National University Rail Center - NURail
US DOT OST-R Tier 1 University Transportation Center

NURail Project ID: NURail2013-UIC-R14

The Case for Rail Transit Expansion in the Chicago Central Area

By

Ed Zotti
Project Manager and Principal Author
Chicago Central Area Committee
161 N. Clark St., Suite 4300, Chicago, IL 60601
edzotti@gmail.com

08-17-2016

Grant Number: DTRT12-G-UTC18

DISCLAIMER

Funding for this research was provided by the NURail Center, University of Illinois at Urbana - Champaign under Grant No. DTRT12-G-UTC18 of the U.S. Department of Transportation, Office of the Assistant Secretary for Research & Technology (OST-R), University Transportation Centers Program. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the U.S. Department of Transportation's University Transportation Centers Program, in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.

TECHNICAL SUMMARY

Title

The Case for Rail Transit Expansion in the Chicago Central Area

Introduction

The Chicago central area has become the principal economic engine of its region. Central area employment is at record levels and accounts for nearly half of city jobs. Between 2000 and 2010, downtown Chicago is gained 48,000 residents, more than any other U.S. city, and is on track to add a similar number between 2010 and 2020. Since 2000, all net housing growth in Chicago has been absorbed downtown. The majority of central area workers use transit to get to their jobs, with a long-term shift from buses to trains. As of 2014, the majority of Chicago transit riders use rail – more than one million trips per workday. Analysis suggests that since 1998 the majority of new professional workers in downtown Chicago have chosen to live in the city and take Chicago Transit Authority trains (the "L") to their jobs. As a consequence, "L" ridership is at the highest level since at least 1960 and the busiest lines are nearing capacity. Current projections indicate that north and northwest side "L" trains will reach the limits of what they can carry within 10 years, even with planned improvements such as a "flyover" at a busy north side junction.

This white paper proposes the construction of a new central area transit line (the "Connector") to add needed capacity in the fastest-growing part of the city. Assuming a 7-10 year implementation timeframe, the Connector's first phase would come online just as north and northwest side "L" lines reached capacity, enabling the central area to absorb a larger share of subsequent increases in transit demand.

The paper calls for construction of 14 miles of new transit line, approximately 70% of which would be located on or adjacent to existing rail right-of-way, vacant land or public property. The Connector would be built in phases and could be funded through a combination of a special service area (SSA) and a "transit TIF" (tax increment finance district).

Approach and Methodology

This white paper addresses the fundamental planning components required to advance the proposed Connector central area transit line: quantifying the need; identifying the proposed solution and demonstrating why it is preferable to other approaches; proposing funding sources; and outlining next steps, including securing approval from public officials, property owners and other stakeholders.

Findings

This white paper provides extensive data and analysis in support of the proposed Connector transit line in Chicago's central area.

Conclusions

The Connector would help Chicago's central area continue to meet the transit demands of the growing downtown employment and permanent residential populations.

Recommendations

Building the Connector would:

1. Add needed transit capacity in the fastest-growing part of the city.
2. Significantly increase developable central area land.
3. Lend itself to phased construction to keep capital outlays manageable.
4. Provide an opportunity to reduce the cost and complexity of land acquisition needed for transit given the central area's abundance of unused rail right-of-way, vacant land and publicly owned land.

Publications

N/A

Primary Contact and Principal Investigator

Ed Zotti
Project Manager and Principal Author
Chicago Central Area Committee
161 N. Clark St., Suite 4300, Chicago, IL 60601
edzotti@gmail.com

NURail Center
217-244-4999
nurail@illinois.edu
http://www.nurailcenter.org/

TABLE OF CONTENTS

The Case for Rail Transit Expansion in the Chicago Central Area

August 17, 2016

CHICAGO CENTRAL AREA COMMITTEE

NURail Center

UTC URBAN TRANSPORTATION CENTER

Introduction

Much of Chicago's existing rail infrastructure is more than 100 years old and was built in the traditional hub and spoke pattern, efficiently moving people from outlying neighborhoods to the central business district. As Chicago evolves into a 21st century global city, it is generating new patterns of movement between home and workplace that echo changes seen in other major centers of business and finance. If the city is to continue to thrive, its rail transit system must adapt to this new environment.

In Chicago as elsewhere, the central business district has grown into multiple centers reflecting concentrations of finance, media, government, consulting, academia and technology. Residential patterns are closely following, bringing significant new concentrations of residential development into the business core. Chicago's traditional system of transit is poorly configured to move people among these multiple centers. What's more, opportunities to support these new development patterns using currently vacant or underutilized land cannot be unlocked until better transit infrastructure is put in place.

The Chicago Central Area Committee, a business group established in 1955 to promote long-term planning in the urban core, has spent the past two years developing a proposal to address these issues. This document makes the case for the Connector, a new central area rail line we believe will transform the city's fabric as profoundly as the Loop "L" did 120 years ago.

The Connector would serve a three-fold purpose. First, it would support the Chicago Transit Authority's efforts to increase the efficiency and reach of the existing rail system and improve distribution of workers within the enlarged central business district. Second, it would support the new residential, technology and services centers emerging on the periphery of the traditional core. Third, it would extend rail service to historically neglected communities, enhancing access to jobs, schools and amenities.

Also benefiting from better rail transit would be visitors to downtown – including neighborhood residents, tourists and business travelers – bound for central area destinations not well served by mass transit, ranging from McCormick Place, the Museum Campus and Soldier Field on the south to Navy Pier on the north. The lack of convenient access to these destinations encourages more automobile trips to the central area, increasing congestion and pollution. If Chicago is to continue to achieve the density and vitality characteristic of world cities while avoiding gridlock and protecting the environment, it must take bold steps to transform the "L" and suburban commuter lines, including Metra and South Shore, into a comprehensive rail network that supports the new patterns of development.

This is not merely a question of convenience, nor are the beneficiaries of the Connector only those who live, work or visit downtown. Rather, expanded rail transit will serve all Chicagoans. The central area has become the principal engine of economic growth in the city and region, providing an increasing share of jobs and opportunities. In the past two decades, most new downtown workers have chosen to live in the city and take the "L" to their jobs. These new workers have strengthened neighborhoods all over the city, not only on the north side but on the west and south sides as well.

Despite the challenges we face, Chicago in important ways has turned the corner. Timely investment is needed to ensure continued growth. The Connector is a critical step in creating a transit system befitting a global city and providing a better quality of life for all our citizens. This white paper explains the project, demonstrates its urgency, and shows we have the resources to make it a reality. All that is required is consensus to proceed.

CHICAGO CENTRAL AREA COMMITTEE – *Executive Committee*
Greg Hummel – Bryan Cave, *Chair*
Kelly O'Brien, *Executive Director*
Ed Zotti, *Project Manager and Principal Author*
Steve Fifield – Fifield Companies
Stephen Friedman – S.B. Friedman Development Advisors
Avi Lothan – Lothan Van Hook DeStefano Architects
Stephen Schlickman – Urban Transportation Center, University of Illinois at Chicago
Doug Voigt – Skidmore Owings & Merrill
Mark Walbrun – Mott MacDonald

Executive Summary

***The challenge:** Chicago's booming central area is s local transit – expansion is essential if growth is to c*

- **The central area has become Chicago's principal economic e** Downtown employment is at a record high, with nearly half If the present trend continues, it will exceed 700,000 jobs in Central Chicago is gaining more residents than any other U.S. 2000, all net housing growth in Chicago has been absorbed d
- **The central area is dependent on rail transit.** The majority o area workers use transit to get to their jobs; most transit ride than 1,000,000 per day – use rail, including the "L," Metra ar Shore. Approximately 85% of central area development bet v and 2015 – 78M of 92M square feet – was built within w alkir of a rail station.
- **The CTA rail system is reaching the limit of what it can carry** ridership is at the highest level since at least 1960. Within 10 likely to increase from 770,000 to ~920,000 riders per day. E planned improvements such as the Red-Purple Bypass are m north and northwest side "L" lines will reach capacity within
- **The Loop is approaching full buildout.** An additional 101M – square feet of central area development is forecast by 2035. vacant or underutilized land in the Loop "rail hub" – accessib the "L" and Metra – is sufficient to support 38M SF and will u ~15 years if the current trend holds. Development thereafter w relegated to sites with inferior rail access or will require cos tl replacement of serviceable structures downtown with result architectural character.
- **Forty-two percent of central area land is currently inaccessi** Much of this property is vacant. If rail access were provided a downtown densities achieved, this property could absorb ma

Figure 1. Concept route for Connector transitway

of additional development. Absent such access, experience suggests that, relative to the core, it will see less development at lower density.

- **Downtown has outgrown the rail system's hub-and-spoke design.** Connectivity between the "L" and Metra is poor. Destinations such as North Michigan Ave. and Navy Pier are inaccessible by "L," Metra, or both. Circulation within much of the central area is slow, inconvenient.

