential Extension Costs

Potential Alignment Alternative	Additional[1] Station Areas	Additional Peak Vehicle Requirements[2]	Additional Capital Costs[3]	Additional Annual Operating Costs
North of I-90 to Sullivan and Provena Mercy	2	2	$3,192,000	$1,366,000
North of I-90 to ATC	3	6	$7,571,000	$2,890,000
Carpentersville to Sullivan	1	6	$6,233,000	$2,890,000
Carpentersville to Provena Mercy	3	8	$9,425,000	$3,691,000
Carpentersville to ATC	4	12	$13,804,000	$5,215,000
I-90 & IL47 to Sullivan	1	2	$2,524,000	$1,366,000
I-90 & IL47 to Provena Mercy	3	5	$6,643,000	$2,168,000
I-90 & IL47 to ATC	4	8	$10,094,000	$3,691,000
IL62 to Sullivan	1	5	$5,306,000	$2,168,000
IL62 to Provena Mercy	3	7	$8,498,000	$3,046,000
IL62 to ATC	4	11	$12,876,000	$5,058,000

Notes:
[1]Additional station areas and costs are relative to the MOS alignment and the conceptual operating plan. Operating plan elements are held constant for MOS expansions.
[2]Includes spare vehicles.
[3]Includes A&E and contingency costs, but does not include additional TSP outside of MOS.

Bicycle and Pedestrian System Integration

The existing and planned regional trail system in Kane County could be integrated with BRT service on the Randall/Orchard Road corridor to serve short-to-medium distance connections to and between station areas. Figure 3-21 illustrates the Kane County trail system (existing and planned/future) in relation to the conceptual station areas. There are existing or planned parallel north-south trail facilities east of the corridor along most of the MOS and a majority of the conceptual station areas have existing or planned connections to the trail facilities in close proximity.

Figure 3-21 Kane County Existing, Planned, and Future Trail Network in Relation to Conceptual BRT Station Areas and Alignment

4 BRT BENEFITS

INTRODUCTION

This chapter presents an analysis of the benefits resulting from the development of Bus Rapid Transit in conjunction with supportive land uses in the Randall/Orchard Road corridor. These benefits range from energy savings to healthier, more active communities. Where appropriate, this analysis employs quantitative approaches based on best practice methodologies. Other benefits are examined using qualitative techniques. Figure 4-1 details the various benefit areas addressed in this analysis. The table highlights benefits analyzed, the measures used to quantify the benefit, and the BRT-related factors used to derive the benefit.

Many of the benefits result from a reduction in the number of single-occupant automobile trips made in the corridor, reflected in the vehicle miles traveled (VMT) measure for the corridor and Kane County overall. The number of vehicle trips and VMT, as well as the number of trips made by transit, walking, and biking, are key inputs into the benefits analysis methodology employed for this study.

The transit priority attributes of BRT service, including queue jump lanes and traffic signal priority treatments, maximize the speed and reliability of transit operations, result in travel time savings for transit riders, and encourage greater use of transit. A number of the user and community benefits are derived from these travel time savings.

VMT, travel time, and other benefits analysis inputs were determined using transportation modeling tools, including the Kane County travel demand model. This chapter provides a detailed review of the modeling results before describing the benefits analysis and results.

Figure 4-1 Benefits Realized from BRT and Supportive Land Uses

Benefit Category	Measure(s)	Explanation/Importance	Key Inputs Used to Derive the Benefit	Other Considerations*
Congestion Mitigation / Traveler Delay Reduction and Cost Savings	Daily Travel Time Savings - Drivers	Drivers may realize travel time benefits due to reduced congestion.	# of trips Travel time	
	Travel Time Savings – Transit Users	Transit users will realize time savings with BRT relative to conventional bus service and/or to driving.	# of trips Travel time	
	Cost Savings Relative to Driving	Transit users and those who walk and bike will realize cost savings relative to driving.	Number of new transit and walking/biking trips (modeling and further assumptions based on research) Cost of driving	Cost of gas prices
Transportation-Related Energy Usage and Emissions	Reduction in fuel usage due to compact development	Compact development reduces fuel consumption by enabling more non-SOV trips and shorter SOV trips, as well as use of walking and bicycling for short trips.	Change in vehicle miles traveled (VMT) Average vehicle fleet fuel efficiency	Fleet fuel efficiency and adoption of alternative fuels
	Reduction in Greenhouse Gas (GhG) emissions due to reduced VMT	Per-capita GhG emissions are lower due to reduced VMT from trips that shift to BRT.	Fuel consumption Average vehicle fleet fuel mix and efficiency	Fleet fuel efficiency and adoption of alternative fuels
	Reduction in emissions of other pollutants that impact air quality (e.g., NO_x, $PM_{2.5}$, SO_2, CO, VOCs)	Air quality is improved due to reduced VMT (after accounting for BRT emissions).	See GhG reduction Average vehicle fleet emissions	Localized modeling is needed for accurate estimation Fleet emissions and adoption of alternative fuels

Benefit Category	Measure(s)	Explanation/Importance	Key Inputs Used to Derive the Benefit	Other Considerations*
Community Health Impacts	Improved health outcomes due to improvements in air quality	Reduced driving, and in particular fewer short trips, reduces concentrations of airborne pollutants that affect human health.	Estimated reduction in emissions (above) Regional research using model of local air quality and health outcomes	Localized modeling is needed for accurate estimation
	Improved health outcomes due to physical activity.	"Active transportation," such as walking and bicycling, to access BRT and services in walkable, mixed-use development increases physical activity. The strongest evidence for specific improvements in health outcomes is for risk of cardiovascular disease, stroke, colon cancer, breast cancer, and onset and treatment of type II diabetes.[9]	Distance passengers travel to access BRT by bicycling or walking (modeling and further assumptions based on research Estimate of local outcomes based on effects from global research	Data is highly localized and more generalized models are still evolving
	Improved safety due to reduction in driving (VMT)	Reducing driving improves safety for drivers and other road users (pedestrians/bicyclists). Additional safety benefits from improved design (e.g., reducing vehicle speeds).	Change in VMT Average injury/fatality rates per mode and passenger-mile traveled (national research)	
Land Use	Reduction of urbanized land required to support conceptual station area development	Compact development patterns utilize land more efficiently and reduce amount of urbanized land required	County growth projections and station area definition	
	Reduction in required parking supply	Reduced cost of building and maintaining parking spaces (land consumption aspect is captured above)	Change in motor vehicles trips Cost per parking space (national research)	

[9] Cavill, N. et al. Economic assessment of transport infrastructure and policies. Methodological guidance on the economic appraisal of health effects related to walking and cycling. Copenhagen, WHO Regional Office for Europe, 2007 (http://www.euro.who.int/__data/assets/pdf_file/0008/87479/E90944.pdf).

Benefit Category	Measure(s)	Explanation/Importance	Key Inputs Used to Derive the Benefit	Other Considerations*
	Reduction in infrastructure costs	Compact development patterns reduce the cost of providing and maintaining public infrastructure	Discussed qualitatively (national research and case study)	
Economic Development	Number of jobs generated/supported	Initial (and ongoing) capital investments in BRT infrastructure support local construction, planning and design jobs. Construction and engineering are examples of jobs most likely to be provided locally. In addition, ongoing annual BRT operations would support jobs.	Discussed qualitatively based on national research, but includes: ▪ BRT capital and operating cost estimates ▪ National estimates for jobs generated by investments in transit capital facilities and operations	
	Increased economic productivity and opportunities	Investments in high-capacity transit stations and other infrastructure improve access and attract development.	Discussed qualitatively	
	Revitalization and increase in land values	Transit-oriented development in conjunction with high quality transit service increase land values and the tax base on nearby parcels	Discussed qualitatively (case study)	

* This column is intended to capture uncertainty related to the methodology used to estimate the benefits. In all cases, factors such as fuel prices and parking availability that impact cost of driving will affect transit demand.

TRANSPORTATION MODELING

Travel demand modeling (referred to as macro-simulation in this report) and intersection-level traffic operational analysis (referred to as micro-simulation in this report) models were used to evaluate: (1) the induced travel resulting from the higher-density development at the conceptual BRT station areas along the Randall/Orchard Road corridor and (2) the shifting of trips to the conceptual BRT service. For this analysis, the corridor considered is the Minimum Operable Segment (MOS). As described/illustrated in Chapter 3, as well as Figure 4-12 below, the MOS comprises the Randall/Orchard corridor between terminal station area just north of I-90 and a station area south of I-88 near Sullivan Road.

Macrosimulation Scenarios and Assumptions

The macrosimulation model utilized the Kane County travel demand model[10] to analyze the travel patterns resulting from the conceptual BRT station area developments and implementation of BRT service. The sidebar below describes the scenarios that were analyzed in the macrosimulation model. Each scenario defines an alternative set of future land use development and transportation system conditions for 2040.

Analysis Scenarios

- **2040 Transportation Plan (Baseline Growth, Transit, and Land Use).** This scenario uses land use and socioeconomic assumptions (i.e., population and employment levels) developed as part of the County's 2040 Transportation Plan. It represents the projected baseline conditions assuming BRT is not built along the Randall/Orchard Road corridor. It is assumed that the Randall/Orchard Road Corridor has been widened to a 6-lane cross-section (three lanes in each direction).
- **Corridor-Focused Development Scenario (Moderate Growth).** This scenario assumes the same increase in population and employment within the Randall/Orchard corridor as in the conceptual, moderate growth BRT land use scenario (Chapter 3). Moderate growth assumes a reallocation of County-wide growth to the corridor. Development patterns are assumed to be more intensive, compact, and nodal in character than the 2040 Transportation Plan scenario. There is no increase in transit mode share and the same 6-lane roadway cross-section is assumed as in the 2040 Plan.
- **BRT/TOD Scenario (Moderate Growth).** This scenario uses the Moderate Growth Land Use Scenario conceptual BRT station area land use and socioeconomic assumptions described in Chapter 3. It is intended to represent a compact, mixed-use land use environment along the Randall/Orchard Road corridor along with BRT operating between station areas. As with all other scenarios, it is assumed that the Randall/Orchard Road Corridor has been widened to a 6-lane cross-section, however traffic operational analysis (microsimulation modeling) considered two cross-section design options: in a "Queue Jump" scenario all lanes are available for general purpose traffic, while in an "Exclusive Lane" scenario one of the lanes in each direction is dedicated for exclusive transit use.
- **High-Intensity TOD Scenario (High Growth).** This scenario uses a set of high-growth socioeconomic assumptions (1.5 times the level of the moderate-growth scenario) to analyze the impacts of high-intensity land use along with BRT operating between station areas. The same Randall/Orchard Road cross-section and BRT design options are considered as in the BRT/TOD scenario.

[10] Developed as part of the 2040 Transportation Plan

The analysis of BRT benefits compares results between scenarios. The primary comparisons are between the BRT/TOD scenario (moderate corridor growth with BRT) and:

- The 2040 Transportation Plan scenario (baseline conditions with no assumed increase in density) or;
- The corridor-focused development scenario (moderate growth and increased land use intensity without BRT).

Unless otherwise specified, BRT/TOD refers to the moderate-growth scenario.

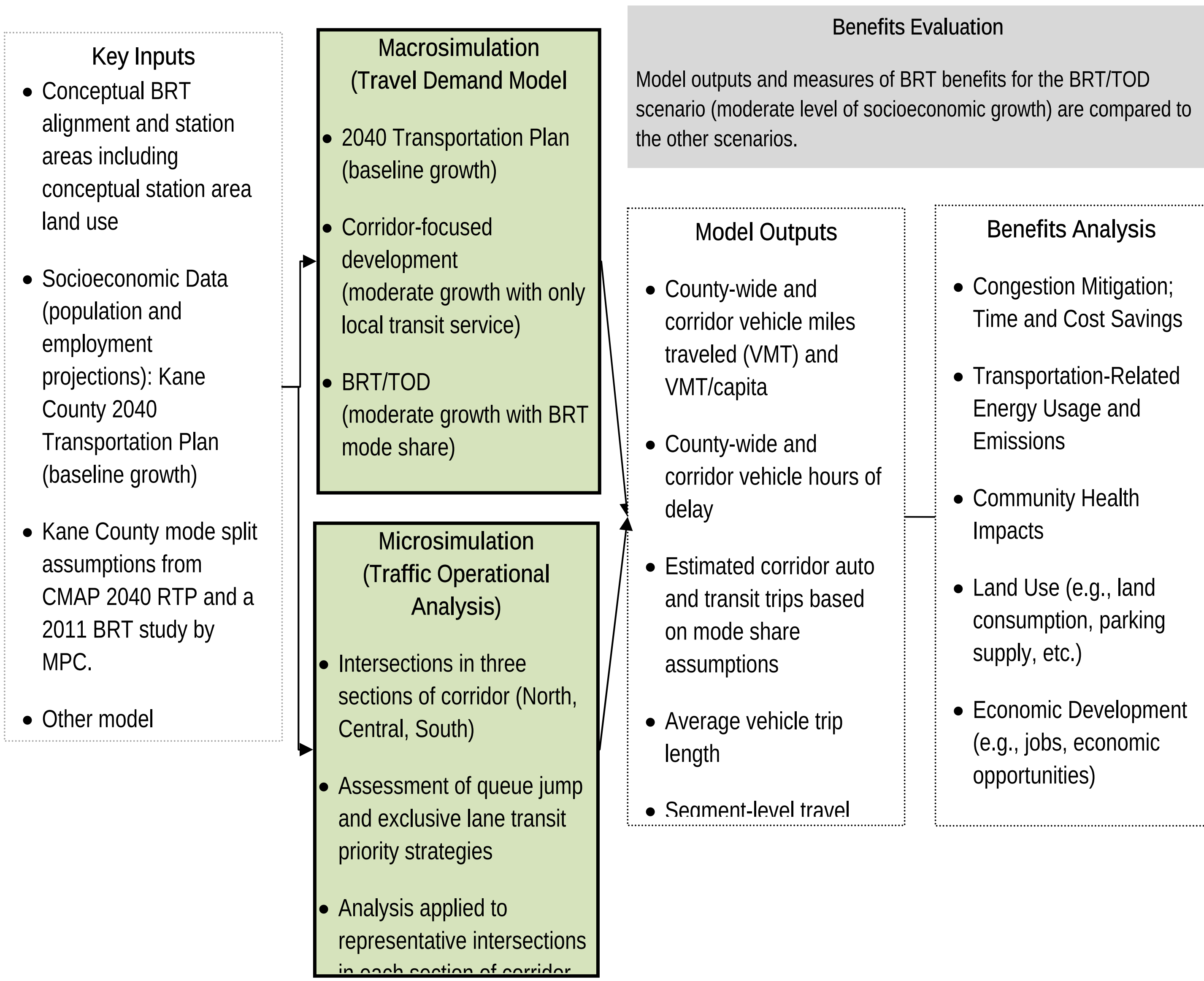
Figure 4-2 BRT Scenario Characteristics

Scenario-->	2040 Transportation Plan	Corridor-Focused Development	BRT/TOD	High Intensity TOD
Scenario Characteristics ->	2040 Local Bus w/ Baseline Growth & Baseline Land Use	2040 Local Bus w/ Moderate Growth & Corridor-Focused Development	2040 BRT w/ Moderate Growth & TOD	2040 BRT w/ High Growth & High Density TOD
Level of Corridor Growth by 2040	Baseline Growth	Moderate Growth	Moderate Growth	High Growth
Growth in (Total) Number of Households in Corridor MOS Station Areas[1]	None	+11,700 (28,400 total)	+11,700 (28,400 total)	+17,600 (34,300 total)
Growth in (Total) Number of Jobs in Corridor MOS Station Areas[1]	None	+35,100 (65,600 total)	+35,100 (65,600 total)	+52,700 (83,200 total)
Transit Service	Local bus	Local Bus	BRT and local bus	BRT and local bus
Assumed Transit Mode Split[3]	4.3%	4.3%	13.5%	13.5%
Land Use / Development Patterns in the Randall/Orchard Corridor	Traditional (no TOD)	More intensive and nodal than baseline	TOD[2] in BRT station areas	Highest intensity with TOD[2] in BRT station areas

Notes: (1) Corridor MOS Station Areas, relative to the 2040 Transportation Plan baseline. (2) TOD (Transit-Oriented Development) refers to higher-density, mixed-use development and pedestrian-oriented, walkable design around BRT station areas.

Figure 4-3 illustrates the transportation modeling process used to analyze the above scenarios.

Figure 4-3 Transportation Modeling Process



Model Assumptions

Key assumptions for the macrosimulation model were based on land use and socioeconomic (population and employment) projections, the BRT station area land use concepts described in Chapter 3, and data on travel patterns from household travel surveys. The assumptions include:

- **Socioeconomic parameters.** Residential population and various categories of employment were based on the 2040 Transportation Plan. Within the conceptual BRT station areas, the BRT/TOD Scenario used the socioeconomic assumptions provided in Chapter 3.
- **Minimum Operable Segment** (MOS). The modeling effort assumed the minimum operable Randall/Orchard Road BRT segment (MOS) of nearly 23 miles from approximately (I-90 to I-88), as described in Chapter 3 (see Figure 3-12).
- **Mode Split**. Mode split describes the share of trips carried out on different modes, such as driving, transit, walking, and biking. The County's travel demand model is primarily based on auto trips, and assumptions for transit mode split were used to reduce the number of auto trips anticipated to use the roadway system.
  - **Transit Mode Split Assumptions.** Figure 4-4 provides underlying transit mode split assumptions for the corridor for various trip purposes. The 2040 Transportation Plan mode split is from the Kane County 2040 Transportation Plan travel demand model. The BRT/TOD scenario mode split was applied only to trips originating and ending in BRT station areas and reflects an additional 14% transit mode split.[11] The 2040 Transportation Plan mode split assumptions were applied in the BRT scenario for all trips in the corridor MOS other than those originating and ending in BRT station areas.

Figure 4-4 Transit Mode Split Assumptions by Trip Purpose

Trip Purpose	Examples	2040 Transportation Plan [1]	BRT/TOD[2]
Home-Based Work (HBW)	To/from home and work	2.6%	16.6%
Home-Based Other (HBO)	To/from home and school, shopping, or errands	5.1%	19.1%
Non-Home-Based (NHB)	To/from locations other than home (e.g., work) and school, shopping, or errands	3.7%	17.7%

Notes: (1) The 2040 Transportation Plan assumptions reflect an overall regional countywide transit mode split of 3.8%, based on CMAP (Chicago Metropolitan Agency for Planning) 2040 projections. (2) The BRT assumptions assume a 14% increase in transit mode share (see footnote).

Source: Kane County Travel Demand Model; Analysis by CH2MHill

  - **Resulting Transit Mode Split.** Figure 4-5 lists the resulting transit mode split for the corridor MOS based on the macrosimulation modeling. Transit is expected to serve 4.3% of trips in the Randall/Orchard Road corridor in 2040 without BRT. With

[11] The higher transit mode split for travel between BRT station areas, where service will be the greatest, is based on expectations from a recent study of BRT in the city of Chicago. Metropolitan Planning Council, Integrating Livability Principles into Transit Planning: An Assessment of Bus Rapid Transit Opportunities in Chicago, Technical Report, August 2011. http://www.metroplanning.org/multimedia/publication/524

BRT, the model estimates an overall 13.5% transit mode split for all trips in the corridor MOS (approximately 9% increase above the 2040 Plan mode split) and an 18.2% mode split for trips that originate and end in BRT station areas (approximately 14% increase above the 2040 plan mode split).[12]

Figure 4-5 Auto-Transit Mode Split (Macrosimulation Model Results)

BRT Scenario	2040 Transportation Plan	BRT/TOD	
Geography	Corridor MOS	Corridor MOS	Station Areas
Auto	95.6%	86.5%	81.8%
Transit	4.3%	13.5%	18.2%

Source: Kane County Travel Demand Model; Analysis by CH2MHill

– **Walking and Biking Mode Split**. The County's travel demand model does not address use of walking and bicycling trips to access services. The mix of uses in a BRT land use environment and the presence of safe and convenient walking/bicycling facilities along the length of the corridor, e.g., building upon the network on off-street trails in Kane County, are assumed to enable increased walking and bicycling in the corridor. A walking/biking mode split estimate of 5.1% was developed[13] and used to estimate the number of short trips in or between stations are that would shift to walking or biking.

- **Number of Persons per Vehicle**. The travel demand model assumptions for the number of persons per vehicle by trip purpose (home-based work, home-based other, and non-home based) were used to estimate the number of person trips. Figure 4-6 presents these assumptions as well as the share of trips by trip purpose in 2040 (assumed to be the constant between the 2040 Transportation Plan and BRT/TOD scenarios).

12 The transit mode split for the 2040 Transportation Plan scenario was based on transit mode split assumptions used in the. CMAP assumes a regional transit mode share of 9.5% in 2040. (Source: CMAP Socioeconomic Inventory Validation and Forecasting Method, 2011, p. 44)

13 Two methods were used to estimate walking/biking mode split and an average of the results was used in the analysis of BRT benefits. (1) A 6% walking/biking mode share was assumed based on the "suburban" average from the Chicago Regional Household Travel Survey. By comparison the CMAP region average was 14.1%. (2) The second method used macrosimulation model results and data from the 2001 National Household Travel Survey (NHTS) to develop a more conservative mode split assumption of 4.1%. Based on the travel demand model, a third of corridor MOS trips are shorter than five miles, and could conceivably be completed by walking or bicycling; for example, the Federal Transit Administration (FTA) considers pedestrian and bicycle improvements within a half-mile walk and a three-mile bicycle ride, respectively, to be eligible for FTA grant programs. Data from the NHTS was used to categorize the length of the modeled number of trips. It was assumed that 75% of these trips that are less than a mile could be completed by walking or biking given pedestrian-oriented land use and 5% of trips between one and three miles. Support for such a shift can be found in national research, such as TCRP Report 128, which found that motor vehicle trip rates are nearly 50% lower in TODs. A recent study (Grabow, Spak, et al, 2012) hypothesized that up to 50% of relatively short trips in the 11 largest mid-western metropolitan statistical areas (MSAs) could be shifted to bicycling based on a peer evaluation and quantified the benefits of shifting 50% of such short car trips (less than about 2.5 miles) to bicycles).

Figure 4-6 Vehicle Occupancy by Trip Purpose

Trip Purpose	Examples	Vehicle Occupancy (Persons per Vehicle)	Share of Trips (2040)
Home-Based Work (HBW)	To/from home and work	1.30	15%
Home-Based Other (HBO)	To/from home and school, shopping, or errands	1.60	50%
Non-Home-Based (NHB)	To/from locations other than home (e.g., work) and school, shopping, or errands	1.15	35%

Source: Kane County Travel Demand Model; Analysis by CH2MHill

- **Vehicle/Transit Lanes on Randall Road.** The model assumed a cross-section of six lanes (three in each direction) for the full length of the Randall Road corridor and that transit and buses would share all lanes. (The microsimulation analysis described below further analyzed the effects of transit priority either in the form of a BRT queue jump or an exclusive transit-only lane (further described in the next section).

Modeling Results

Key Findings: Macrosimulation Modeling

In the BRT/TOD scenario compared to the 2040 Transportation Plan:

- The travel demand model predicts an additional over 5,600 new transit trips.
- Overall VMT in the Randall/Orchard Road corridor MOS increases by 0.8%, but VMT per capita decreases by 15.5%. County-wide VMT decreases by 1.6% overall and by 3.5% on a per capita basis.

Due to the travel demand model's limited ability to anticipate the effect of compact development and a mix of uses on travel patterns, these figures likely do not account for the full potential to reduce overall VMT, which research has shown to range from 12% to 25%.

Based on the assumptions outlined above, the macrosimulation model was used to estimate the amount of travel that would take place in the Randall Road corridor and describe impacts of the BRT/TOD land use scenario. The discussion of modeling results provided in this section focuses on the 2040 Transportation Plan and BRT/TOD scenarios, which are used to estimate the potential impact of BRT.

An additional high-intensity TOD scenario with BRT and high-density land use is included in several of the macrosimulation results tables to illustrate the sensitivity of the macrosimulation results to a higher level of development (1.5 times the moderate-growth scenario). However, the benefits analysis assumes a moderate level of corridor growth with BRT.

Travel Results

The travel demand model describes the amount of travel, measured in vehicle miles traveled (VMT), and the number of trips made.

Vehicle Miles Traveled (VMT): Randall/Orchard Road Corridor MOS

As shown in Figure 4-7, the model projects that VMT in the Randall Road corridor will increase slightly (less than 1%) in the BRT/TOD scenario relative to the 2040 Transportation Plan scenario. The increase in vehicle travel reflects an over 19% increase in the population contributing to VMT, resulting in a 15.5% reduction in daily VMT per capita (from 9.7 to 8.2 miles).

The model results are based on existing trip origin-destination patterns and may not fully anticipate the effect of more compact land use patterns and an increased mix of uses on reducing VMT, by providing services in closer proximity to residential locations, which reduces motor vehicle trip lengths and enables more trips to be completed by non-motorized means (walking and bicycling). Research estimates this effect to be 12% to 25%,[14] and the projected 15.5% reduction in VMT per capita for the corridor MOS is within this range.

However, an alternate comparison is to the corridor-focused development scenario. If just the additional population in the BRT/TOD scenario were to drive at the 2040 Transportation Plan rate of 9.2 daily VMT per person, total VMT would increase by nearly 35,000 VMT per day or 3.0% above the level estimated for the BRT/TOD scenario.

Conditions under the high-intensity TOD scenario would further reduce VMT per capita, to 6.1 miles, an over 36% reduction from the 2040 Transportation Plan level with baseline land use.

Figure 4-7 2040 Randall/Orchard Road Corridor MOS Travel Results: Daily VMT

Model Scenario	Assumed Transit Mode Split	Daily VMT	% Change[2]	Population Contributing to Randall Road VMT	% Change	Daily VMT Per Capita	% Change[2]
2040 Transportation Plan	4.3%	1,169,507	-	120,950	-	9.7	-
BRT/TOD	13.5%	1,178,386	+0.8%	144,250	+19.3%	8.2	-15.5%
High-Intensity Development[1]	13.5%	1,201,466	+2.7%	196,090	+62.1%	6.1	-36.6%

Notes: (1) The high-intensity TOD scenario assumes 1.5 times the level of growth in the moderate-growth scenario. (2) Relative to 2040 Transportation Plan.

Source: Kane County Travel Demand Model; Analysis by CH2MHill

Vehicle Miles Traveled (VMT): Kane County

As shown in Figure 4-8, the model projects a 1.6% decrease in county-wide VMT between the 2040 Transportation Plan scenario and the BRT/TOD scenario, corresponding to a 1.9% increase in the number of drivers (from inside or outside of the county) that contribute to travel in the county. On a per-capita basis, this represents a 3.5% reduction in VMT from the 2040 Transportation Plan level.

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[14] TRB, Special Report 298: Driving and the Built Environment: Effects of Compact Development on Motorized Travel, Energy Use, and CO2 Emissions, September 2009.

Figure 4-8 2040 County-Wide Travel Results: Daily VMT

Model Scenario	Daily VMT	% Change[2]	Population Contributing to County-wide VMT[3]	% Change[2]	Daily VMT Per Capita	% *Change*[2]
2040 Transportation Plan	22,475,830	-	2,011,900	-	11.2	-
BRT/TOD	22,105,360	-1.6%	2,050,300	+1.9%	10.8	-3.5%
High-Intensity Development[1]	22,447,850	-4.2%	2,095,700	+4.2%	10.7	-4.1%

Notes: (1) The high-intensity TOD scenario assumes 1.5 times the moderate growth level. (2) Relative to 2040 Transportation Plan. (3) Population contributing to travel in the County

Source: Kane County Travel Demand Model; Analysis by CH2MHill

Motor Vehicle Trips: Randall/Orchard Road Corridor MOS

As shown in Figure 4-9 (table) and Figure 4-10 (diagram), the macrosimulation model predicts an increase in the total number of vehicle trips from 24,500 in the 2040 Transportation Plan scenario to 44,700 vehicle trips in the BRT/TOD scenario. Trips predicted by the model are between zones along the corridor and do not include all trips utilizing the Randall/Orchard corridor. As shown in Row D of Figure 4-9, the model predicts 1,090 transit trips in the 2040 Transportation Plan scenario, 1,900 transit trips in the corridor-focused development scenario, and 6,020 transit trips in the BRT/TOD scenario. The number of new transit trips used in the analysis of benefits is based on a comparison between the corridor-focused development and BRT/TOD scenarios. There is a reduction in vehicle trips of over 4,100 vehicle trips, resulting in 5,760 new person-trips using transit with BRT (Figure 4-9, row G).

The model also predicts that in the BRT/TOD scenario about two-thirds of trips in the corridor MOS will be concentrated within or between BRT station areas (29,500 of the total vehicle trips). It was assumed that 18.2% of these trips will use transit.