The proposal: *A light metro line would enlarge the rail system's capacity and reach at reasonable cost*

- **A new central area transit line (the "Connector") would add capacity in the fastest-growing part of the city** – see Figure 1**.** Assuming a 7-10 year implementation timeframe, the Connector's first phase would come online just as north and northwest side "L" lines reached capacity, enabling the central area – already the city's major growth center – to absorb a larger share of subsequent increases in transit demand.
- **The Connector would significantly increase developable central area land.** On completion, ~80% of the central area would be within walking distance of a rail station vs. 58% now. Figure 2 illustrates the extent of rail service coverage on project completion. The line would link all four Metra operations and the "L" to major destinations and development sites, doubling the amount of central area property accessible to both city and suburban rail systems and permitting substantial expansion of the urban core.
- **The Connector could be built in phases, keeping capital outlays manageable.** The 2-mile first phase, or "minimum operable segment" (MOS), would extend from Union Station to Illinois/Columbus at a cost of ~$750M. The MOS would connect the West Loop Metra stations to North Michigan Ave., a long-sought goal. Later phases in less densely built up districts would be cheaper – ~$150M/mile based on comparable U.S. projects – and could be built opportunistically based on market conditions and developer interest.
- **The central area's abundance of unused rail right-of-way, vacant land and publicly owned property offers an opportunity to reduce the cost**

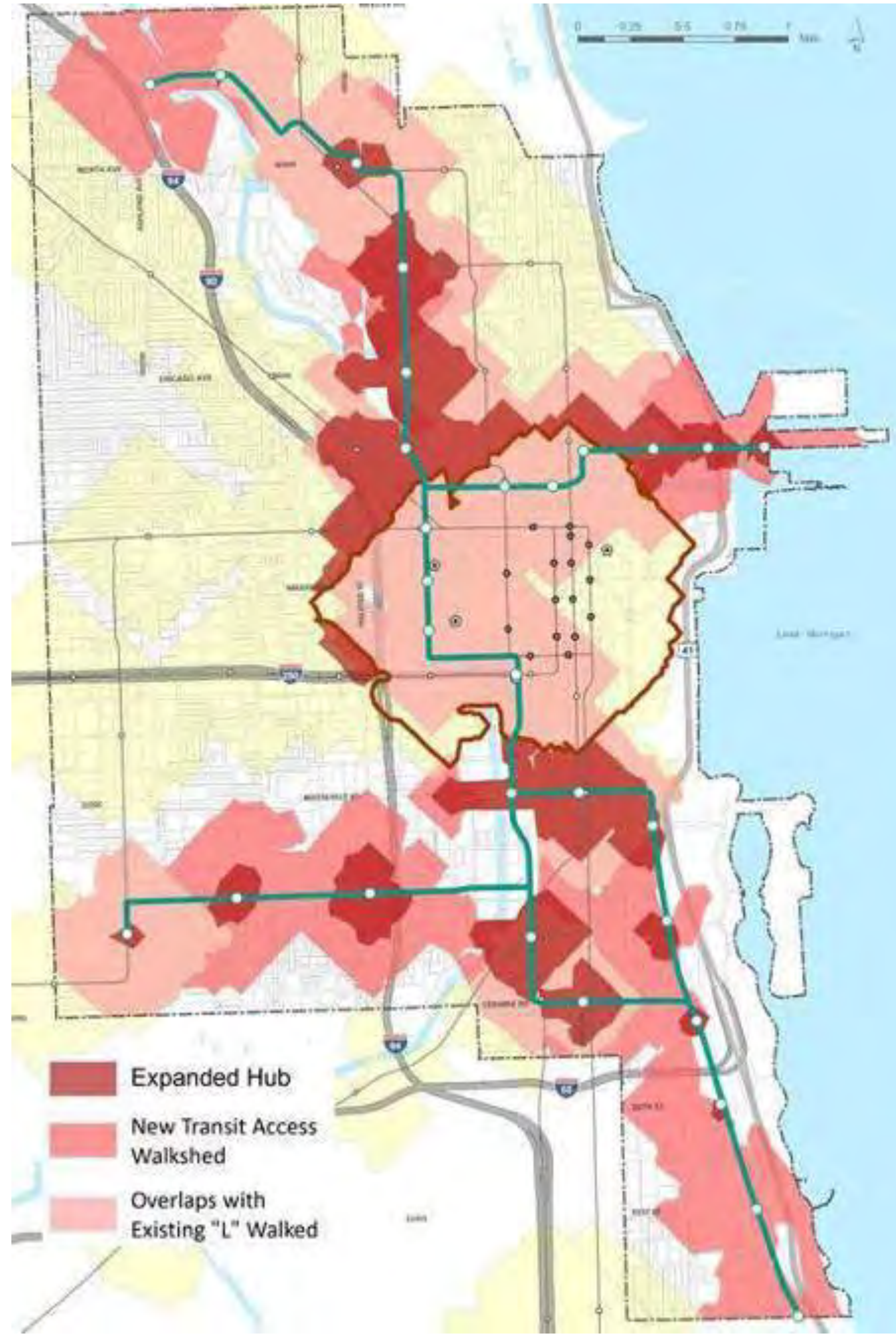


Figure 2. Additional property made rail accessible by proposed improvement

and complexity of land acquisition needed for transit.** Of the 14 miles of new transit line proposed, more than 70% would be located on or adjacent to existing rail right-of-way, vacant land or public property. Automated rubber-tired vehicles using weather-protected stations would minimize operating expense, noise, and "polar vortex" concerns.

- **Based on scoping meetings with property owners, use of the former Carroll Ave. railroad right-of-way presents no insurmountable obstacles.** The Carroll Ave. ROW along the river's north bank is a key link in the MOS. Solutions have been identified for technical issues raised to date by the affected commercial property owners and they indicate no objection to use of the corridor for transit.

Finance: *The downtown property tax base is sufficient to cover the local share of cost with a modest rate increase*

- **A 0.25% property tax increment levied through a special service area (SSA) would be sufficient to fund the local share of the MOS.** Given the financial condition of the city and state, an SSA or a transit TIF (tax increment finance district) are the only practical ways to raise local funds – a blend of the two may be ideal. (Amendment of the TIF statute to include the Connector would be needed.) If an SSA covered only parcels within walking distance of an MOS stop, a tax levy of 25 basis points (0.25%) on all property classes would generate sufficient bondable revenue to fund the expected 50% local share of project cost. If the levy were restricted to commercial property, a larger SSA bound by the lake, Chicago Ave., Halsted St., and Roosevelt Rd. would generate enough money at the same rate – see Figure 3 and chart below.

Project approach	Automated, grade-separated light metro
Preliminary MOS budget	$750M
Local match	$375M
Proposed SSA tax rate	0.25% (25 basis points)
Bond yield – 10 min walkshed	$380M (all property classifications)
Bond yield – concept district	$480M (commercial properties only)

- **Later phases of the project would provide opportunities for public-private partnerships.** The sizable vacant tracts made accessible by rail would support large-scale development. Developers could reasonably be expected to help fund improvements making their projects possible; such partnerships are common throughout the developed world.

Buffer	Assessed Value	Calculated Market Value	Equalized Assessed Value	Number of Parcels
10 min Core Walkshed	5,709,308,579	30,031,857,992	15,198,750,368	4,152
Central Area	7,281,335,817	38,401,857,827	19,383,644,078	5,663

Figure 3. Hypothetical SSA boundaries (pink = proposed MOS walkshed)

- **Coordination of federal funding requests with CTA would ensure transit expansion did not siphon off resources needed to maintain the existing system.** Two likely sources of federal funds are: (1) TIFIA, which provides credit assistance for surface transportation projects of regional significance – this program is expected to have enough funds to meet the needs of both CTA and new transit; and (2) FTA New Starts. This funding is needed by CTA but the local share of projects such as the Red Line South Extension and Red-Purple Modernization is large; raising the MOS local share would be easier. It may be possible to time federal funding requests so that all projects can be advanced in parallel.

Next steps: *Obtain buy-in from public, private sectors*

- **Reach out to developers, MOS property owners, downtown business community.** Funds must be raised for detailed engineering and cost analysis of MOS; if an SSA is to be established, support must be generated.
- **Present to public agencies and officials.** City Hall, CTA have been kept informed but blessing must be obtained for specific approach.
- **Conduct scoping meetings along remainder of proposed alignment.** Community acceptance of aerial solution is highly desirable.
- **Finalize key elements of later-phase alignments.**