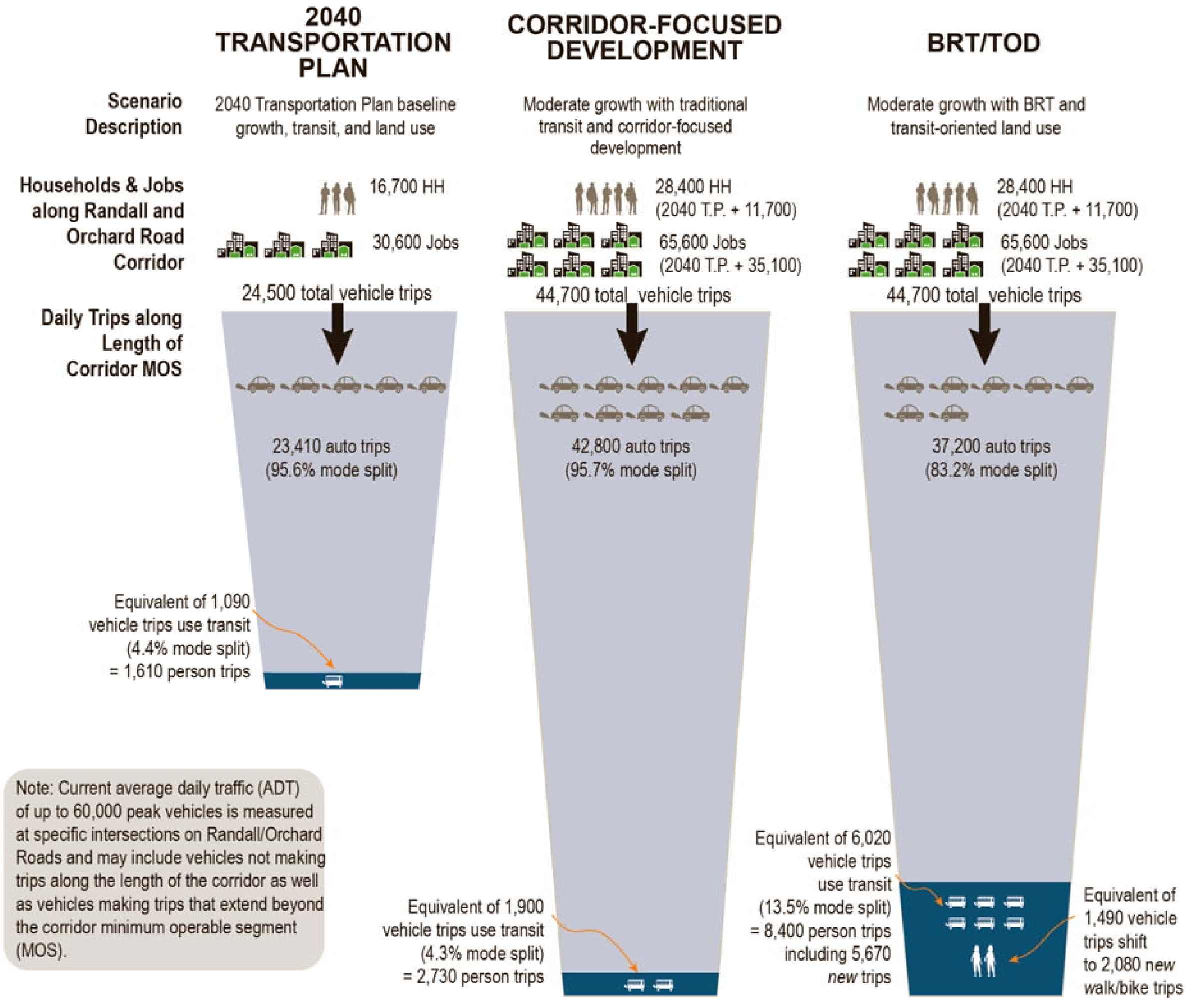
Figure 4-9 2040 Randall/Orchard Road Corridor MOS Travel Results: Daily Number of Trips

	Model Outputs (Daily)	2040 Transportation Plan	Corridor-Focused Development	BRT/TOD
A	# Total Corridor Trips[1]	24,500	44,700	44,700
B	Assumed Transit Mode Split	4.3%	4.3%	13.5%
C	# Auto Trips	23,410	42,800	38,680
D	# Transit Trips	1,090	1,900	6,020
E	# Vehicle Trips Reduced by BRT	N/A	N/A	4,120
F	# Transit Person Trips	1,610	2,730	8,400
G	Net New Transit Trips due to BRT	N/A	N/A	5,670

Notes by row: (A) Number of vehicle trips between zones along the corridor in each scenario, as predicted by the model; figures do not include all trips utilizing the Randall/Orchard corridor. Current average daily traffic (ADT) of up to 60,000 peak vehicles is measured at specific intersections and may include vehicles not making trips along the length of the corridor or making trips that extend beyond the BRT MOS. (B) Transit mode split assumptions for each scenario listed in Figure 4-5. (E) Number of daily vehicle trips that shift to transit, comparing the BRT/TOD and corridor-focused development scenarios. This is calculated as 6,020 - 1,900. (F) Number of people making trips, based on vehicle occupancy assumptions listed in Figure 4-6. (G) Number of people making new transit trips attributed to BRT. This is calculated as 8,400 – 2,730.

Source: Kane County Travel Demand Model; Analysis by CH2MHill

Figure 4-10 Comparison of 2040 Auto and Transit Trips in Corridor MOS by Scenario

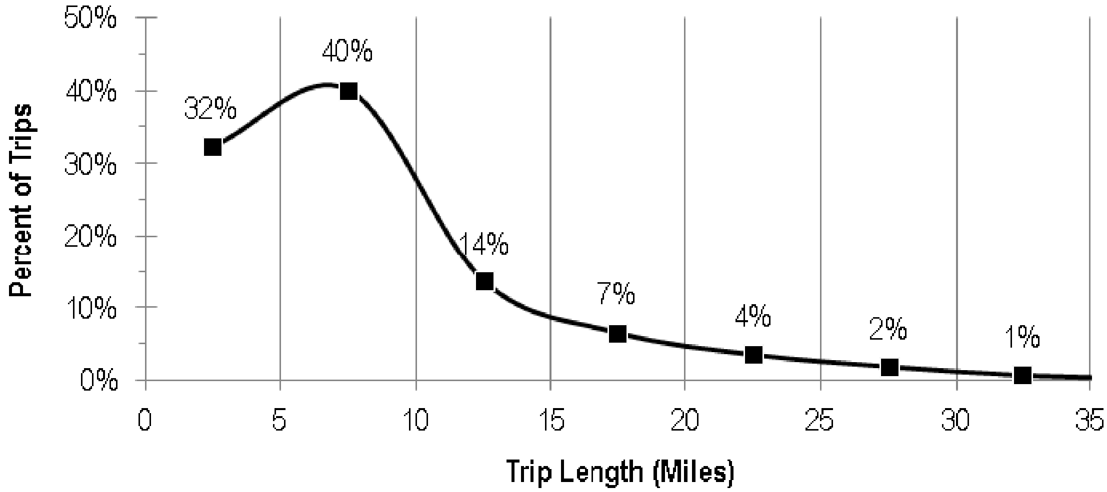


Trip Length

The total distance of the Randall/Orchard Road corridor MOS is 22.9 miles. Including traffic analysis zone boundaries that extend beyond the corridor MOS, the corridor length is approximately 25 miles. Between the north and south County lines, the corridor extends for over 30 miles.

Based on the macrosimulation model, the average trip length within Kane County for all trip purposes in 2040 is roughly 13 miles countywide and roughly 8.5 miles along the Randall/Orchard Road corridor. The macrosimulation model indicates that trip length is essentially constant between the 2040 Transportation Plan and the BRT/TOD scenarios, however this result is based on existing origin-destination patterns and survey data and, as discussed above, may understate the impact of compact land use patterns and mixed use development. Figure 4-11 depicts ranges of trip length as a percentage of trips for the Randall/Orchard Road corridor.

Figure 4-11 Vehicle Trip Length, 2040



Note: The study area includes traffic analysis zones that extend beyond the BRT corridor that are assumed to have access to station locations. Therefore some trip lengths are greater than the BRT minimum operable segment length of 22.9 miles).

Source: Kane County Travel Demand Model; Analysis by CH2MHill

Geographic Distribution of Trips

The Randall/Orchard Road corridor MOS was divided into three sections—North, Central and South—based on existing and future travel demand behavior observed from the travel demand model. The model reflects population and employment travel demand within and between the corridor sections. Inputs from the travel demand model were utilized to develop representative intersection/segment-level micro-simulation models for each section of the corridor. Figure 4-12 and Figure 4-13 identify the proportion of trips by section for the corridor.

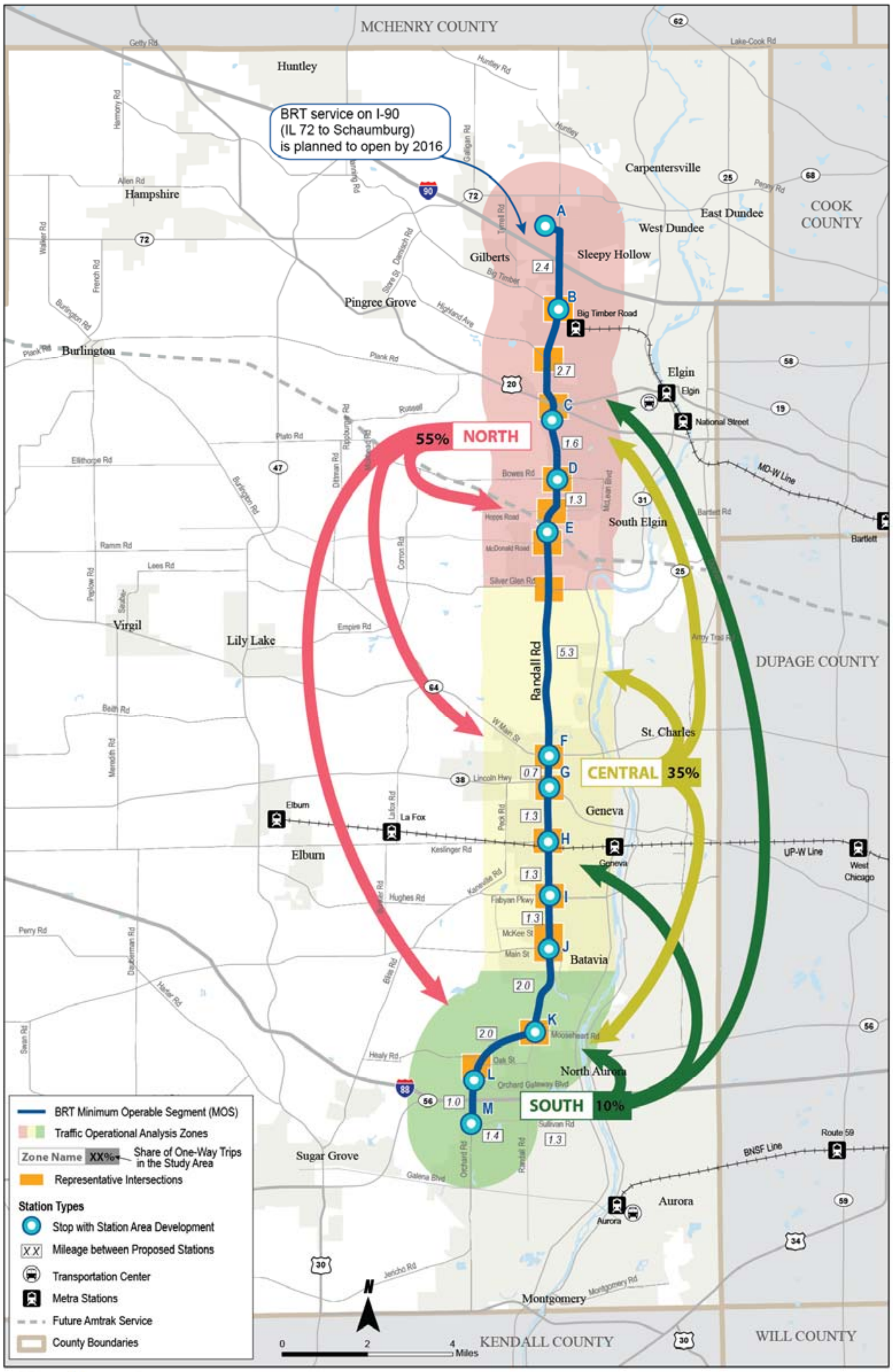
Figure 4-12 Geographic Distribution of Trips in Randall/Orchard Road Corridor, 2040

Randall Road Section	% of Trips	# Auto Trips (BRT/TOD)
North Section (I-90 to Silver Glen Rd)	55%	21,274
Central Section (Silver Glen Road to S. of Main Street, Batavia)	35%	13,538
South Section (S. of Main Street, Batavia to Sullivan Road)	10%	3,868

Note: The percentages represented in the table above describe trips encompassing both origins and destinations for all three sections of the corridor. *For example; 55% of the trips for the North Section constitutes trips that are originating in the North Section and ending in the North Section (N-N) plus trips originating in the North Section and ending in the Central and South Section (N-C & N-S) plus trips originating in the Central and South Section and ending in the North Section (C-N & S-N).*

Source: Kane County Travel Demand Model; Analysis by CH2MHill

Figure 4-13 Travel Demand Model, Distribution of Trips and Modeled Intersections



Nelson\Nygaard consulting associates

Microsimulation Modeling (Traffic Operational Analysis)

Key Findings: Traffic Operational Analysis

Relative to the corridor-focused development scenario:

- Implementing BRT with queue jumps to provide transit priority reduces travel time by an estimated 26% for buses and 13% for autos; queue jumps can function as general purpose right-turn lanes.
- Dedicating a third travel lane to exclusive transit use reduces transit travel time by 45%, but reducing auto capacity to two lanes increases auto travel times by 35%.

Traffic operational analysis, also known as microsimulation, was used to model the effects of projected travel demand and transit priority features in three sections of the corridor. One or more intersections were analyzed in each section. The simulation results were applied to representative intersections along the corridor to estimate auto and transit corridor travel time.