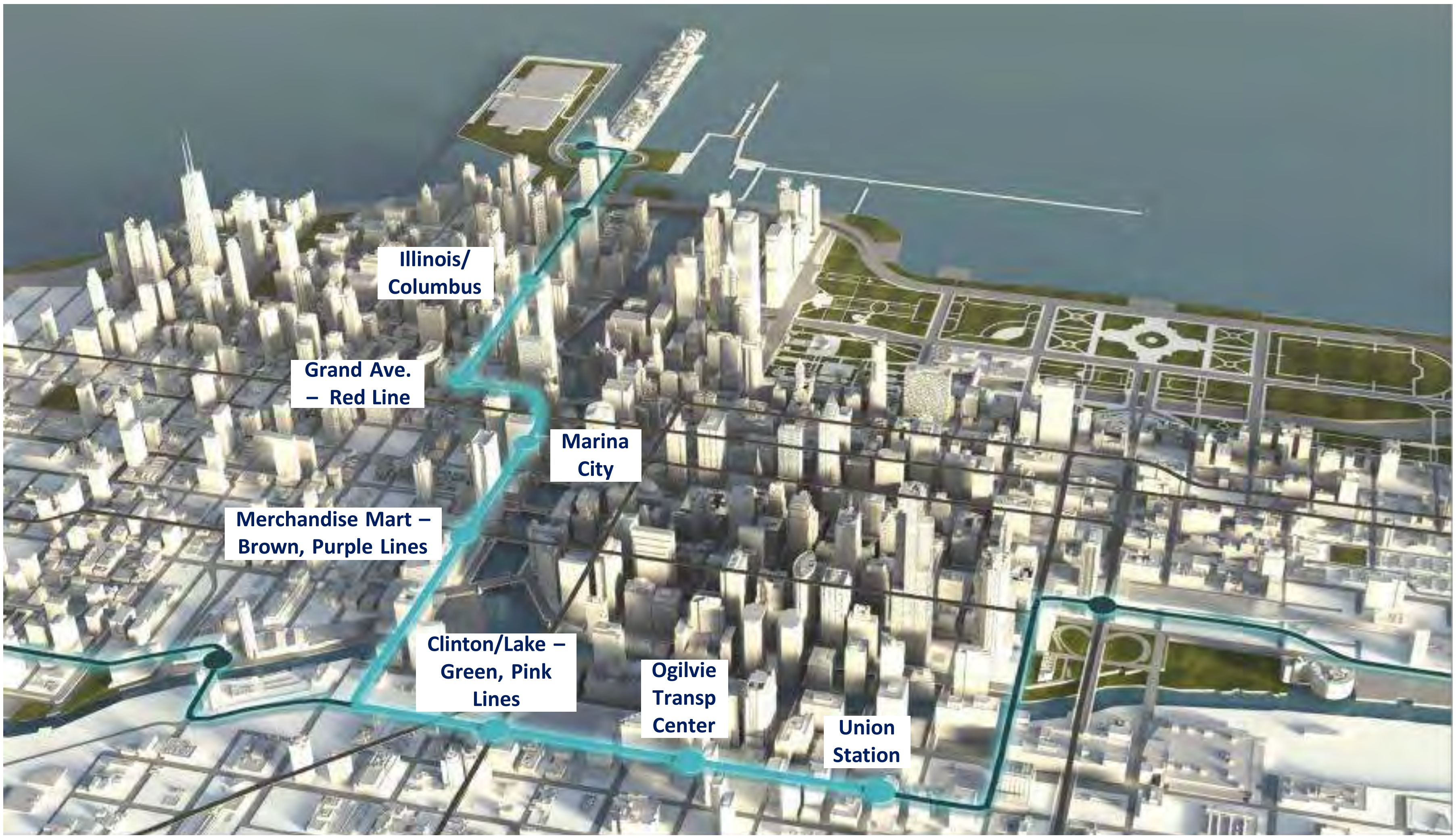


Figure 4. Proposed minimum operable segment (MOS)

Booming Central Area Strains 'L'

Professionals who work downtown, live in the city and take the 'L' to work are taxing the rail system's capacity

Chicago has been revitalized in recent decades by the growing number of professionals who live in the city, work in the central area, and take the "L" to their jobs. But growth is straining the city's transit infrastructure, as detailed in Appendix A:

- "L" ridership grew 51% between 1992 and 2015. Average weekday ridership is now at the highest level since at least 1960.
- During the morning peak, particularly in the fall, trains on the busiest lines are often crush-loaded (riders will wait on the platform for the next train rather than attempt to board) while still several miles from the Loop.
- As evident in Figure 5 , "L" ridership closely follows central area professional employment, which has grown steadily for more than 40 years. If the present trend continues, central area employment will increase by 60,000 to 90,000 over the next 10 years and average weekday "L" ridership will grow by 120,000 to 180,000.
- By the end of this time, the "L" lines serving the busiest rail corridors – the Red, Blue, Brown and Purple Lines – will operate at capacity during the busiest periods, even if planned improvements are made.
- If planned improvements are not made, the busiest lines will reach capacity during peak periods in the fall of 2017.

As discussed in Appendix B, once the above improvements are complete, further increases in north side "L" capacity will require multiple billions of dollars over many years. Measures to increase transit capacity in the interim have thus become urgent, and are the subject of this report.

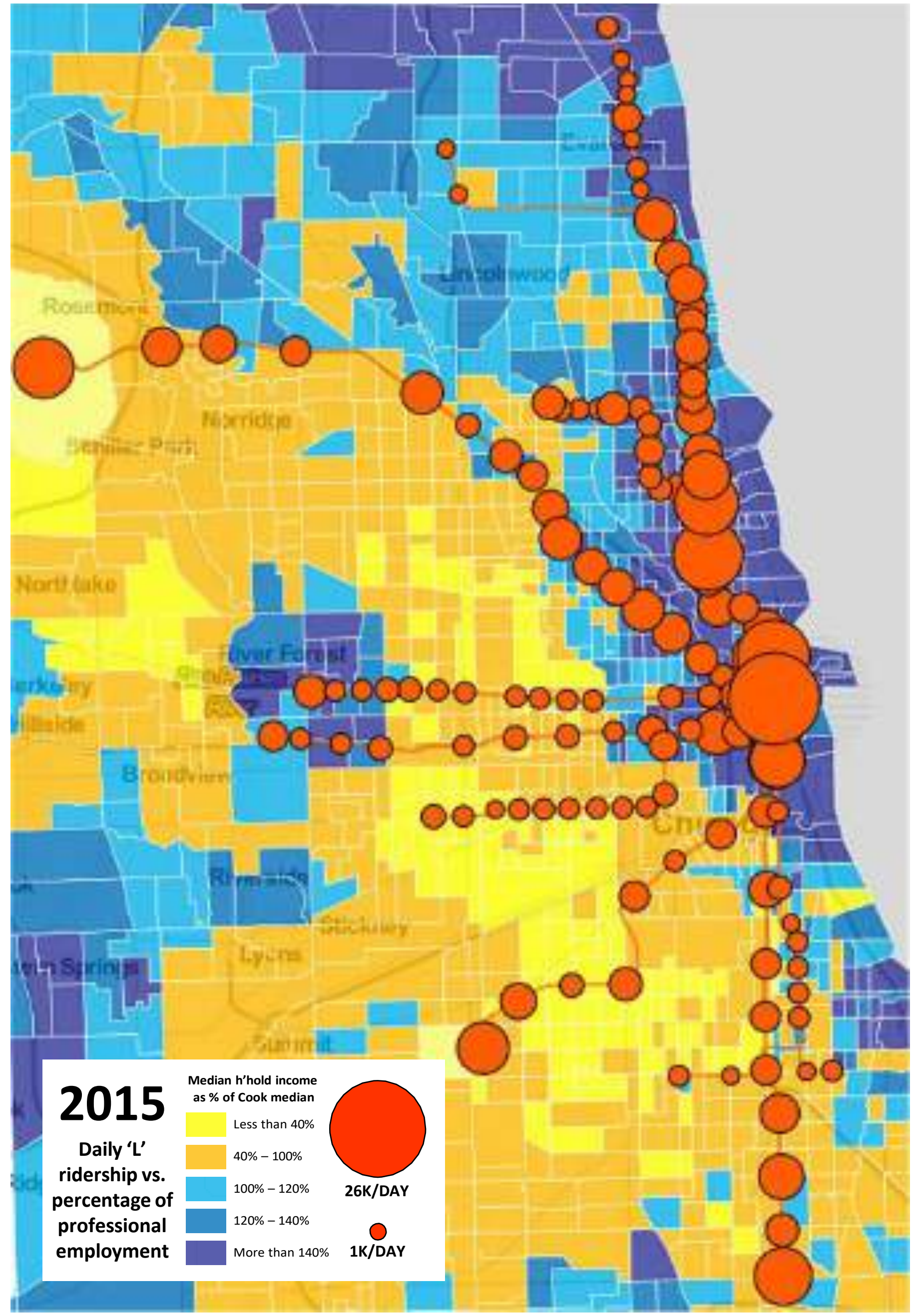


Figure 5. 'L' ridership vs. professional employment

Transit Expansion Priority: Core

Growth in households and 'L' ridership is concentrated in the central area, but available land is becoming scarce

Prudence suggests transit expansion in the Chicago central area should be given a high priority. In the past, most growth occurred on the urban fringe, and investment in new transit focused on extension of service to outlying areas. The situation today is substantially reversed, as shown in Appendix A:

- Growth in population, households, and "L" ridership is overwhelmingly concentrated in the urban core – see Figure 6. Between 2000 and 2010 the residential population of downtown Chicago increased by more, in percentage and absolute terms, than any other U.S. city including New York, and is on track to increase by >100K between 2000 and 2020 – this despite a 200K drop in overall city population between 2000 and 2010. Increases notwithstanding, central area population (182K in 2010) remains well below that of Chicago's U.S. peers, suggesting high potential for additional growth if resources were provided.

- After years of expansion, the Chicago central area is running out of room. As explained in Appendix G, the city is projected to see 101M-130M GSF of real estate development over the next 20 years. The traditional core, which historically has absorbed the lion's share of development, can accommodate an additional 38M GSF and will run out of likely sites in ~15 years. Development thereafter will be relegated to sites with currently inferior rail access.

- The densely built up core is surrounded by hundreds of acres of vacant or underutilized land, much of it inaccessible by "L." As the analysis in Appendix G shows, central area land without rail access historically has attracted little development. Abundant vacant land near the city center is a resource many of Chicago's prosperous peers do not have and offers a competitive edge if convenient access can be provided.

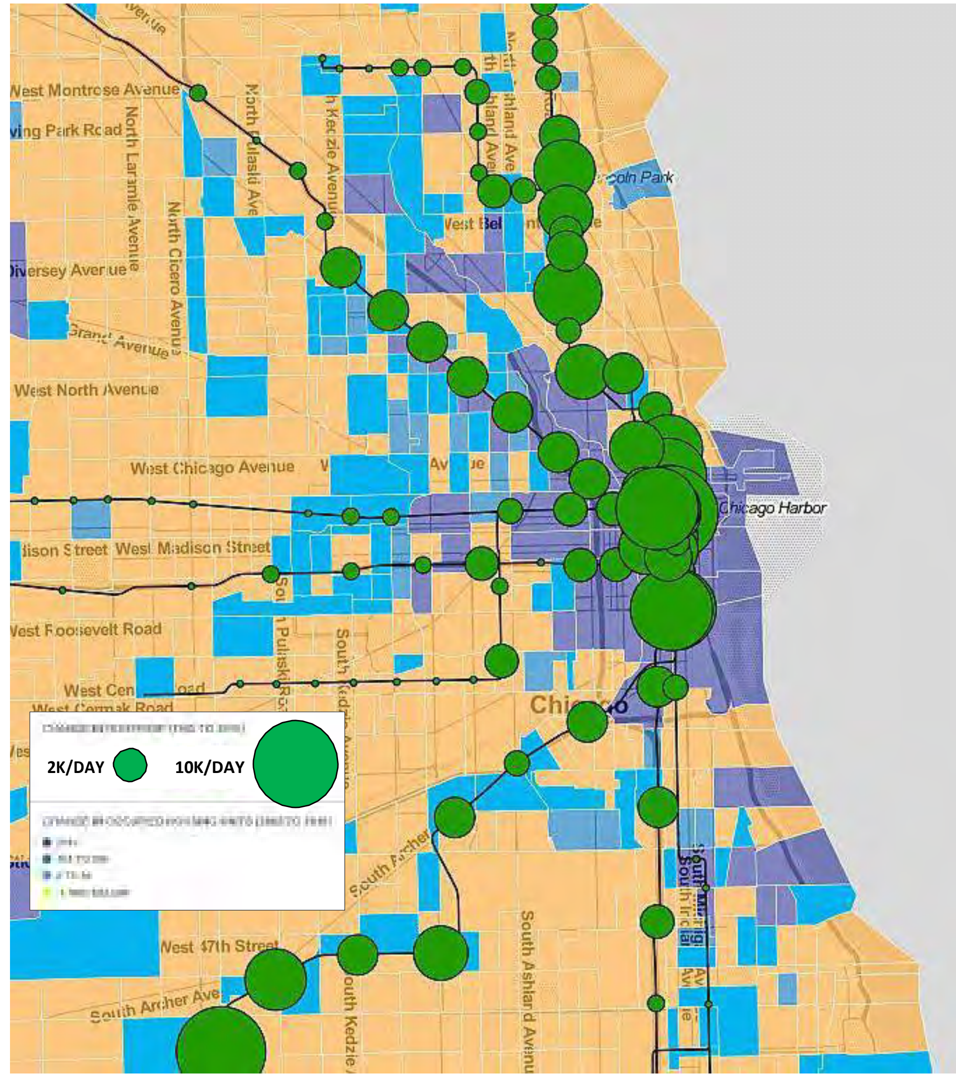


Figure 6. 'L' ridership growth vs. change in number of households

- Core transit expansion with extensions to the southwest and south is an opportunity to accelerate revitalization of neglected areas with high potential and interest.

- Improved central area transit would ameliorate many practical problems of long standing as detailed in Appendix E.

Lessons of Previous Plans

Past proposals for downtown transit expansion were too costly, provided insufficient benefit and lacked wide support

The first plan to seriously address the need for improved central area transit was the Chicago Central Area Transit Plan, introduced in 1968 (Figure 7). Though embraced by City Hall and pursued for 11 years, the plan did not come to fruition, nor has any of the schemes proposed since. A review of these plans (Appendix C) suggests the following lessons:

- The earliest plans were ahead of their time. Growth in the latter part of the twentieth century occurred primarily on the urban perimeter; the major successful postwar “L” expansions all served outlying areas. Improving transportation in the central area seemed less urgent.
- Expanded downtown transit was seen as mainly benefiting suburbanites and the business community rather than all Chicagoans.
- The plans were too expensive, ambitious, or controversial. Estimates for downtown subways ran to the billions of dollars. Delays in gaining consensus for the Circulator light rail plan of the 1990s contributed to its demise.

In view of this history, if central area transit expansion is to succeed, it must:

- Provide wide benefits and address concerns recognized as urgent.
- Lend itself to phased implementation, with each increment modest in scope and reasonably priced. Given existing maintenance needs, the only local funding to be used for *new* transit should be money that would not be available but for the project.
- Be designed for minimal intrusiveness and thoroughly vetted with stakeholders to assure public acceptance.

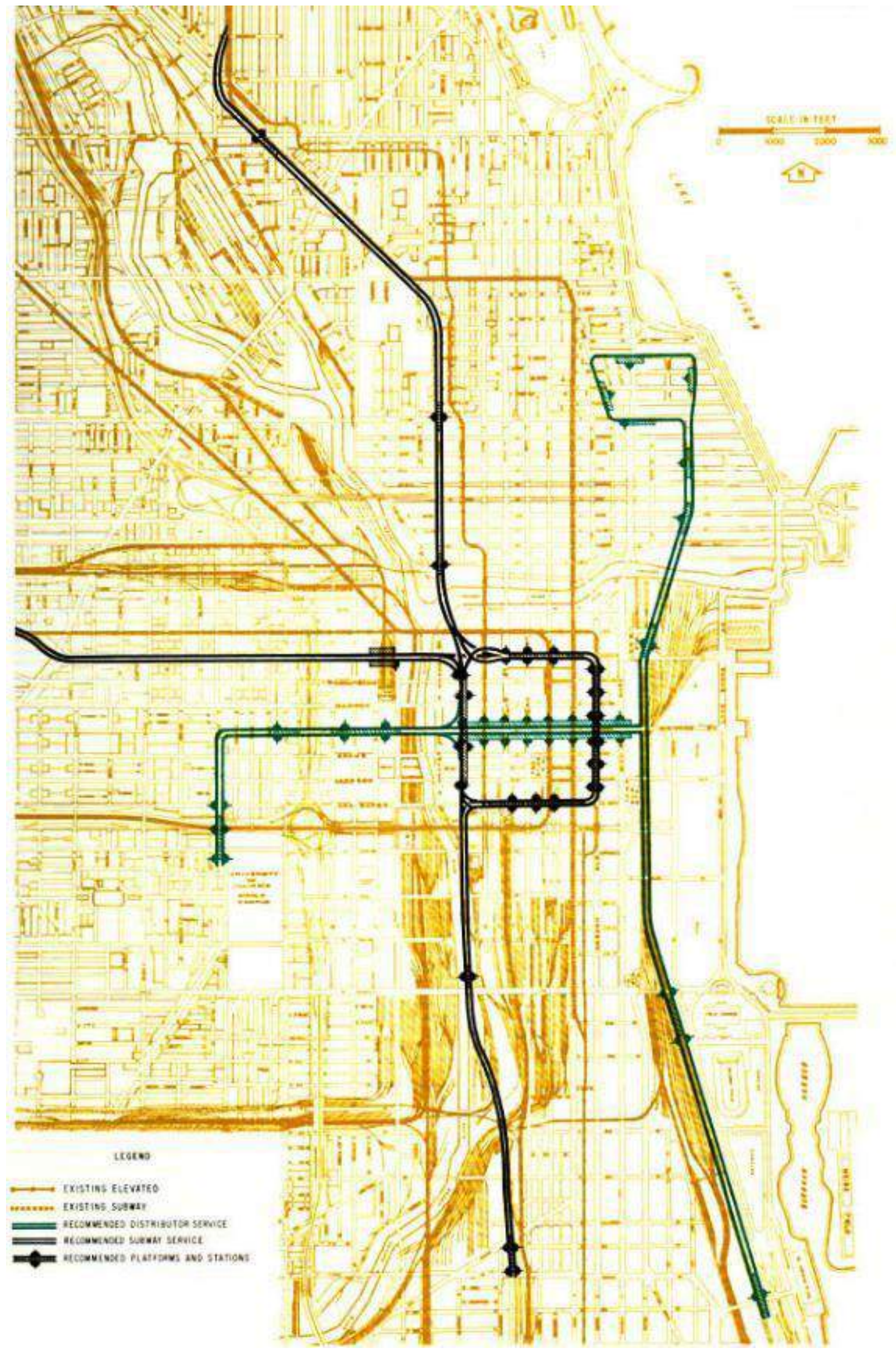


Figure 7. 1968 Chicago Central Area Transit Plan

Experience of Other Cities

Chicago's transit growth pattern reflects the U.S. trend, but other cities are doing more about it

Transit operations in selected U.S. and world cities were reviewed – see Appendices D and J. Observations:

- In all of Chicago's U.S. peer cities, rapid transit (rail) ridership is up, often sharply, while bus ridership is flat, increasing modestly, or in decline (Figure 8).
- Rail ridership exceeds bus ridership in four of the seven peer cities and is increasing transit market share in all the cities (Figure 9). In Chicago, the "L" accounted for 33% of CTA rides in 1996, 47% in October 2015.
- Among the peer cities, most are making multi-billion dollar investments in rail – Los Angeles, New York, and San Francisco each have multiple projects underway. The only two peer cities with no rail expansion projects under construction are Chicago and Philadelphia.