Figure 4-14 Intersections in Microsimulation Analysis

Randall Road Section	Modeled Intersections	# of Intersections Represented	Intersections Represented by Model
North Section (I-90 to Silver Glen Rd)	Big Timber Road Highland Avenue US-20 Weld Road	8	Big Timber Road Highland Ave US-20 Ramps Weld Road Bowes Road Hopps Road McDonald Road Silver Glen Road
Central Section (Silver Glen Road to S. of Main Street, Batavia)	Fabyan Parkway	5	Main St/IL-64 IL-38 Keslinger Road/Kaneville Road Fabyan Pkwy McKee Street / Main Street [1]
South Section (S. of Main Street, Batavia to Sullivan Road)	Orchard Road	2	Orchard Road Oak Street

Notes: (1) Coordinated signals

Source: Microsimulation Analysis by CH2MHill

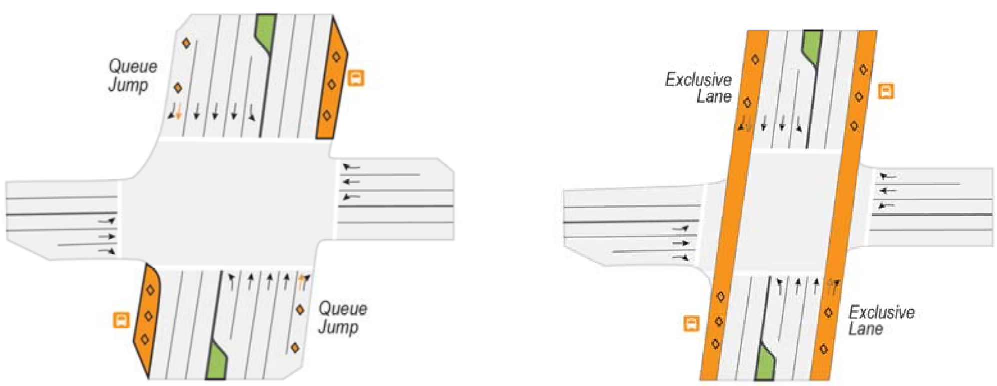
Simulation Results

The per-intersection travel time results from the microsimulation analysis were applied to the applicable intersections in each of the three sections of Randall/Orchard Road corridor MOS to estimate the auto and bus travel time impact under the 2040 Transportation Plan scenario and two transit priority scenarios for BRT service. In all cases, the travel time was for the PM peak hour and the full length of the corridor MOS was assumed to have a six-lane cross-section.

The two transit priority scenarios evaluated were (1) the use of queue jumps and (2) exclusive bus lanes, both of which are described more extensively in the BRT Primer (Appendix C):

1. **Queue Jumps**. An additional outside travel lane was assumed for 250 feet approaching the intersection.[15] This lane would be used in coordination with the traffic signal system to allow an approaching bus to bypass traffic queued at an intersection, proceed straight through the intersection, and reach a stop at the far side of the intersection with minimal delay. The lane could also be used by right-turning vehicles. The left panel of Figure 4-15 provides an illustration of a queue jump.
2. **Exclusive Lanes**. The outside (3rd) lane of Randall/Orchard Roads would be designated for exclusive use by buses, providing continuous transit lanes. Vehicles would be allowed to use the lane for right turns, or to reach a right-turn lane. The right panel of Figure 4-15 illustrates an exclusive lane treatment.

Figure 4-15 Transit Priority Treatments



Left: An additional right-turn lane provides a queue jump that allows buses to proceed straight through an intersection to a far-side bus stop. There would generally be three through lanes for general purpose travel. Right: A third, outside lane of the corridor would be converted to an exclusive lane for transit use (or added if not present). Two through lanes for general purpose travel would be provided and the transit lane could be utilized for right-turn movements, or to access a right-turn lane.

Source: Nelson\Nygaard

Intersection-level Delay

Figure 4-16 presents the effects on average intersection delay in each of the three sections of the Randall Road corridor from implementing these transit priority scenarios. Average delay is calculated as the change in average travel time to traverse an intersection between the BRT/TOD scenario with each transit priority approach and the same moderate-growth scenario traffic demand but without BRT service and the corresponding increase in transit mode split. In all three sections of Randall Road, the BRT queue jump scenario is estimated to reduce delay for both autos and transit vehicles. The reduction in auto travel time is due to the additional outside lane approaching an intersection that can be utilized by buses as well as right-turning cars. Providing

[15] Depending on the amount of congestion and delay, the queue jump lane may need to be longer than 250 feet at certain intersections.

transit priority using exclusive bus lanes reduces transit delay more than the queue jumps, but also increases auto delay.

Figure 4-16 Average Change in Intersection Delay Relative to Corridor-Focused Development Scenario Traffic Demand

Randall Road Section	Average Change in Delay (sec)			
	BRT/TOD with Queue Jumps		BRT/TOD with Exclusive Lanes	
	Auto	Bus	Auto	Bus
North Section	-17	-39	+13	-69
Central Section	-4	-11	+27	-16
South Section	-3	-10	+16	-18

Note: Negative change in delay represents faster travel

Source: Kane County Travel Demand Model and Microsimulation Analysis by CH2MHill

Corridor-wide Travel Time

Figure 4-17 presents the effects of the change in intersection delay on travel time for the Randall/Orchard Road corridor MOS. Implementing transit priority using queue jumps is estimated to reduce travel time by 13% for autos and by 26% for buses, compared to the corridor-focused development scenario. Implementing transit priority using exclusive bus lanes is estimated to reduce transit travel time by 45%, but reducing auto capacity to two lanes increases auto travel times by 35%.

Figure 4-17 Average PM Peak Hour Corridor Travel Time with Transit Priority Features

	Corridor-Focused Development	BRT/TOD with Queue Jumps	BRT/TOD with Exclusive Lanes
Auto Travel Time (Minutes)	46.0	40.0	62.0
% Change from Baseline	-	-13%	+35%
Bus Travel Time (Minutes)	58.0	43.0	32.0
% Change from Baseline	-	-26%	-45%

Source: Kane County Travel Demand Model and Microsimulation Analysis by CH2MHill

Performance of East-West Arterial Streets

The microsimulation analysis focused on the performance of the Randall/Orchard Road corridor MOS. Several significant east-west travel corridors have high levels of congestion in 2040, including Big Timber Road, Highland Avenue, US-20, and Silver Glen Road in the north section of the corridor; Main Street (IL-64), Keslinger Road, Kaneville Road, and Fabyan Parkway in the central section; and Orchard Road in the south section. Performance of cross-streets plays an important role in determining the available traffic signal cycle time to provide transit priority on the Randall/Orchard Road corridor mainline.

BENEFITS ANALYSIS

The benefits of BRT on the Randall/Orchard Road corridor MOS, as introduced in Figure 4-1 and summarized below, were evaluated using the trip characteristics derived from the macro- and micro-simulation transportation modeling. For the purpose of this analysis, the benefits of BRT are those that would be realized in addition to any benefits that are projected in the 2040 Transportation Plan. As appropriate, the BRT/TOD scenario is compared to the 2040 Transportation Plan (baseline) or the corridor-focused development scenario (moderate growth without BRT service).

This section first describes additional methodology and assumptions needed to evaluate each category of benefits. Each benefit area is described, including the relevance of the category, results, and other considerations such as data limitations or sources of uncertainty.

- Congestion Mitigation; Time and Cost Savings
- Transportation-Related Energy Usage and Emissions
- Community Health Impacts
- Land Use (e.g., land consumption, parking supply, etc.)
- Economic Development (e.g., jobs, economic opportunities)

Methodology and Additional Assumptions

Calculating BRT benefits required additional assumptions beyond those described in the Transportation Modeling section. In particular, it was necessary to incorporate assumptions for walking and biking, which are not addressed in the County's travel demand model. As described above, a 5.1% walking/biking mode split was assumed to account for walking and biking for relatively short trips that originate and end in BRT station areas. Figure 4-18 applies this assumption to the basic macro-simulation results provided in Figure 4-9. Results highlighted in the figure are those that are updated from the earlier table.

Figure 4-18 2040 Vehicle and Person Trips and Auto Mode Split with Post-Model Adjustments, Corridor MOS and BRT Station Areas

	Scenario-->	2040 Transportation Plan	Corridor-Focused Development	BRT/TOD Macrosimulation Model		BRT/TOD With Post-Model Adjustments [3]	
	Level of Corridor Growth by 2040	Baseline	Moderate Growth	Moderate Growth	Moderate Growth	Moderate Growth	Moderate Growth
	Land Use/Development Patterns in Randall/Orchard Corridor	Traditional	More intensive, nodal, and compact development	TOD in BRT Station Areas	TOD in BRT Station Areas	TOD in BRT Station Areas	TOD in BRT Station Areas
	Geography	Corridor MOS	Corridor MOS	In/Btwn Stat. Areas	Corridor MOS	In/Btwn Stat. Areas	Corridor MOS
A	Total Model Trips	24,500	44,700	29,500	44,700	29,500	44,700
B	Auto Vehicle Trips	23,410	42,800	24,140	38,680	22,660	37,190[6]
-		95.6%	95.7%	81.8%	86.5%	76.8%	83.2%
C	Transit Trips[1]	1,090	1,900	5,370	6,020	5,370	6,020
-		4.4%	4.3%	18.2%	13.5%	18.2%	13.5%
D	Vehicle Trips Shifted to Transit due to BRT	None	None	N/A[4]	4,120	N/A[4]	4,120
E	Auto Trips Shifted to Walk/Bike Trips	None	None	N/A[5]	N/A[5]	1,490	1,490[6]
F=D+E	Vehicle Trips Shifted/Reduced	None	None	N/A[4]	4,120	N/A[4]	5,610
G	Transit Person Trips[2]	1,610	2,730	5,370	8,400	5,370	8,400
H	New Transit (Person) Trips	None	None	N/A[4]	5,670	N/A[4]	5,670
I=G+H	New Walk/Bike (Person) Trips[2]	None	None	N/A[5]	N/A[5]	2,080	2,080[6]

Notes: This table is an adaptation of Figure 4-9. (1) Based on mode split assumptions listed in Figure 4-5. (2) Calculated using auto occupancy assumptions from travel demand model, listed in Figure 4-6. (3) Adjusted to incorporate walk/bike mode split for short trips that originate and end in BRT station areas. (4) Not determined specifically for station areas; analyzed at the corridor level. (5) Not available in County travel demand model. (6) Average based on low and high walk/bike mode split assumptions for trips that originate and end in BRT station areas.

Source: Kane County Travel Demand Model and Microsimulation Analysis by CH2MHill; Additional analysis by Nelson\Nygaard

Figure 4-19 presents additional assumptions used to quantity the BRT benefits.

Figure 4-19 Other Assumptions Used in Benefits Analysis

Assumption	Value	Description/Source
Cost of Driving (per mile, 2012)	$0.60	AAA, Cost of Driving, 2012. Based on composite small-medium-large sedan cost for annual driving of 15,000 miles per year. This estimate assumes a fuel cost of $3.36 per gallon, the late-2011 U.S. price from AAA's Fuel Gauge Report, www.FuelGaugeReport.com. Fuel mileage is based on EPA fuel-economy ratings weighted 60% city and 40% highway driving. http://newsroom.aaa.com/wp-content/uploads/2012/04/YourDrivingCosts2012.pdf
Transit Trip Cost (2012)	$1.75	Pace. Based on one-way adult fare. http://www.pacebus.com/sub/schedules/fare_information.asp
Pace Operating Cost per Hour (2012)	$104	Pace. Projected 2012 operating cost per vehicle revenue hour. http://www.pacebus.com/pdf/2012Budget/2012_Final_Budget_Book.pdf
Annualization Factor	250	Data from the macrosimulation model was annualized using a factor of 250 used in the Kane County travel demand model. By comparison the FTA Summit model for transit ridership estimation uses a factor of 280 and higher factors are observed in urban systems with a high degree of weekend use. While this is a goal for the BRT station areas, the lower value provides a more conservative estimate and remains consistent with the County's travel demand model. This same factor was used to annualize walking trips. Biking trips were annualized using a factor of 124, derived from bicycling in Stockholm and used in the World Health Organization's modeling tool (HEAT) for bicycling-related health impacts..
Value of a Statistical Life (VSL)	$6,200,000	U.S. DOT, This value is the most recent adjustment to 2008 US DOT guidance that placed the economic value of preventing a human fatality at $5.8 million, the mean value of various studies, within a range of $3.2 to $8.4 million. http://regs.dot.gov/docs/Value_of_Life_July_29_2011.pdf. Note: U.S. EPA recommends a higher value of $7.8 million associated with human mortality.
GhG Emissions per Gallon of Gas (grams)	8,887	U.S. EPA, Based on 2012-2016 emissions standards. http://www.epa.gov/otaq/climate/documents/420f11041.pdf

Congestion Mitigation (Traveler Delay and Cost)

Key Findings: Congestion Mitigation (Traveler Delay and Cost)

For the BRT/TOD scenarios relative to the corridor-focused development scenario:

- Implementing BRT with queue jumps saves existing transit riders an average of 5 minutes per trip compared to traditional bus, compared to 8 minutes per trip with exclusive bus lanes.
- For BRT riders, queue jumps result in a travel time of about 1 minute less than driving for an average trip. Exclusive lanes save BRT riders about 4 minutes per trip compared to driving.
- For drivers, queue jumps reduce travel times by an estimated 1.9 minutes on an average trip, since the queue jumps function as right-turn lanes, but dedicating a travel lane to transit increases travel time for drivers by about 5 minutes for an average trip.
- The combined effects for drivers, transit riders, and new transit riders is travel time savings over 1,500 daily hours with queue jumps, but an increase of nearly 2,400 daily travel hours with exclusive bus lanes, since driving still accounts for the majority of corridor trips.

This category of benefits includes direct savings (time and monetary) realized by people who continue to drive along the corridor and people who use transit. The benefits of BRT are assessed in comparison to the corridor-focused development scenario.

Travel Time Savings – Drivers

Drivers make an estimated nearly 43,000 auto trips[16] between zones along the MOS in the corridor-focused development scenario, with an average travel time of 46 minutes for the Randall/Orchard Road BRT corridor MOS, based on the afternoon peak period in the southbound direction. The length of an average trip is about a third of the corridor (eight miles).

In the BRT/TOD scenario, the number of auto trips falls to about 37,000, including increased transit use and increased use of walking and biking for short trips. Figure 4-20 presents total travel time savings for drivers for the two types of BRT transit priority improvements that were modeled, as described above.

- With queue jumps for BRT vehicles, auto travel time for the corridor MOS is estimated to decline by 13%, to 40 minutes, as the queue jump lanes also serve as right-turn lanes. Aggregate travel time is reduced by nearly 1,200 hours per day compared to the corridor-focused development scenario, or an average of 1.9 minutes saved per vehicle trip.
- With exclusive lanes, BRT is allowed exclusive use of one of the existing travel lanes (assuming three travel lanes in each direction for the corridor MOS). Average auto travel

[16] Current average daily traffic (ADT) of up to 60,000 peak vehicles is measured at specific intersections on Randall/Orchard Roads and may include vehicles not making trips along the length of the corridor as well as vehicles making trips that extend beyond the BRT MOS.

time for the corridor MOS is estimated to increase by nearly 35% to 62 minutes. Aggregate travel time increases by nearly 3,000 hours per day, or about five minutes per vehicle trip.

Other Considerations: Based on the modeling results, the distance traveled for an average trip remains constant, however more compact development patterns should reduce the length of an average trip, resulting in additional potential savings.