Judging from light rail and bus rapid transit (BRT) projects in the U.S. and selected world cities, it appears that:

- With few exceptions, grade-separated rail systems offer faster service and attain higher ridership than surface (at-grade) light rail or BRT.
- Surface light rail in most cases is not cost-effective compared to BRT for the volume of riders carried.
- BRT in the U.S. does not support ridership on the scale likely to be needed in Chicago. The busiest BRT system (in New York) carries half the riders of the busiest grade-separated light rail system (in London).

in sum, Chicago's peer cities are seeing growing transit ridership and a shift from bus to rail, and most are making major investments in the latter.

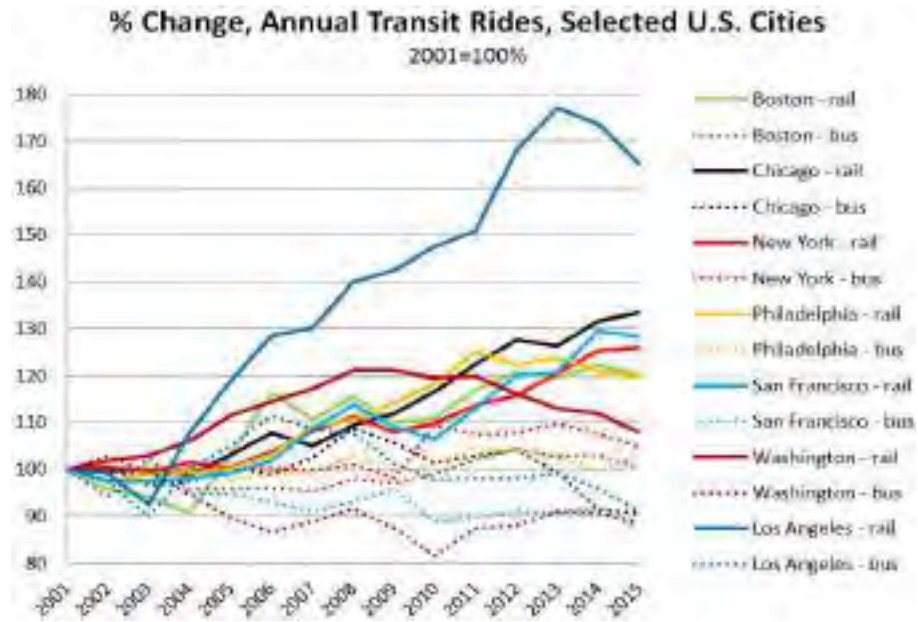


Figure 8. U.S. transit ridership trends

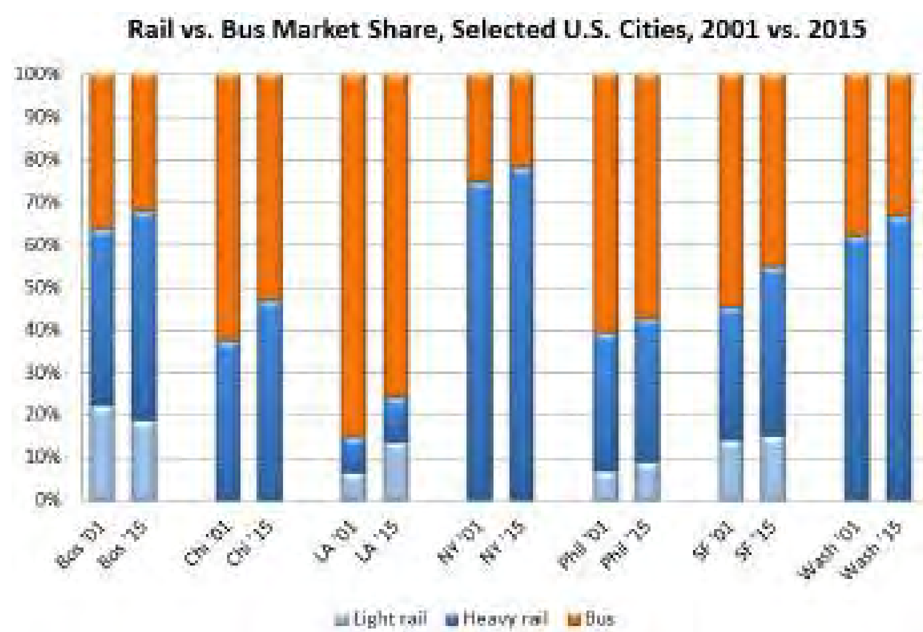


Figure 9. Rail vs. bus market share in Chicago and peer U.S. cities

Toward a Transit Expansion Plan

The case for transit expansion is summarized in the executive summary and made in detail in appendices A and E. Once the need is acknowledged, the next step is to develop a high level plan and determine its feasibility. The task of the white paper team in this respect was as follows:

1. **Choose the technology.** Identify potential transit modes, such as bus rapid transit, light rail, etc.; weigh their costs and benefits; and select the mode best suited to the city's needs and budget.
2. **Identify the route.** Identify and prioritize potential transit corridors; devise a tentative route plan serving the top-priority corridors; and determine the first phase to be constructed (the "minimum operable segment" or MOS).
3. **Estimate the costs.** Estimate the cost to construct, operate and maintain the new system, with particular attention to the MOS.
4. **Determine the optimal funding mechanism.** Identify and evaluate potential funding mechanisms and estimate the likely yield.
5. **Estimate the benefits.** Estimate the benefits of expanded transit in terms of riders carried and development stimulated.
6. **Assess alignment feasibility.** Identify specific transit alignments within the corridors and determine their feasibility through meetings with stakeholders and engineering analysis.
7. **Build consensus.** Present the plan to key stakeholders, including public officials, property owners, business, civic and community groups, and citizens; make adjustments as needed; and generate broad agreement on the best way to proceed.
8. **Identify next steps.**

These steps are considered in the sections below.

Figure 10. Chicago's existing central area transit network

Choosing the Technology

Light metro, although more expensive than other options, offers the most long-term benefit and is recommended

Based on preliminary analysis as described in Appendix E, light metro as defined in this document appears to offer the most advantages and is recommended for further study. Models for the system envisioned include London's Docklands Light Rail (Figure 11) and the Vancouver SkyTrain (see Appendix J). Light metro offers the following benefits:

- **Reasonable construction cost.** The preliminary MOS construction estimate is $750M, or $375M/mile. The MOS is the most complex part of the proposed system. If advantage can be taken of existing rail ROW and vacant property in outlying areas, the cost of extensions should be less.
- **High speed.** Light metro would use grade-separated right of way and be capable of higher speeds than technologies such as BRT or light rail that operate on city streets.
- **Low operating cost.** Light metro systems such as the Vancouver SkyTrain are automated, with no operators aboard trains, and recover a high percentage of their operating costs from fares. Because of grade crossings, driverless operation is not practical in the MOS, but would be possible in later phases of the project if grade-separated operation is achieved due to elimination of cross traffic and other dangers.
- **Higher capacity.** The envisioned light metro system could accommodate 450-600 riders/train, depending on train dimensions. The typical BRT vehicle is an articulated bus with a capacity of 100 riders. Surface light rail vehicles can be coupled into trains but length is limited by city block size (so cross traffic is not blocked when a train is stopped at a station); a typical light rail consist carries about 250 riders.

Figure 11. Docklands Light Rail, London

- **Weather-protected operation.** Platforms can be enclosed, with platform-edge doors that align and open in tandem with doors on vehicles. Automated operation is needed to ensure precise alignment.
- **Greater development stimulus.** Developers generally prefer rail over bus since rail service cannot be easily withdrawn.
- **Relatively short construction schedule.** The MOS could be brought online in 7-10 years, in time to avert the congestion scenario described in Appendix A.
- **Easy extension.** Assuming the grade-separated solution described in this document can be achieved, the system can be more readily extended to outlying neighborhoods than surface solutions, which would be slower and more likely to face local opposition due to concerns about safety, conflicts with car/truck traffic, etc.
- **An easier sell.** At-grade solutions are highly visible, potentially affecting hundreds of property and business owners, and often generate strong opposition. The north bank leg of the MOS, in contrast, would largely invisible and directly affects about two dozen properties. The Clinton St. leg would provide needed amenities for West Loop residents.

Selecting a Route

The Connector would provide needed service in fast-growing areas at modest cost, paving the way for core expansion

A proposed route called the Connector transitway (Figure 12) was devised as described in Appendix E. The route offers many benefits:

- As the illustration shows, it would serve areas experiencing rapid growth in households, population and "L" ridership, both downtown and in close-in communities such as Bronzeville, the Near South Side, Pilsen, the Near North Side and Lincoln Park.
- It would permit continued expansion of the revitalized core by providing access to areas now vacant or underutilized due to lack of rail service.
- Much of the line would be built on, over, or adjacent to existing railroad infrastructure or vacant property, permitting fast, high-capacity grade-separated operation at modest cost with minimal adverse impact on the surrounding neighborhood.
- It would connect all four Metra commuter terminals to the "L," greatly increasing the convenience of both.
- It would provide convenient access to destinations that are now difficult to reach via the "L," Metra or both, including Navy Pier, Streeterville, North Michigan Avenue, River North, the West Loop, the Museum Campus, and McCormick Place.
- It would relieve crowding on north side "L" lines, particularly at close-in stops where boarding at peak times is becoming increasingly difficult.
- It would improve circulation within the central area for the growing number of downtown residents, reducing travel times and cost.
- It would ensure continuing revitalization of neighborhoods that have suffered from underinvestment.
- It would serve waterfront corridors with high development potential.

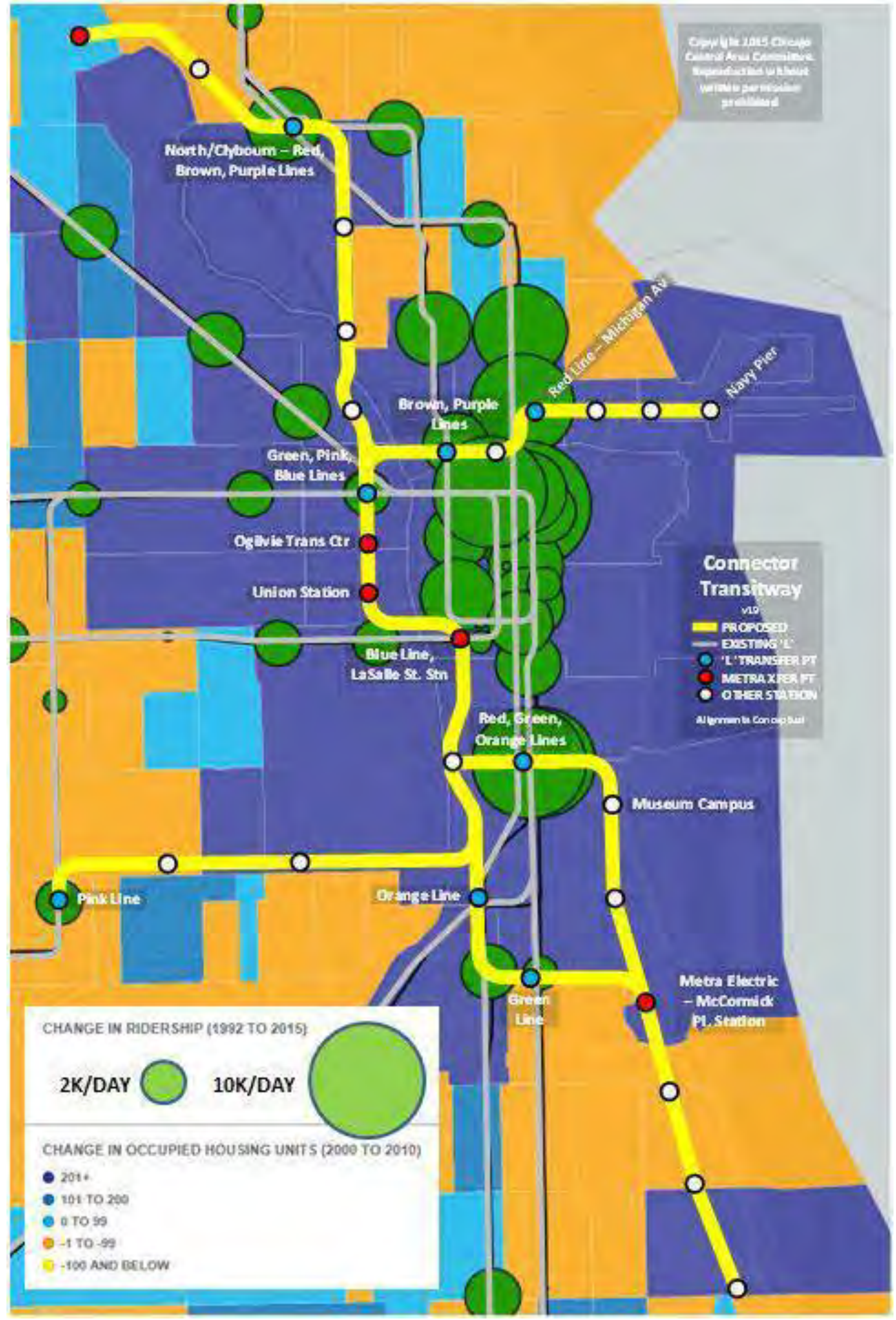


Figure 12. Proposed Connector route vs. household, "L" ridership growth

Identifying the First Phase

The 'minimum operable segment' would extend from the West Loop Metra stations to Columbus/Illinois

The first phase of the project, called the "minimum operable segment" or MOS, is the smallest section on which useful service can be provided. Federal funders tend to favor projects with a relatively inexpensive MOS. The proposed Connector MOS, as shown in Figure 13, extends from Union Station to Columbus/Illinois. It offers the following advantages:

- It is ~2 miles long, making it a reasonably-sized "starter project."
- Previous studies have shown that North Michigan Avenue is the major destination for central area trips other than the Loop.
- It would provide convenient service for the following potential users:
  - West Loop Metra riders bound for River North, North Michigan Avenue, and Streeterville (including the Northwestern medical campus);
  - West Loop Metra riders bound for destinations along the Green Line on the near west side;
  - Red, Brown, and Purple Line riders bound for West Loop offices;
  - Red, Brown, Purple, Green, and Pink Line riders bound for Streeterville; and
  - West Loop residents bound for Streeterville and River North and vice versa. Substantial evening and weekend traffic is anticipated among MOS corridor residents headed for the River North entertainment district.
- The Clinton Street segment is the central element of the overall project and the logical starting point for whatever phasing scheme is adopted.

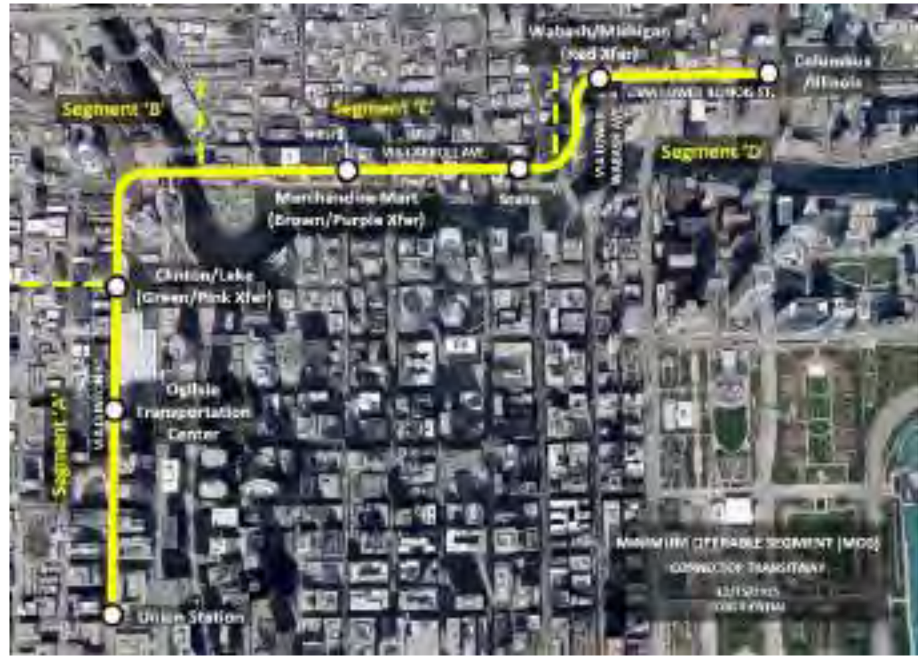


Figure 13. Proposed minimum operable segment (MOS)

Later phases can easily be extended to the north, south or east as funding permits and market conditions warrant.

- The proposed MOS provides service to high profile destinations and is of keen interest to a variety of stakeholders, including office developers, the North Michigan Avenue business community, Streeterville residents, and others.
- The proposed MOS would stimulate office development along the north bank of the Chicago River's main branch, recognizing its prominence as a commercial corridor.

Scoping meetings were conducted with property managers and owners along the north leg of the MOS (including the Carroll Ave. right-of-way) to assess feasibility of this alignment for transit use. No major impediments have been identified to date and the property owners and managers contacted are generally supportive of the project.

Estimating Project Benefits

Rail is a major development driver. A new line would add needed land and catalyze construction of 50M-80M GSF

Past and prospective benefits of transit from a development standpoint were analyzed, as described in Appendix G. The analysis shows that:

- Rail transit is a major driver of development in the Chicago central area. Of 92M GSF built between 1996 and 2015, 85% was within walking distance of a rail stop – see Figure 14.
- More than 90% of <u>office</u> development, and 46% of <u>all</u> development, occurs within the "rail hub" – that is, the part of the central area within walking distance of both the "L" and Metra (red line in Figure 14).
- Lack of rail access is a deterrent to development. Portions of the central area with no rail access account for 42% of the land area but attracted only 15% of development.
- The traditional core has enough sites to support 38M GSF of additional development and will be fully built out in 13-17 years.
- If the proposed Connector were built, the portion of the central area within walking distance of a rail stop would increase from 58% to ~80% of the developable land area (dark pink in Figure 2).
- The Connector would enlarge the rail hub by 95% (red in Figure 2).
- In view of the scarcity of sites within the traditional core, land made rail-accessible by the Connector could capture 50%-60% of expected development over the next 20 years, or 50M-80M GSF.

Given the many public and private improvements already in place, it seems likely the Connector would (a) recognize the north bank and validate the river as a major development corridor and (b) accelerate redevelopment of the south lakefront – see Figure 15, Figure 16, and Figure 17.