Figure 4-20 Daily Travel Time Savings - Drivers

	Scenario-->	Corridor-Focused Development	BRT/TOD with Queue Jumps	BRT/TOD with Exclusive Lanes
A	Auto Trips (daily)	42,800	37,200 [a]	37,200 [a]
B	Avg Travel Time (SB PM Peak)	46.0	40.0 (-13%)	62.0 (+35%)
C	Avg Trip Length as % of Corridor	32%	32%	32%
D=A*B*C	Aggregate Avg Travel Time (Hours/Day)	9,126 [b]	7,936	12,301
E	Travel Time Savings (Hours/Day)	-	1,190 [c]	-3,174 [c]
F = E/A	Average Minutes Saved per Vehicle Trip	-	1.9 (decrease)	-5.1 (increase)

Notes: (a) Includes estimated shift from auto to walking/biking for short trips originating and ending within BRT station areas. (b) 2040 daily auto trips with BRT multiplied by corridor-focused development scenario average travel time and trip length. (c) Aggregate travel time for each BRT/TOD scenario minus aggregate travel time for corridor-focused development scenario.

Source: Kane County Travel Demand Model and analysis by CH2MHill. Additional calculations by Nelson\Nygaard.

Travel Time Savings – Transit Users

Based on results from the macrosimulation model, BRT would also provide travel time savings for both existing (2040) transit riders and new riders attracted to BRT service. Figure 4-21 presents the travel time savings results.

Existing Riders

In the corridor-focused development scenario there are 1,900 vehicle-equivalent trips—over 2,700 person-trips—on transit in the Randall/Orchard Road corridor MOS (rows A and B); this is considered to be the baseline for transit use and assumes that by 2040 there would be more extensive transit service on Randall Road. Travel time savings for these passengers assume a bus would take 58 minutes to travel the length of the corridor MOS and that an average trip covers 32% of the MOS. On average, existing riders would save five minutes per day with queue jumps (218 hours in aggregate) and eight minutes with exclusive lanes (379 hours in aggregate).

Existing Auto-Travelers Shifting to Transit

There are nearly 5,700 net new daily transit person trips projected in the BRT/TOD scenario (row G). Travel time savings for these passengers assume that an auto would take 46 minutes to travel the length of the corridor and the same average trip length covering 32% of the corridor. On average, existing drivers would save one minute daily per trip with queue jumps (90 hours in aggregate) and four minutes with exclusive lanes (423 hours in aggregate).

Other Considerations: It should be noted that these results do not include transit access times or driving time prior to reaching the corridor.

Figure 4-21 Daily Travel Time Savings – Transit Riders

	Scenario-->	Corridor-Focused Development	BRT/TOD with Queue Jumps	BRT/TOD with Exclusive Lanes
EXISTING TRANSIT RIDERS				
A	2040 Daily Vehicle-Equivalent Transit Trips	1,900		
B	2040 Daily Transit Riders (Person Trips)	2,730	2,730	2,730
C	Avg Bus Travel Time (SB PM Peak)	58.0	43.0	32.0
D	Avg Trip Length as % of Corridor	32%	32%	32%
E = B*C*D	Aggregate Avg Travel Time (Hours/Day)	844	626	466
	Aggregate Travel Time Savings	-	218	379
F	Avg Minutes Saved per Rider	-	5	8
EXISTING AUTO TRAVELERS (SHIFTING TO TRANSIT)				
G	Net New Daily 2040 Transit Riders (Person Trips)	5,670	5,670	5,670
H	Avg Auto Travel Time (SB PM Peak)	46.0		
I	Avg Bus Travel Time (SB PM Peak)		43.0	32.0
J	Avg Trip Length as % of Corridor	32%	32%	32%
K = H*I*J	Aggregate Avg Transit Travel Time (Hours/Day)	1,391	1,300	968
	Aggregate Travel Time Savings	-	91	423
L	Avg Minutes Saved per Rider		1	4

Source: Kane County Travel Demand Model and analysis by CH2MHill. Additional calculations by Nelson\Nygaard.

Overall Travel Time Savings

Overall, considering drivers, transit riders, and new transit riders attracted to BRT from autos, implementing queue jumps for transit priority saves over 1,500 hours daily, a reduction of 13% from the corridor-focused development scenario. However, exclusive lanes increase overall travel time by nearly 2,400 hours daily, an increase of 20%, due to the increase in auto travel time.

Direct Cost Savings Relative to Driving

This section estimates direct cost savings from reduced driving and the lower monetary cost of riding transit, walking, and biking relative to driving. Figure 4-22 identifies the cost savings per capita from reduced driving for trips in the Randall/Orchard Road corridor MOS. VMT per capita is reduced by about 1.5 miles per day from the 2040 Transportation Plan scenario, which translates into annual cost savings of nearly $225 per person traveling in the corridor.

Figure 4-22 Direct Cost Savings from Reduced Driving in the Corridor MOS

Scenario-->	2040 Transportation Plan	BRT/TOD
VMT per Person Driving in Corridor [1]	9.7	8.2
Daily Cost per Capita	$5.76	$4.87
Annual Cost per Person Driving in Corridor (annualized at 250 days/year) [2]	$1,441	$1,217
Annual Savings per Person Driving in Corridor	-	$224

Notes: (1) Per capita refers to people contributing to VMT in the corridor MOS (based on macrosimulation model). (2) Annualization factor used in Kane County travel demand model.

Source: Kane County Travel Demand Model and analysis by CH2MHill. Additional calculations by Nelson\Nygaard.

Figure 4-23 shows the cost savings realized by new transit riders, based on the difference between the cost of driving and using transit. Driving costs for the estimated 4,930 vehicle trips that shift to transit in the BRT/TOD scenario are about $4.77 for an average trip, based on a 2012 cost of $0.60 per mile, which includes fuel costs of $3.36 per gallon. By comparison, the cost of a transit trip is $1.75, based on a 2012 Pace adult fare. Transit costs for 5,670 new transit riders are reduced by about $2.40 per trip, or nearly $600 per year.

Figure 4-23 Direct Cost Savings from Shifting Driving Trips to Transit

	Scenario-->	BRT/TOD
Driving Cost		
A	2040 Daily Vehicle Trips Shifted to Transit [1]	4,930
B	Driving Cost per Mile, 2012	$0.60
C	Average Trip Length (Miles)	8.0
D=B*C	Driving Cost per Trip	$4.77
E=A*D	Aggregate Daily Driving Cost	$23,506
Transit Cost		
F	New Daily 2040 Transit Person Trips [2]	5,670
G	Transit Cost	$1.75
H=F*G	Aggregate Daily Transit Cost	$9,923
Cost Savings		
I=(E+H)/F	Daily Cost Savings per New Rider	$2.40
J=I*270	Annual Cost Savings per New Rider[1]	$599

Notes: (1) Annualized using a factor of 250. (2) Vehicle trips converted to person trips on transit using macrosimulation model vehicle occupancy assumptions (between 1.15 to 1.60 persons per vehicle, depending on trip purpose).

Source: Kane County Travel Demand Model and analysis by CH2MHill. Additional calculations by Nelson\Nygaard.

A third category of direct cost savings is realized by drivers who shift to walking and bicycling for short trips in pedestrian-oriented, mixed-use BRT station areas, enabled by pedestrian and bicycle infrastructure and connectivity improvements along the corridor. As described above, it is estimated that nearly 1,500 daily vehicle-equivalent trips—trips by over 2,000 people—could shift to walking and biking. There would be cost savings of over $775,000 annually, or an average of nearly $375 per person shifting to walking and biking for short trips.

Figure 4-24 Direct Cost Savings from Shifting Short Station Area Trips to Walking and Biking

	Scenario-->	BRT/TOD
A	2040 New Walking/Biking Vehicle-Equivalent Trips	1,490
B	2040 New Walking/Biking Person Trips [1]	2,080
C	Assumed Average Length of Trips Replaced by Walking or Biking in TOD Land Use Environment [2]	2.5 Miles
D=A*C*Number of Days * $0.60	Annual Cost Savings (annualized at 250 days/year for walking and 125 days/year for biking) [3]	$776,200
E=D/B	Annual Cost Savings per Person Shifting to Walking/Biking	$373

Notes: (1) Vehicle trips converted to person trips using the macrosimulation model vehicle occupancy. (2) Assumes that walking/biking trips will replace auto trips with an average length of 2.5 miles (midpoint of the 0-5 mile trip category from the macrosimulation model). (3) Assumes a two-thirds / one-third split between walking and biking and a driving cost of $0.60 per mile. In addition to other annualization assumptions, bicycle trips are assumed only for half of the year due to weather.

Source: Kane County Travel Demand Model and analysis by CH2MHill. Additional calculations by Nelson\Nygaard.

Other Considerations: These results are sensitive to the cost of driving; the price of gas is one of the most variable components of this cost and the 2011 cost of $3.36 per gallon is assumed. Transit, walking, and biking would be expected to be more attractive if the cost of gas increases beyond current levels. As described in the following sections, it should be noted that short vehicle trips that walking and biking could replace are responsible for a disproportionate share of air pollution due to “cold starts.”

Transportation-Related Energy Usage and Emissions

Key Findings: Energy Usage and Emissions

Relative to the corridor-focused development scenario:

- The shift of auto trips to BRT and walking/bicycling results in an estimated annual fuel savings of nearly 329,000 gallons of gasoline. BRT service offsets this fuel savings with an estimated use of over 371,000 gallons of diesel fuel (assuming hybrid-electric or equivalent technology that should be economically feasible by 2040).
- The shift of auto trips to BRT and walking/bicycling is estimated to reduce GhG emissions by nearly 3,100 CO_2-equivalent metric tons annually in the Randall/Orchard Road Corridor, a reduction of about 3.1%. County-wide, emissions are estimated to fall by about 2%. Emissions from BRT would exceed the estimated reductions in the corridor by about 11%, but are just 9% of the estimated reduction in County-wide emissions.
- As a result of emerging stringent emissions standards for passenger vehicles and buses, estimated reductions in air quality are relatively marginal compared to regional air pollutant emissions. (As discussed below, these results are based on average emissions factors and detailed modeling would more accurately estimate overall and localized benefits.) BRT's contribution to emissions is comparatively small.

Transportation-related emissions (greenhouse gases and other criteria pollutants) and energy usage are primarily related to vehicle fuel efficiency, type of fuel consumed, and vehicle miles traveled (VMT). As described above, the VMT effects include:

- Per-capita VMT in the corridor is projected to decline from 9.7 in the 2040 Transportation Plan scenario to 8.2 in the BRT/TOD scenario, a reduction of 15.5%.
- Due to a 19.3% increase in the population contributing to VMT in the corridor, corridor VMT is projected to increase slightly (0.8%) in the BRT/TOD scenario compared to the 2040 Transportation Plan. This is because overall growth is being reallocated to the corridor and it is accepting a greater share of the County's projected population and job growth.
- County-wide VMT is projected to decline by 1.6% in the BRT/TOD scenario. Daily per-capita VMT of 10.8 for the County overall is projected to be 3.5% lower than the 2040 Transportation Plan baseline.

At a high-level, these trends translate into County-wide reductions in energy usage, GhG emissions, and air pollutant emissions, in proportion to the reduction in VMT. The following sub-sections provide a more in-depth discussion of these topics and estimate the potential for reductions in transportation-related energy usage and emissions based on the number of vehicle trips projected to shift to transit or walking and bicycling.

Transportation-Related Energy Usage

Transportation-related energy consumption is related to the amount of motor vehicle travel. BRT directly affects fuel consumption by shifting travelers away from single-occupant vehicles (SOV), thereby reducing auto trips and VMT. It can also foster compact development patterns that enable more non-SOV trips and shorter SOV trips.

Figure 4-25 shows the effect on fuel consumption from auto trips that shift to BRT (row A) or from short auto trips that shift to walking or bicycling (row B). The analysis compares the BRT/TOD scenario to the corridor-focused development scenario in order to show the impact of BRT with growth held constant. Annual fuel savings are estimated at over 295,000 gallons from trips that shift to transit and about 33,000 gallons from short trips that shift to walking and biking, a total of nearly 329,000 gallons annually.

Figure 4-25 Fuel Savings from Replaced Auto Trips, Randall/Orchard Corridor MOS

	Category	2040 New Daily Vehicle Trips Reduced	Annual Auto Trips Replaced[1]	Average Vehicle Trip Length[2]	Annual VMT Reduction	Annual Fuel Savings[3] (Gallons)
A	Shift to BRT	4,120	1,030,000	8.0	8,240,000	295,340
B	Shift Walk/Bike	1,490 [a]	372,500	2.5	931,250	33,380
C	TOTAL	5,610	1,402,500	-	9,171,250	328,720

Notes: (1) Annualized using a factor of 250 used in the Kane County travel demand model. (2) Assumes that transit trips will replace auto trips with an average trip length of 8.0 miles and that walking/biking trips will replace auto trips with an average length of 2.5 miles (midpoint of the 0-5 mile trip category from the macrosimulation model). (3) Assumes fleet fuel efficiency of 27.9 MPG, based on U.S. Energy Information Administration (EIA), 2011 Annual Energy Outlook, 2035 projection for on-the-road light-duty vehicle stock fuel efficiency, combined car and light truck. (a) Assumes average of estimates of number of short trips that will shift to walking and biking.

Source: Kane County Travel Demand Model and analysis by CH2MHill. Additional calculations by Nelson\Nygaard

Figure 4-26 identifies the fuel consumption and GhG emissions impacts of providing BRT service in the Randall/Orchard Road corridor. It provides estimates for conventional diesel and hybrid-electric vehicles, which are assumed to be about 50% more fuel efficient than conventional diesel buses based on various studies (see note #2 in the figure below). BRT vehicles are estimated to consume over 371,000 gallons of diesel fuel annually assuming hybrid bus technology or over 557,000 gallons assuming a conventional diesel bus. By 2040 it should be cost-effective to adopt hybrid technology—or an alternative fuel technology with similar or better fuel efficiency and emissions characteristics.

Figure 4-26 Fuel Savings from BRT Service, Randall/Orchard Corridor MOS

	Fuel Type	Annual Vehicle Miles[1]	Annual Fuel Consumption [2] (Gallons of Diesel)
A	Conventional Diesel	1,226,060	557,300
B	Hybrid	1,226,060	371,500

Notes: (1) Assumes a 25-mile one-way distance and BRT operating characteristics described in Chapter 3, including weekday frequency of buses every 10 minutes during peak hours, 15 minutes during off-peak hours (including weekend daytime), and 30 minutes at night. (2) Assumes conventional diesel bus fuel efficiency of 2.2 miles per gallon and hybrid-electric bus fuel efficiency of 3.3 miles per gallon. Source: Calculations based on National Renewable Energy Laboratory testing of 60-foot diesel and hybrid buses, cited in Vincent and Jerram, The Potential for Bus Rapid Transit to Reduce Transportation-Related CO_2 Emissions, *Journal of Public Transportation*, 2006. http://www.gobrt.org/BTI_BRT_CO2_Journal_2006.pdf. Studies for King County Metro (Seattle) and New York City Transit show similar results.

Source: Nelson\Nygaard

Other Considerations: The analysis does not incorporate assumptions for adoption of alternative fuel types in light-duty vehicles. The transit analysis also does not incorporate projections for transit fuel efficiency that may be attained by 2040, or alternative fueling types other than diesel hybrid electric (as such decisions would likely be made by Pace as part of an overall strategy).

Greenhouse Gas Emissions

Auto-Related GhG Emissions

Building upon the calculations of fuel consumption, Figure 4-27 presents analysis of greenhouse gas (GhG) emissions impacts of motor vehicle trips that shift to BRT, walking, and bicycling. Vehicle trips that shift to BRT are estimated to reduce GhG emissions by nearly 2,800 MT CO_2e, while trips that can be made using walking and bicycling account for reductions of an additional over 300 MT CO_2e. The total reduction of about 3,100 MT CO_2e represents about a 3.1% decrease over GhG emissions in the corridor-focused development scenario.

The level of GhG emissions is highly dependent on fuel efficiency; a fleet average of 28 miles per gallon is assumed (see note #1 in the figure below). The calculations include carbon dioxide (CO_2), which is the primary greenhouse gas, as well as a factor to include several gases that comprise a small share of vehicle emissions, but are potent greenhouse gases: methane (CH_4) and nitrous oxide (N_2O), as well as hydrofluorocarbons (HFCs), which are emitted from leaking air conditioners. The calculations assume that emissions of these gases are about 5% of the level of CO_2 emissions.

Figure 4-27 Fuel Savings and GhG Emissions Reductions from Replaced Auto Trips, Randall/Orchard Corridor MOS

	Category	Annual Auto Trips Replaced	Annual VMT Reduction	Annual Fuel Savings[1] (Gallons)	Annual GhG Reduction (MT CO2e) [2]
A	Shift to BRT	1,030,000	8,240,000	295,300	2,762
B	Shift Walk/Bike	372,500	931,000	33,400	312
C	TOTAL	1,402,500	9,171,000	328,700	3,075

Notes: (1) Assumes fleet fuel efficiency of 27.9 MPG, based on U.S. Energy Information Administration (EIA), 2011 Annual Energy Outlook, 2035 projection for on-the-road light-duty vehicle stock fuel efficiency, combined car and light truck. (2) Based on a factor of 8,887 grams of CO_2 per gallon of gas, assuming 2012-2016 emissions standards, from U.S. EPA. http://www.epa.gov/otaq/climate/documents/420f11041.pdf

Source: Nelson\Nygaard

BRT-Related GhG Emissions

As in the above discussion of fuel consumption, use of diesel-hybrid buses is assumed. BRT vehicles are estimated to emit over 3,900 MT CO_2e annually, as shown in Figure 4-28. Based solely on the corridor-level model results, when accounting for emissions from BRT this would represent a net increase of over 400 MT CO_2e in overall GhG emissions with BRT, compared to the corridor-focused development scenario. However, this result should be considered in the context of several other factors:

- Data for bus vehicle emissions is more typical of an urban environment rather than a BRT system operating with fewer stops and at a higher average speed, and therefore likely overestimates emissions.[17]
- Transit emissions are often considered in terms of emissions per passenger-mile. BRT emissions equate to about 317 grams of CO_2e per passenger-mile annually (Figure 4-28) based on the transportation modeling data. This includes both new BRT trips and an assumption for use of BRT as part of existing 2040 transit trips (see note #4 in Figure 4-28). By comparison, a research study estimated typical emissions of 294 grams per passenger-mile annually for standard bus service and 66 grams per passenger-mile on a well-utilized BRT system, illustrating the potential of BRT.[18]
- Under the BRT/TOD scenario, a greater share of county-wide growth has been focused on the Randall/Orchard Road Corridor, therefore County-wide modeling results illustrate the broader GhG emissions impacts. Figure 4-29 compares County-wide emissions for the BRT/TOD scenario to the 2040 Transportation Plan and corridor-focused development scenarios. Emissions decline by about 2% relative to the corridor-focused development scenario.

Figure 4-28 Fuel Savings and GhG Emissions from BRT Service

	Fuel Type	Annual Vehicle Miles[1]	Annual Fuel Consumption [2] (Gallons of Diesel)	Annual GhG Emissions [3] (MT CO_2e)	Annual GhG Emissions per Passenger-Mile [4] (Grams)
A	Conventional Diesel	1,226,060	557,300	5,970	476
B	Hybrid	1,226,060	371,530	3,980	317

Notes: (1) Assumes a 25-mile one-way distance and BRT operating characteristics described in Chapter 3, including weekday frequency of every 10 minutes during peak hours, 15 minutes during off-peak hours (including weekend daytime), and 30 minutes at night. (2) Assumes conventional diesel bus fuel efficiency of 2.2 miles per gallon and hybrid-electric bus fuel efficiency of 3.3 miles per gallon. Source: Calculations based on National Renewable Energy Laboratory testing of 60-foot diesel and hybrid buses, cited in Vincent and Jerram, 2006. Studies for King County Metro (Seattle) and New York City Transit show similar results. (3) Based on emissions factor of 0.01018 MT CO2e per gallon of diesel. GhG calculation increased by 5% to account for GhGs other than CO_2 (CH_4, N_2O, and HFCs), at high end of range in EPA guidance. Source: U.S. EPA, Greenhouse Gas Emissions from a Typical Passenger Vehicle, December 2011. (4) The calculation of BRT passenger-miles assumes that 50% of existing 2040 transit riders would use BRT for a portion of a trip (assumed to be two-thirds of an average 8-mile trip).

Source: Nelson\Nygaard

[17] Vincent and Jerram, 2006.

[18] Vincent and Jerram, The Potential for Bus Rapid Transit to Reduce Transportation-Related CO_2 Emissions, *Journal of Public Transportation*, 2006. http://www.gobrt.org/BTI_BRT_CO2_Journal_2006.pdf.

Figure 4-29 Fuel Savings and GhG Emissions, County-Wide

	2040 Scenario	Annual VMT Reduction	Annual Fuel Savings[1] (Gallons)	Annual GhG Reduction (MT CO2e) [2]
A	2040 Transportation Plan	5.62 M	2.01 M	1.88 M
B	Corridor-Focused Development	5.64 M	2.02 M	1.89 M
C	BRT/TOD	5.54 M	1.98 M	1.85 M
	Reduction in BRT/TOD (C) compared to 2040 Transportation Plan (A)			31,054 (-1.6%)
	Reduction in BRT/TOD (C) compared to Corridor-Focused Development (B)			37,192 (-2.0%)

Notes: (1) Assumes fleet fuel efficiency of 27.9 MPG, based on U.S. Energy Information Administration (EIA), 2011 Annual Energy Outlook, 2035 projection for on-the-road light-duty vehicle stock fuel efficiency, combined car and light truck. (2) Based on a factor of 8,887 grams of CO_2 per gallon of gas, assuming 2012-2016 emissions standards, from U.S. EPA. (3) The calculation of BRT passenger-miles assumes that 50% of existing 2040 transit riders would use BRT for a portion of a trip (assumed to be two-thirds of an average 8-mile trip).

Source: Nelson\Nygaard

Other Considerations: The analysis does not incorporate assumptions for adoption of alternative fuel types in light-duty vehicles or projections for transit fuel types or fuel efficiency that may be possible by 2040. Per-passenger emissions offer a useful benchmark for comparing transit emissions (however, estimating ridership is beyond the scope of this analysis).

Air Quality

Automobile tailpipe emissions contain pollutants that are associated with adverse effects on human health, either through direct emissions or by contributing to elevated concentrations of other pollutants that are formed in the air, such as particulates or ground-level ozone from reaction of NOx and VOCs. A significant portion of pollutant emissions are from the transportation sector.

BRT reduces overall VMT and thus air pollutant emissions in Kane County, based on macrosimulation results. This reduction is due to shifting auto trips to transit and fostering a land use environment that is more conducive to walking and biking to accomplish routine trips, or making shorter auto trips. Pollutant emissions are not uniform and short automobile trips contribute disproportionately to the air quality impact of driving. The first few minutes of automobile operation before emission control systems become fully effective, known as "cold starts," account for 25% of VOCs and 19% of primary PM2.5 emissions.[19] Nearly a third of trips in the Randall/Orchard Road corridor MOS are projected to be under five miles in length and a portion of these relatively short trips could be accomplished by walking or bicycling. The role of BRT in fostering a built environment that is conducive to walking and biking for short trip can thus have a significant impact on air quality.

Auto-Related Air Pollutant Emissions

Figure 4-30 provides high-level estimates of reductions in pollutant emissions, based on average emissions factors per VMT for each pollutant. Row C identifies the estimated total annual reduction, including trips that shift to BRT (row A) and short trips that shift to walking and

[19] M. L.Grabow, S.N. Spak, et al., "Air Quality and Exercise-Related Health Benefits from Reduced Car Travel in the Midwestern United States," *Environmental Health Perspectives*, 2012. No. 120, p. 68-76. http://dx.doi.org/10.1289/ehp.1103440

bicycling (row B). By comparison, CMAP's air quality conformity analysis for the 2040 Regional Transportation Plan (RTP) identifies projected 2040 regional emissions of about 52 tons of NOx and 62 tons of VOCs per summer *day* for ozone conformity. The RTP analysis projects annual regional emissions of over 20,000 tons of NOx and over 1,000 tons of PM2.5 (direct) in 2040.

Figure 4-30 Passenger Vehicle Emissions Reductions in Air Pollutants, Randall/Orchard Corridor MOS

	Source of VMT Reduction	Annual VMT Reduced	Annual Pollutant Emissions Reduced[1, 2] (MT)				
			NOx	PM2.5	SO_2	CO	VOC
A	Shift to Transit (BRT)	8,240,000	12.7	0.4	0.7	192.8	25.2
B	Shift Walk/Bike	931,000	1.4	0.0	0.1	21.8	2.8
C= A+B	TOTAL	9,171,000	14.2	0.5	0.8	214.5	28.1

Notes: (1) Based on VMT and emissions factors from the Center for Clean Air Policy (CCAP), 2007. NOx=Nitrogen Oxides, PM-2.5=Fine Particulates, SO_2=Sulfur Dioxides, CO=Carbon Monoxide, VOC=Volatile Organic Compounds

Source: Nelson\Nygaard

BRT-Related Air Pollutant Emissions

Figure 4-31 shows pollutant emissions from BRT vehicles, assuming a "cleaner" diesel bus available in 2010 with after-market emissions technology. It is assumed that emissions technology meeting or exceeding this level will be available by 2040. The new emissions generated by BRT are small relative to the reduction in passenger vehicle emissions listed in Figure 4-30 (above).

Figure 4-31 Transit Air Pollutant Emissions

	Annual VMT	Pollutant Emissions Generated [2] (MT)	
		NOx	PM10
BRT (Diesel Hybrid)	1,226,060	1.0	0.02

Notes: (1) California Air Resources Board, Methods to Find the Cost-Effectiveness of Funding Air Quality Projects,Emissions Factor Tables, Table 6, Cleaner diesel bus with emissions treatment technology. http://www.arb.ca.gov/planning/tsaq/eval/emftables.pdf.
(2) NOx=Nitrogen Oxides, PM10= Particulates

Source: Nelson\Nygaard

Other Considerations: The high-level approach used to estimate air quality uses national average emissions factors; however actual air quality impacts are dependent on other, highly local factors including weather patterns and more specific trip characteristics (e.g., trip length, "chaining" of short trips that reduces cold starts, etc.). Localized modeling could be accomplished using a model such as the EPA's MOVES model. In addition, there are numerous sources of uncertainty related to air pollutant emissions trends. These include adoption of more stringent emissions standards (e.g., in 2004, light trucks were subjected to same emissions standards as autos) and increasing use of vehicles that do not have internal combustion engines (electric vehicles).

Community Health Impacts

Key Findings: Community Health Impacts

Relative to the corridor-focused development scenario:

- Although localized modeling would be required to accurately estimate the health-related effects of BRT in the Randall/Orchard corridor, the effects of BRT in reducing air pollutant emissions would be expected to confirm applicability of localized research conducted in the Midwest. This research modeled the effects of reducing short automobile trips, and found reduced concentrations of air pollutants, resulting in health benefits including lower mortality and improvement in various health outcomes.
- The health benefit of walking and bicycling (including transit access and short trips) is estimated at over $980,000 annually, including both mortality and the effects of disease/injury. These benefits result from an estimated 125 annual miles of walking or over 185 annual miles of biking per person making these trips.
- Based on national average rates, auto-related related fatalities and injuries would decline slightly (about 3%) as a result of reduced auto VMT, with a small portion of the resulting reductions in auto-related fatalities and injuries (about 5% and 20%, respectively) offset by fatalities and injuries attributed to BRT. About 1.6 crimes per year are estimated to occur on BRT on average.

Air Quality

The previous section detailed the relationship between driving and air pollution and the potential effects of BRT in reducing the level of air pollutant emissions. Health impacts related to air pollution include the following, which particularly affect individuals with existing heart and lung conditions or diabetes, older adults, and children:[20]

- Aggravation of respiratory and cardiovascular disease
- Increased frequency and severity of respiratory symptoms such as difficulty breathing and coughing
- Increased susceptibility to respiratory infections
- Effects on the nervous system, including the brain, such as IQ loss and impacts on learning, memory, and behavior
- Increased cancer risk
- Premature death

The public health impact of air pollution reductions can be assessed using factors that relate the change in the concentration of a pollutant to a change in the incidence of an adverse health outcome, based on epidemiological studies. A tool such as the EPA's BenMap model can be used to apply localized data on air quality impacts and health responses to estimate the effect of a change such as implementing BRT on the Randall Road corridor. Such an analysis is beyond the

[20] http://www.epa.gov/airtrends/2011/report/airpollution.pdf

scope of this report, however a recent study[21] utilized the BenMap tool to analyze the health outcomes from shifting 50% of short automobile trips (less than about five miles round trip) to bicycling in 11 Metropolitan Statistical Areas (MSAs) in the Midwest. Results from this study are summarized below to illustrate analogous effects on health. Figure 4-32 provides the results of reducing concentrations of fine particulates (PM2.5) and ozone (O3) for various health outcomes, in terms of incidences per year over the 11 MSA region and normalized by this regional population.