Figure 14. Development 1996-2015 vs. rail access

Illustrative representation of potential development opportunities along proposed alignment. Subject to City approval and zoning requirements

Figure 15. Potential development (in white} - minimum operable segment

Illustrative representation of potential development opportunities along proposed alignment. Subject to City approval and zoning requirements

Figure 16. Potential development (in white) – south branch

Illustrative representation of potential development opportunities along proposed alignment. Subject to City approval and zoning requirements

Figure 17. Potential development (in white) – south lakefront

Financing the Project

The central area tax base could support a special service area (SSA) to fund the MOS at a modest rate

Based on analysis as detailed in Appendix F, the white paper team concluded that:

- The federal government could be expected to cover 50% of the project cost at most, and it was imperative the Connector not tap U.S. funding sources needed for the capital backlog at CTA and other local agencies.

- The best way to fund the local share of the MOS may be a combination of (a) a special service area (SSA) that would impose a tax on properties in a defined central area district sufficient to support the necessary bonds, and (b) a "transit TIF" (tax increment finance district), as recently enacted by the Illinois General Assembly – amendment of the TIF statute to include the Connector would be needed. Downtown commercial property owners had agreed to an SSA to fund the Circulator project in the 1990s. An SSA is a stable funding source attractive to the bond markets – see further discussion in Appendix H.

- Upon analysis using the Cook County assessor's property value database, it was determined that, if all property classifications were taxed, properties within a 10-minute walk of MOS stops provided sufficient tax base to support a preliminary project budget of $750M at a rate of 25 basis points (0.25%). See chart below.

Project approach	Automated, grade-separated light metro
Preliminary MOS budget	$750M
Local match	$375M
Proposed SSA tax rate	0.25% (25 basis points)
Bond yield – 10 min walkshed	$380M (all property classifications)
Bond yield – concept district	$480M (commercial properties only)

- If the tax was limited to commercial properties only, the SSA would need to encompass a larger district, defined for purposes of illustration as shown in Figure 18. **NOTE:** Boundaries shown for proof of concept only. Actual boundaries subject to negotiation and city approval.

Buffer	Assessed Value	Calculated Market Value	Equalized Assessed Value	Number of Parcels
10 min Core Walkshed	5,709,308,579	30,031,857,992	15,198,750,368	4,152
Central Area	7,281,335,817	38,401,857,827	19,383,644,078	5,663

Figure 18. Hypothetical SSA boundaries (dashed red line)

Federal funding strategy. Federal funding sources are described in Appendix H. In discussions with CTA and the city, it was established that:

- The value of the Connector had been demonstrated.

- The city's priority transit expansion project was the Red Line Extension (RLE) to 130th Street – see Appendix B.

- Given the RLE budget of $2.3B, the challenge of raising the local match, the potential availability of Connector local match funding, and the national rather than local nature of competition for U.S. dollars, it was conceivable funding applications for RLE and the Connector could be interleaved to permit parallel advancement of the two projects. This possibility requires further exploration.

Next Steps

Needs: detailed cost estimates, finalized alignment, decision maker OK, consensus on implementation structure

If the decision is made to move forward with the Connector, the next steps to be accomplished include:

- **Enlistment of support from public agencies and officials.** Officials and agencies must be consulted to resolve technical questions and determine willingness to proceed. City Hall buy-in is critical.
- **Enlistment of business support.** Business endorsement of an SSA and funds for pre-engineering must be solicited. This effort is currently underway.
- **Pre-engineering analysis,** including:
  - – Detailed cost estimates and finalization of alignment for MOS; stakeholder buy-in for remainder of alignment must be sought
  - – High-level alignment, budgeting and stakeholder buy-in for later phases.
- **Identify implementation mechanism.** A structure must be devised to:
  - – Administer the SSA
  - – Contract for and oversee Connector design and construction
  - – Apply for federal funds and oversee the approval process
  - – Update city plans and zoning to support transit improvements
  - – Secure the right of way.

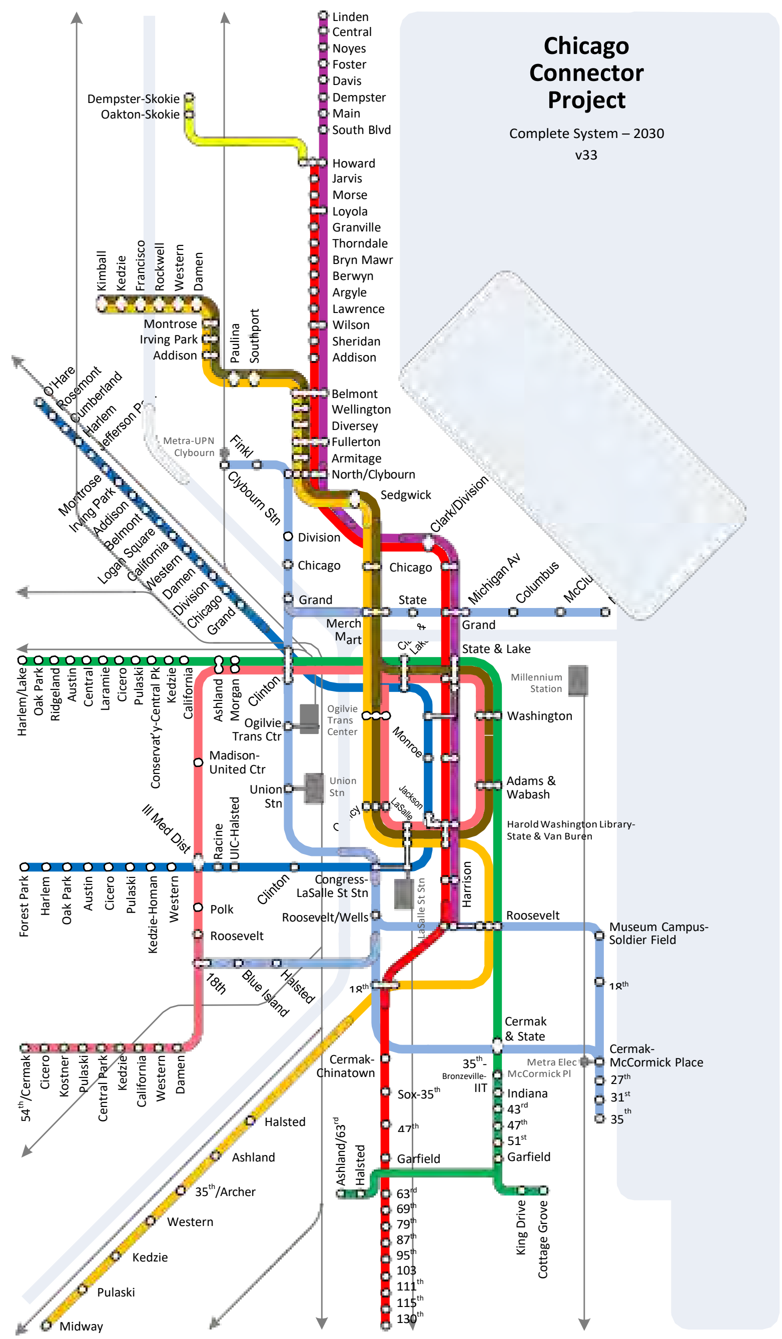


Figure 19. CTA rail system on completion of proposed Connector

Acknowledgments

The Case for Rail Transit Expansion in the Chicago Central Area was jointly funded by the Urban Transportation Center (UTC) at the University of Illinois at Chicago and the Chicago Central Area Committee (CCAC).

UTC's funding source was the National University Rail Center (NURail) at the University of Illinois at Urbana-Champaign, which in turn receives funding from the U.S. Department of Transportation.

CCAC received financial contributions from the following organizations, whose generosity is gratefully acknowledged:

Bryan Cave LLP
The John Buck Company
Chicago Loop Alliance
East Bank Club
Fifield Companies
Friedman Properties
The Habitat Company
Hines
McCaffery Interests
Merchandise Mart Properties
Riverside Investment & Development
Streeterville Organization of Active Residents
300 North LaSalle
Zeller Development Corporation

Substantial in-kind contributions were provided by members of the executive committee and project team, cited below.

Executive Committee

Greg Hummel – Bryan Cave LLP, *Chair*
Kelly O'Brien – Chicago Central Area Committee, *Executive Director*
Avram Lothan – Lothan Van Hook DeStefano Architects
Stephen Schlickman – Urban Transportation Center, University of Illinois at Chicago
P.S. Sriraj – Urban Transportation Center, University of Illinois at Chicago
Doug Voigt – Skidmore, Owings & Merrill
Mark Walbrun – Mott MacDonald
Ed Zotti – Chicago Central Area Committee

Project Team

Ed Zotti, *Project Manager and Principal Author*
Bryan Cave LLP
- Greg Hummel

Doejo
- Darren Marshall

Fifield Companies
- Steve Fifield

S.B. Friedman Development Advisors
- Stephen Friedman
- Ranadip Bose
- Harpreet Gill
- Ethan Lassiter

Hines
- Greg Van Schaack

Lothan Van Hook DeStefano Architecture
- Avram Lothan
- Kerrie Mistry

Mott MacDonald
- Mark Walbrun
- John Green
- Eric Vaillancourt

PORT Urbanism
- Andrew Moddrell

Skidmore, Owings & Merrill
- Phil Enquist
- Doug Voigt
- Dawveed Scully
- Justin Lim
- Neil Katz
- Michael Kavalar
- Matthew Shaxted

Urban Transportation Center, University of Illinois at Chicago
- Stephen Schlickman
- P.S. Sriraj
- Paul Metaxatos

Mike Rothschild, *Data Scientist*
Daniel Lubben, Lucy Honold, *Interns*

Steering Committee

Malek Abdulsamad, Streeterville Properties
Carla Agostinelli, West Loop Community Organization
Tom Black, The Habitat Company
Ranadip Bose, SB Friedman Development Advisors
Ron Burke, Active Transportation Alliance