Figure 4-32 Estimated Annual Reduction in Adverse Health Incidences per Reduction in Pollutant Level from Converting 50% of Short Trips to Bicycling in 11 MSA Region

Pollutant	Mean Reduction in Pollutant Concentration	Annual Reduction in Adverse Health Incidences					
Fine Particulates		Mortality	Asthma	Chronic Bronchitis	Respiratory Problems	Cardiovascular Problems	Work-Loss
PM2.5[a] (per unit reduction)	0.01 ug/m^3	433	2,018	75	93,607	659	15,607
Per Capita (Millions of People)		13.8	64.5	2.4	2990.6	21.1	498.6
Ozone		Mortality	Acute Respiratory Problems	ER Visits (Respiratory)	Acute Respiratory Problems	School Day Loss	Worker Productivity
O_3 (Ozone)[b] (per unit reduction)	0.07 ppm	9	3,467	963	3,467	976	2,627
Per Capita (Millions of People)		0.3	110.8	30.8	110.8	31.2	83.9

Notes: (a) Change in $PM_{2.5}$ is in micrograms per cubic meter, mean over a grid area. (b) Change in O_3 is in parts per million, season average daily maximum, mean over a grid area.

Source: Grabow, Spak, et al, 2012. Tables 1 and 2.

Other Considerations: Although there is clear evidence concerning the effects of air pollutant emissions on public health, evaluating the benefits requires localized analysis using models such as the EPA BenMAP model, as used in the analysis summarized above.

Active Transportation

Active Transportation refers to non-motorized transportation modes, such as walking and bicycling, integrated with public transportation, that help incorporate physical activity into everyday routines. The World Health Organization's *Transport, Environment, and Health* report cites the following benefits from sustained physical activity[22]:

- 50% reduction in the risk of developing heart disease (similar effect to not smoking)
- 50% reduction in the risk of developing adult diabetes

[21] Grabow, Spak, et al., 2012.

[22] http://www.euro.who.int/__data/assets/pdf_file/0003/87573/E72015.pdf

- 50% reduction in the risk of becoming obese
- 30% reduction in the risk of developing hypertension
- Decline in blood pressure in people with hypertension (a similar effect to drugs)
- Reduced osteoporosis
- Relief of symptoms of depression and anxiety
- Prevention of falls in the elderly.

The Centers for Disease Control (CDC) recommends that adults have at least 150 minutes per week of moderate physical activity—an average of 22 minutes per day—and suggests that this level of activity can be attained in a 10-minute walk, three times a day, five days a week, [23] such as through walking and bicycling as part of commuting or everyday routines. In the Chicago metropolitan area, nearly 38% of adults had insufficient (more than 10 minutes per week but less than the recommended level) physical activity in 2005, while about 13% of the population had less than 10 minutes per week of physical activity.[24] Various studies have found that transit users are more likely to take more frequent and longer walking trips; most transit trips involve walking on at least one end of the trip.[25]

The previous section discussed a study of health benefits from air quality improvements resulting from use of bicycling for 50% of short trips. This study utilized the World Health Organization's HEAT model to estimate annual benefits from reduced mortality for short suburban trips in the Chicago area. The results include annual savings of nearly $2,300 per cyclist per year among over 211,500 cyclists, or over $10 per average 2.2 mile trip, and 131 lives saved annually.[26]

Figure 4-33 estimates that about 125 miles of walking or over 185 miles of biking annually per new transit rider walking or bicycling to BRT stops on the Randall/Orchard Road corridor. The estimates assume average walking access trips of a half-mile and biking access trips of 1.5 miles. Figure 4-34 estimates the amount of annual walking and biking for short trips. Both estimates assume mixed-uses and safe, convenient pedestrian and bicycle access routes to destinations.

[23] CDC, http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html

[24] CDC, http://www.cdc.gov/nccdphp/dnpa/physical/stats/metropolitan.htm

[25] Victoria Transport Policy Institute, *Public Transit Benefits and Costs*, 2012, p. 43. http://www.vtpi.org/tranben.pdf

[26] Grabow, Spak, et al, 2012. Table 3.

Figure 4-33 Assumptions for Walking and Bicycling Distances for Access to Transit (BRT/TOD)

Access mode -->	Walking	Bicycling
# Net New Riders	5,670	
Mode Share[1]	67%	33%
# Access Trips	3,800	1,870
Avg. Access Distance per Trip (Miles)2	0.5	1.5
Total Daily Access Distance (Miles)	1,900	2,805
Days per Year3	250	124
Total Annual Access Distance (Miles)3	475,000	347,800
Annual Distance per Person Making Trips	125	186

Notes: (1) Assumes a walking/biking mode split of two-thirds walking and one-third bicycling trips. (2) Assumes average half-mile walk (station areas are about a half-mile radius) and 1.5 mile bicycle trip (the FTA uses a three-mile bicycle catchment area in its guidance for funding grants). (3) Walking trips are annualized using the travel demand model factor of 250. Biking trips are annualized by a factor 124 (recommended by the WHO HEAT tool, derived from bicycling in Stockholm); this assumes bicycling primarily during dry-weather months.

Figure 4-34 Assumptions for Walking and Bicycling Distances for Short Trips (BRT/TOD)

Access mode -->	Walking	Bicycling
# Net New Walking/Biking Trips	5,400	
Mode Share[1]	67%	33%
# Trips	1,390	690
Avg Distance per Trip (Miles)[2]	0.5	1.5
Total Daily Distance (Miles)	695	1,035
Days per Year	250	124
Total Annual Distance (Miles)[3]	173,750	128,340
Annual Distance per Person Making Trips	125	186

Notes: (1) Assumes a walking/biking mode split of two-thirds walking and one-third bicycling trips. (2) Assumes average half-mile walk (station areas are about a half-mile radius) and 1.5 mile bicycle trip (the FTA uses a three-mile bicycle catchment area in its guidance for funding grants). (3) Walking trips are annualized using the travel demand model factor of 250. Biking trips are annualized by a factor 124 (recommended by the WHO HEAT tool, derived from bicycling in Stockholm); this assumes bicycling primarily during dry-weather months.

Figure 4-35 estimates the benefits from physical activity from the estimated walking and bicycling, based on a study by the New Zealand Transport Agency.[27] These estimates include both mortality and morbidity (including reduced quality of life due to injury or disease). The methodology weights the benefits received per person by their level of physical activity, with an active person receiving fewer benefits from increased activity than an inactive or sedentary

[27] New Zealand Transport Agency, "Valuing the health benefits of physical activity," Research Report 359, 2008. http://trid.trb.org/view.aspx?id=889301

person. The walking and biking distances were assigned to one of these categories based on local data.

The annual health benefits of physical activity are estimated at nearly $720,000 from walking and over $260,000 from biking, a total of over $980,000, using the mean benefit per person of about $2,900 in the methodology (low end of $2,400 and high end of $3,400).

<u>Other Considerations:</u> The New Zealand Transport Agency methodology used a Value of Statistical Life of about $2.5 million. This is half (or less) than U.S. DOT or U.S. EPA standards, however it is approximately at the lower end of current U.S. EPA guidance.

Figure 4-35 Benefits from Increased Physical Activity due to Walking and Bicycling (BRT/TOD)

		Total Distance (from above tables)	Physical Activity Level			Weighted Benefit per Person
			Sedentary	Inactive	Active	
A	Benefit Weight		1.00	0.85	0.15	
B	% Physically Active[1]		11.6%	34.9%	53.5%	
C	Mean Benefit (US $)[2]		$337	$859	$232	$1,428
	WALKING	Total Distance Walked				
D=D1*A*B	Transit Access	474,860	55,202	140,808	38,119	
E=E1*A*B	Short Trips	173,750	20,198	51,506	13,943	
F=D+E	Total Distance	648,750	75,417	192,314	52,062	
G	Walking required for benefits (Miles)		388	280	194	
H=C/G	Benefit (US $ / Mile)		$0.87	$3.07	$1.20	$5.00
I=C*G	Total Walking Benefit		$65,400	$590,500	$62,400	$718,300
	BIKING	Total Distance Biked				
J=J1*A*B	Transit Access	347,820	40,434	103,107	27,913	
K=K1*A*B	Short Trips	128,340	14,920	38,045	10,299	
L=J+K	Total Distance	476,160	55,354	141,152	38,212	
M	Cycling Required for Benefits (Miles)		777	559	388	
N=C/M	Benefit (US $ / Mile)		$0.43	$1.54	$0.60	$2.57
O=L*N	Total Bicycling Benefit		$24,000	$216,700	$22,900	$263,600
P=I+O	Combined Walking and Biking Benefit					$981,900

Notes: (1) "Active" was based on the percentage of Kane County's population estimated to have a sufficient level of physical activity (from the County's 2011 Health Assessment), while the remainder was split between inactive or sedentary percentage based on 2005 CDC data for the Chicago region. (2) Based on a total benefit of $2,896, weighted by the benefit weighting factor in Row A and allocated by the local level of physical activity in Row B.

Source: Analysis based on methodology in New Zealand Transport Agency, "Valuing the health benefits of physical activity," Research Report 359, 2008.

Safety

Statistics show that transit is a relatively safe mode of travel compared to passenger vehicles. The American Public Transit Association (APTA) estimated the rate of fatal accidents per transit passenger mile (all public transportation modes combined) to be 1/25th the rate of fatalities per highway passenger mile for the years 2002 to 2006.[28]

Figure 4-36 provides fatality, injury, and crimes rates per 100 million VMT for both passenger vehicles and buses. Motor vehicle-related injuries and fatalities occur at national average rates of 0.9 fatalities and 83 injuries, respectively, per 100 million VMT.[29] Analogous rates for buses are 0.3 fatalities and 124 injuries per 100 million transit vehicle-miles.[30] Based on Randall/Orchard corridor VMT trends, injuries and fatalities would be expected to increase slightly (less than 1%), but decline by about 15.5% on a per capita basis in the BRT/TOD scenario.

Figure 4-36 Annual Fatality, Injury, and Crime Rates per 100 Million VMT

	Fatalities	Injuries	Violent Crime	Other Offenses [c]	Property Crime
Passenger Car Occupants	0.83 [a]	83 [a]	-	-	-
Motor Bus	0.32 [b]	124 [b]	12.2 [c]	104 [c]	12.7 [c]

Source: Bureau of Transportation Statistics (BTS), National Transportation Statistics, 2010. http://www.bts.gov/publications/national_transportation_statistics. (a) Table 2-21: Passenger Car Occupant Safety Data (Preliminary). (b) Table 2-24: Bus Occupant Safety Data (Preliminary). (c) Table 2-38: Reports of Violent Crime, Property Crime, and Arrests by Transit Mode. "Other offenses" include arrests for other assaults, vandalism; trespassing and fare evasion. Bus VMT is from National Transportation Statistics, Table 2-24.

Figure 4-37 shows estimates for average annual reduction in fatalities (0.08) and injuries (nearly 8) for passenger vehicles based on the reductions in auto VMT.

Figure 4-37 Estimated Annual Reduction in Passenger Car Occupant Fatalities and Injuries, Randall/Orchard Corridor MOS, BRT/TOD Relative To Corridor-Focused Development Scenario

Source of VMT Reduction	Annual VMT Reduced	Annual *Reduction* in Fatalities[2]	Annual *Reduction* in Injuries[2]
Shift to Transit (BRT)	8,240,000	0.07	6.8
Shift Walk/Bike	931,000	0.01	0.8
TOTAL	9,171,000	0.08	7.6

Source: Nelson\Nygaard, based on Kane County Travel Demand Model data and fatality and injury rates listed in Figure 4-36

[28] Glen Weisbrod and Arlee Reno, *Economic Impact of Public Transportation Investment (Prepared as part of TCRP Project J-11, Task 7),* American Public Transit Association (APTA), October 2009. http://www.apta.com/resources/reportsandpublications/Documents/economic_impact_of_public_transportation_investment.pdf

[29] Bureau of Transportation Statistics (BTS), National Transportation Statistics, 2008, Table 2-21: Passenger Car Occupant Safety Data

[30] BTS, National Transportation Statistics, 2008, Table 2-33: Transit Safety Data by Mode for All Reported Accidents

Figure 4-38 shows estimates for fatalities and injuries on BRT. About 0.004 fatalities per year and 1.5 injuries per year are estimated for BRT service in the Randall/Orchard corridor MOS, based on national averages rates over the projected 1.2 million annual BRT vehicle-miles. On average, these BRT-related fatalities and injuries offset the reductions from reduced VMT by a small amount—about 5% and 20% of the reductions in auto-related fatalities and injuries, respectively. Crime is an additional consideration for transit, but crime on transit is a small fraction of overall crime. Crime rates on transit buses per 100 million vehicle-miles are listed in Figure 4-36 (above), based on national data. As shown in Figure 4-38, estimates for BRT are an average of 1.6 crimes per year.

Figure 4-38 Estimated Annual BRT-Related Fatalities, Injuries, and Crimes

Annual Vehicle-Miles[1]	Annual Fatalities[2]	Annual Injuries[2]	All Crimes
1,226,058	0.004	1.5	1.6

Source: Nelson\Nygaard, based on fatality, injury, and crime rates listed in Figure 4-36

Other Considerations: Improved pedestrian and bicycle safety is an additional consideration and may be achieved by improved street design and pedestrian/bicycle enhancements that "calm" traffic and increase safety of non-motorized travel. These types of improvements may occur along the corridor by 2040 and/or be brought about in the proposed station areas as a result of land use patterns encouraged by BRT. Lower vehicle speeds are correlated with reduced severity of injuries and fewer fatalities from collisions.

Land Use Impacts

This section describes several categories of land use-related BRT benefits.

Key Findings: Land Use

Moderate-intensity station area development would reduce the amount of land utilized by over eight square miles, about equivalent to the land area of the city of Geneva.

Fifty-five fewer acres of surface parking land area would be required, saving nearly $3.5 million in annual parking operations and maintenance costs

In general, infrastructure costs in "compact development" that is contiguous with the urban edge are estimated to be 75 to 95% of such costs in "sprawling" development patterns.

Land Consumption

Transit corridor development integrated with transit-supportive land use planning and densities could support more residences and jobs in intensely developed station areas, preserving land for other purposes. Figure 4-39 compares the amount of land utilized in the conceptual medium-density land use scenario, for the Randall Road corridor (i.e., BRT/TOD scenario, as described in Chapter 3) to the amount of land that would be needed to accommodate the same population and jobs at lower-densities. In this scenario, an additional eight square miles of land would be required, an increase of over 250%. This is approximately equivalent to the land area of Geneva (and more than the land area of Carpentersville or Montgomery).

Figure 4-39 Estimated Land Consumption Benefit, BRT/TOD vs. Low-Density

Land Use Scenario	Residential	Employment		Total
		Retail	Commercial	
BRT/TOD				
Total Net Acres	1,127	467	479	2,073
Total Net Square Miles	1.8	0.7	0.7	3.2
Population or Jobs	51,266	8,253	32,973	-
Population or Job Density per Acre	45.5	17.7	68.9	-
Low-Density Comparison				
Low-Density Persons or Jobs per Acre	11.7 [a]	6.1 [b]	20.7 [c]	-
Net Residential Acres Needed	4,379	1,353	1,590	7,321
Total Net Square Miles	6.8	2.1	2.5	11.4
Increase in Land Consumption (square miles)	5.1	1.4	1.7	8.2
% Increase in Land Consumption	288%	190%	232%	253%

Notes: (a) Determined by assuming 4 dwelling units per acre and multiplying by the projected average household size in 2040 (about 2.9 persons per household). (b) Assumed a floor area ratio (FAR) of 0.175, half of the FAR assumed for typical retail/services uses in the medium-density BRT land use scenario. (c) Assumed an FAR of 0.25, a third of the FAR assumed for typical office/employment uses in the medium-density BRT land use scenario.

Source: Nelson\Nygaard

Impacts on Parking Demand

In addition to reducing the amount of urbanization required to accommodate population and employment growth, the shift of auto trips to transit, walking, and bicycling reduces parking demand and the amount of parking that must be provided.

As shown in Figure 4-40, nearly 40 fewer acres of surface parking land area would be required, saving over $2.4 million in annual parking operations and maintenance costs (based on an annual $432 per space[31] in 2011 dollars).

Figure 4-40 Parking Demand Assumptions and Impacts

	BRT/TOD, Relative to Corridor-Focused Development	
A	Change in parking demand[1]	5,610
	Parking Land Consumption Assumptions and Impacts	
B	Parking Land Area per Space (sq ft) [2]	300
C = A * B	Reduction in land area for parking (acres)	39
	Parking Cost Assumptions and Impacts	
D	Land cost per space[2]	$455
E	Construction cost per space[2]	$2,000
F	Annual O&M cost per space[2]	$200
G = D+E+f	Total annual cost per space	$432
H = A * G	Potential reduction in annual parking costs (to provider)	$2,423,500

Notes: (1) Reduction in vehicle trips due to auto trips that shift to transit or walking and biking. (2) http://www.planning.org/pas/at60/report59.htm. (3) Based on "suburban surface" parking, VTPI, Evaluating Public Transit Benefits and Costs, Table 18 (p. 39)

Source: Nelson\Nygaard

Transportation and Other Public Infrastructure Costs

A 1998 TCRP report[32] concluded that infrastructure costs in "compact development" that is contiguous with the urban edge are 75 to 95% of such costs in "sprawling" development patterns. This is primarily due to fewer roadways; road costs are estimated to be 75% of the cost compared to sprawling areas. The report estimates that water and sewer infrastructure is estimated to be 80% of the cost and schools 95% of the cost compared to sprawling areas. The sidebar below describes similar conclusions from an analysis of an area targeted for new development in Davenport, Iowa.

[31] VTPI, Evaluating Public Transit Benefits and Costs, Table 18 (p. 39)

[32] Robert Burchell, Naveed A. Shad, et al, *The Costs of Sprawl Revisited: The Evidence of Sprawl's Negative and Positive Impacts,* Transportation Research Board, TCRP Report 39, 1998. (Cited in ECONorthwet and PBQD, *Estimating the Benefits and Costs of Public Transportation Investments*, Transportation Research Board, TCRP Report 78, 2002.)

Conventional vs. Compact Development Infrastructure Costs

In Davenport, Iowa, two development scenarios were analyzed for Davenport's Northwest Quadrant, where a new sewer interceptor would open 25 square miles of land for development and new roadway infrastructure would be required. The first scenario was conventional development with typical suburban streets and single uses. The second scenario, termed "nodal development," envisioned a grid street system and was considered a "smart growth" approach to neighborhood design. Analysis results include:

- The annualized 30-year life cycle costs for roadways is nearly $45 million for conventional development, but nearly $24 million for the nodal development scenario
- There are over 68 roadway lane-miles in the conventional case, with 250-1,200 foot block lengths, compared to over 47 lane-miles for the compact development case, which has 250-600 foot block lengths. Both cases have a through capacity of 7,200 vehicles per hour.
- It would cost nearly $12 million to provide 30-minute transit service with quarter-mile pedestrian access from all residences, compared to over $5 million in the compact development case.

Source: Nelson\Nygaard, Davenport in Motion: Building a 21st Century Transportation System, Appendix B, 2010.
http://www.cityofdavenportiowa.com/egov/apps/document/center.egov?path=doc&id=9965&id2=6992&linked=0

Economic Development and Job Creation

This section describes several categories of economic development benefits related to BRT, including job creation. These benefits are discussed more broadly than others estimated in this chapter.

Key Findings: Economic Development and Job Creation

Over 300 one-time jobs could be supported by BRT construction and other capital costs, excluding vehicles, which it is assumed would not be available locally. Over 300 annual jobs could be supported by ongoing BRT operations.

Other economic benefits of BRT include increased productivity, access to employment and educational opportunities, revitalization of existing commercial area, and increased property/land values.

Job Creation

Capital investments in BRT infrastructure support local construction, planning and design jobs. A recent report that analyzed economic stimulus-funded infrastructure projects found that spending on public transportation projects created 31% more jobs and 71% more job hours per dollar spent than building roads. Investments in improving/maintaining existing streets (such as would be needed to support BRT in the Randall corridor) generated 16% more jobs per dollar than building new roads.[33] Figure 4-41 identifies the number of jobs that could be supported annually based on spending on transit capital or operating investments in public transportation. Figure 4-42 estimates annual jobs that could be supported by constructing and operating BRT on Randall Road, assuming use of queue jumps and transit signal priority improvements. Using the cost estimates from Chapter 3, over 300 jobs could be supported by BRT construction and other capital costs, excluding vehicles, which it is assumed would not be available locally. Over 300 annual jobs could be supported by ongoing BRT operations.

Figure 4-41 Jobs Supported per Million Dollars of Transit Investment, 2012 (Adjusted for Inflation)

	Capital/Operating Mix	Annual Jobs Supported per $1 Million Investment
100% Capital Investment	100//0	21
% Transit Operations	0/100	36
	29/71	32

Note: Includes both direct and indirect economic impacts. Adjusted from 2007 to 2012 dollars based on inflation of 12% (average of PPI and CPI) for this time period.

Source: Glen Weisbrod and Arlee Reno, *Economic Impact of Public Transportation Investment*, October 2009. Prepared for the American Public Transportation Association as part of TCRP Project J-11, Task 7. Exhibit 3-5.

Figure 4-42 Estimated Annual Jobs Supported Based on High-Level Costs of Constructing and Operating BRT in Randall/Orchard Corridor MOS

	Estimated Investment	Jobs Supported
Capital (Excluding Vehicles) [a]	$15.8M	330 (one-time)
Operations [b]	$8.4M	310 (annual)

Notes: (a) Includes 28 queue jump lanes at an assumed 750 feet at a cost of $1 million per lane-mile, TSP improvements at 14 signalized intersections, and 13 stations at a cost of about $500,000 each. Excludes vehicles, which it is assumed are not available to purchase locally (about $20 million for 21 vehicles at over $900,000 each). (b) Assumes over 81,000 annual vehicle hours at Pace 2012 projected cost of $104 per hour.

Increased Economic Productivity

As described above, BRT can provide personal and employee time savings by reducing transit travel time and helping avoid time spent in traffic congestion. With the increasing adoption of mobile devices, some travelers can put time spent riding transit to more productive use than they can while driving.

Improved Economic Opportunities

BRT provides workers with increased mobility options, expanding employment and educational opportunities, and providing employers with access to a broader labor pool. As described above, BRT reduces commuter transportation costs, allowing consumers to shift household expenditures to economic sectors that return a stronger benefit to the local economy.

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[33] Smart Growth America, "Recent Lessons from the Stimulus: Transportation Funding and Job Creation," February 2011. http://www.smartgrowthamerica.org/documents/lessons-from-the-stimulus.pdf

Revitalization

Transit-oriented development around stations can revitalize aging commercial areas creating economic opportunities and enhancing tax revenues for local jurisdictions. BRT can provide transit connections between transit oriented developments (TODs) and support and increase access to new retail markets (e.g., going out to lunch, midday errands, cafes, etc.).

Increased Land/Property Values

Public investments in high-capacity transit stations and other infrastructure improve access, catalyze development around station areas, and increase land values. Higher land values around stations in turn encourage higher-density development to occur, assuming that supportive land use policies are in place to enable higher-density, mixed-use transit-oriented development. A number of studies have demonstrated increases in both residential and commercial property value along rail lines, and this effect has increasingly also been demonstrated for BRT. Several examples were provided in the BRT Primer (see Figure 30); the sidebar below provides a more in-depth discussion of the South East Busway in Brisbane, Australia.

Land Value Impacts along Brisbane's South East Busway

Brisbane's South East Busway demonstrates that a fully developed BRT line can result in development benefits comparable to rail transit. The South East Busway was developed from 1999 to 2001 and consists of 10 stations along a 16.3 km corridor, including 16.1 km of dedicated busway.[1] A key aim was to promote transit-oriented development along a low-density corridor. At both a regional shopping center and a hospital station, busway construction was concurrent with redevelopment of the facilities.[2]

Property values within walking distance of busway stations grew by up to 20% and two to three times faster than property values in the surrounding area, an increase attributed to construction of the busway.[3] These impacts were realized within a few months after the busway opened: median property values for adjacent suburbs increased by between 3.9% and 20.9%, compared with a change of between negative 4.4% and 6.6% for non-adjacent suburbs. After one to two years, median housing prices in the adjacent suburbs increased between 12.5% and 63.5%, compared with a change of between negative 1.0% and 33.3% for non-adjacent suburbs.[4]

1. Sean Rathwell and Stephen Schijins, "Ottawa and Brisbane: Comparing a Mature Busway System with Its State-of-the-Art Progeny," *Journal of Public Transportation, Vol. 5, 2002*, 167.
2. Rathwell and Schijins, "Ottawa and Brisbane: Comparing a Mature Busway System with Its State-of-the-Art Progeny," 172.
3. Herbert Levinson et al, *TCRP Report 90: Bus Rapid Transit*, *Volumes 1 and 2*. Washington, D.C.: Transportation Research Board, 2003.
4. ACT Planning & Land Use Authority, *Economic Benefits of Transitways*, http://www.tams.act.gov.au/__data/assets/pdf_file/0006/68586/Economic_benefits.pdf.

Impacts on local transit service

The emergence of BRT station areas along the Randall/Orchard Road corridor as destinations, linked with convenient BRT service, will also have an impact on existing local transit service in Kane County. BRT will likely build demand for enhanced local transit service to Fox Valley downtowns, including to Metra stations that lack direct connections to BRT service.

Summary of Impacts

Figure 4-43 summarizes the scenarios compared and results for various transportation modeling data and benefits evaluated.

Figure 4-43 Summary of BRT Benefits: BRT/TOD compared to:

	Corridor MOS		County-wide	
Data or Benefit Category	**2040 Transportation Plan**	**Corridor-Focused Development**	**2040 Transportation Plan**	**Corridor-Focused Development**
Population	+70% (11,700 HH)	same	N/A	N/A
Employment	+115% (35,070)	same	N/A	N/A
VMT	+0.8%	-1.5%	-1.6%	-2.0%
VMT per Capita[1]	-15.5%	-1.5%	-3.5%	-2.0%
Overall Travel Time Savings[2] Queue Jumps Exclusive Lanes	 N/A N/A	 -13% (savings) +20% (increase)	 N/A N/A	 N/A N/A
Annual cost savings per new transit rider	N/A	$600 (50% of driving cost)	N/A	N/A
Fuel Consumption and GhG Emissions – Passenger Vehicles[3]	N/A	-3.1% [4]	N/A	-2.0% [5]
Community Health Impacts	N/A	Decrease in auto-related injuries, improved health outcomes	N/A	N/A
Land Use	N/A	Decrease in land consumption, parking requirements	N/A	N/A
Economic Development	N/A	Increase in jobs	N/A	N/A

Notes: [1] Per capita refers to the population contributing to Randall/Orchard Road corridor or county-wide VMT. [2] Includes drivers and existing and new transit users. [3] Does not include BRT vehicles. [4] Calculated based on the number of trips that shift to BRT, walking, and bicycling. [5] Based on the modeled change in county-wide VMT from the Kane County travel demand model.

5 CONCLUSIONS AND NEXT STEPS

CONCLUSIONS

This study assesses the overall viability of Bus Rapid Transit in the Randall/Orchard Road corridor while illustrating a set of conceptual station area developments needed to support the potential transit system investments. The study highlights that BRT along the Randall/Orchard Road corridor can be an element of a comprehensive strategy for transforming land uses in Kane County. By focusing some of the expected county-wide growth into Transit Oriented Developments (TOD) at select BRT station areas, corridor residents, workers, and visitors will have additional transportation options available to them, reducing the existing reliance on automobile travel. While the overall travel demand in the corridor would grow, many of these trips will be shorter and could be made via transit, bicycling, or walking.

The resulting changes in travel patterns would help the County realize a number of benefits including:

- Reduced travel times and transportation costs, especially for those taking transit
- Reduced fuel consumption and greenhouse gas emissions
- Reduced traffic fatalities and an increase in healthy lifestyle activities
- Decreased land use consumption
- Increased economic activity in the corridor

NEXT STEPS

While the study illustrates a conceptual long-term vision for the corridor, near-term steps will be required to reach consensus on future land use policies and ensure that short-term land use development does not preclude future TOD along the corridor. A number of factors will present challenges when developing the final vision for the corridor and identifying the action items needed to realize the vision. These include:

- Multiple private land owners at potential station areas
- Multiple jurisdictions governing land use and other standards/policies for the corridor
- Varying degrees of local support for TOD and transit system investments

Critical next steps in the process include:

- Cultivating political and public partnerships to identify and promote supporting policies
- Conducting outreach to land owners and community members about the vision and necessary actions to achieve it
- Identifying public investments in the transit system, pedestrian and bicycle connectivity (including securing right-of-way for and completing the trail system along the corridor

and ensuring connections to each station area), and station area developments, along with sources of funding

- Codifying supporting policies in comprehensive plans and zoning codes as soon as possible to provide a roadmap for future development and retain options for station area development
- Refining transit and roadway designs as future land use decisions take shape

APPENDICES

Appendix A	**List of Acronyms**
Appendix B	**Glossary**
Appendix C	**BRT Primer**