Christine Carlyle, Solomon Cordwell Buenz
Rafael Carreira, Riverside Investment & Development Company
Bob Chodos, Newmark Grubb Knight Frank
Loriann Duffy, Hines
Michael Edwards, Chicago Loop Alliance
Steve Fifield, Fifield Companies
Yonah Freemark, Metropolitan Planning Council
Jason Friedman, Friedman Properties
Stephen Galler, The Habitat Company
John Green, Mott MacDonald
Jacky Grimshaw, Center for Neighborhood Technology
Greg Hummel, Bryan Cave LLP
Laura Jones, Chicago Loop Alliance
Tom Kasznia, Perkins + Will
Peter Lemmon, Kimley-Horn
Phil Levin, Magnificent Mile Association
Avram Lothan, Lothan Van Hook DeStefano Architecture
Darren Marshall, Doejo
Dennis McClendon, Chicago CartoGraphics
Thomas McElroy, Level-1 Global Solutions, LLC
Tyler Meyr, Forum Studio
Kelly O'Brien, Chicago Central Area Committee
Susan Ohde, South Loop Neighbors
Allan Perales, McCaffery Interests
Will Press, The John Buck Company
Stephen Schlickman, Urban Transportation Center – University of Illinois at Chicago
Peter Skosey, Metropolitan Planning Council
Deborah Soehlig, Greater South Loop Association
Gail Spreen, Streeterville Organization of Active Residents
P.S. Sriraj, Urban Transportation Center – University of Illinois at Chicago
Mike Szkatulski, RMC International
Ron Tabaczynski, BOMA Chicago
Greg Van Schaack, Hines
Doug Voigt, Skidmore, Owings & Merrill
Mark Walbrun, Mott MacDonald
Kyle Whitehead, Active Transportation Alliance
Ed Zotti, Chicago Central Area Committee

Appendix A – Relationship of City Economic Trends and Transit

With rising professional employment driving demand, the busiest "L" lines will reach capacity in a few years

CTA rail ridership has increased substantially in recent years. During the morning peak, particularly in the fall, trains on the busiest lines are often crush-loaded (riders will wait on the platform for the next train rather than attempt to board) while still several miles from the Loop.

A review of census, jobs, and transit data suggests that ridership growth is a predictable consequence of growing professional employment in the central area and that, if present trends continue, large parts of the rail system will soon reach capacity.[1] In particular, the data indicate that:

- Chicago is attracting large numbers of well-educated professionals who work in the central area, live in the city, and take the "L" to work.
- As a result, "L" ridership has grown considerably – average weekday riders increased 51% between 1992 and 2015.
- Since 1998, "L" ridership has followed central area professional employment in a predictable manner.
- Based on this relationship, weekday "L" ridership can be expected to grow from 770,000 as of 2015 to 890,000-950,000 in ten years.
- By the end of this time, the "L" lines serving the busiest rail corridors – the Red, Blue, Brown and Purple Lines – will operate at capacity during peak times, even if planned improvements are made.
- If planned improvements are not made, the busiest lines will reach capacity during peak periods in the fall of 2017.

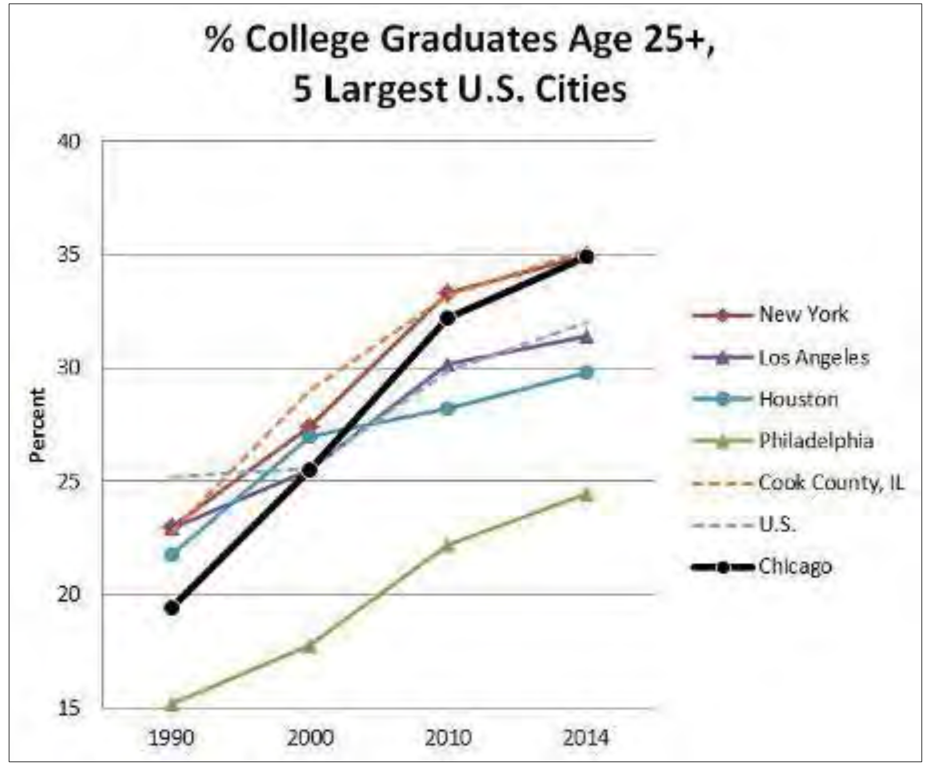


Figure A-1

A rigorous mathematical demonstration of the relationship between city economic trends and "L" ridership growth was beyond the scope of this study. However, the correlations when depicted graphically are striking and the implications for transit planning would appear to warrant further study. This appendix provides a fuller look at the relevant data, primarily in graphical form.

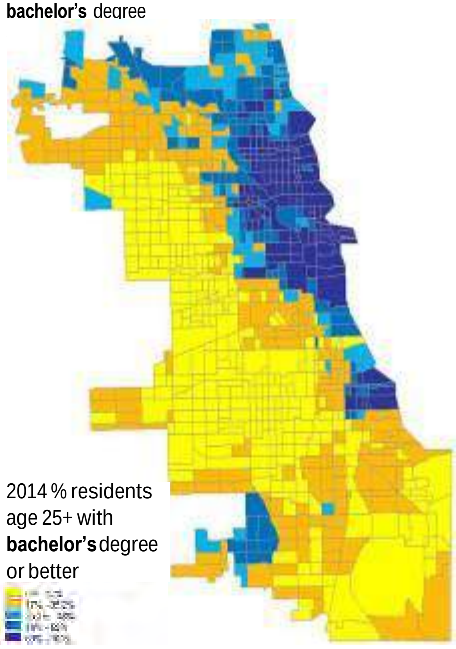
Overview of Chicago Socioeconomic Trends

The economic fortunes of the city of Chicago have improved markedly since 1980, as evidenced by the following trends:

- The percentage of college graduates living in the city of Chicago has sharply increased since 1980. It now exceeds the U.S. average and is at parity with Cook County overall. Among the five largest U.S. cities, the fraction of Chicagoans with college degrees is on par with New York and ahead of Los Angeles, Houston, and Philadelphia – see Figure A-1.

- Census tracts with a high percentage of college graduates closely correspond with those having a high fraction of residents in professional occupations, tabulated in the census as "management, business, science and arts employment" – see Figure A-2 for a comparison of 2014 data. Professional employment was not tabulated in the same way in earlier censuses, making long-term comparison difficult. However, it seems likely the proportion of Chicagoans in professional jobs has increased in parallel with the rise in educational attainment since 1980, and this report so assumes.[2]

2014 % residents
age 25+ with
bachelor's degree



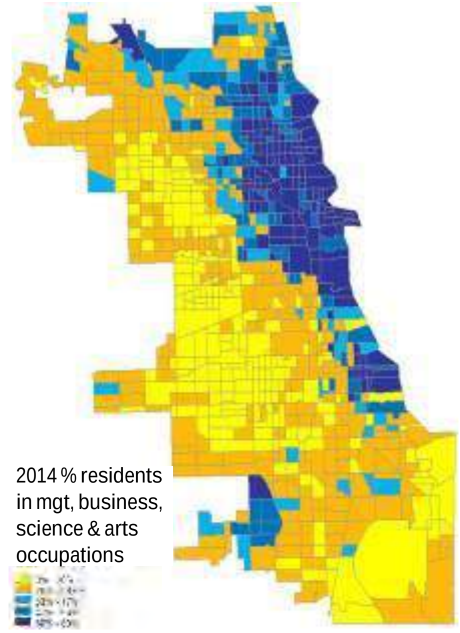


Figure A-2

- Median household income in Chicago remains below the Cook County median, but the gap has narrowed – the city was at 80% of the county median in 1980 but 87% in 2014. In a broad swath of the city, extending from the far northwest side to Cermak Road, median income exceeds that for the county, often by wide margins.

The maps on the following pages illustrate these trends. Three maps are shown for each of the census years from 1980 through 2010 plus 2014. From right to left, they depict:

- The percentage of residents in each census tract having a bachelor's degree or higher
- Median household income as a percentage of the Cook County median
- Median value of owner-occupied homes as a percentage of the Cook median.

Shades of blue indicate tracts above the Cook County median; yellow, orange and red are below.

Several observations may be made:

- Chicago has experienced what journalist Alan Ehrenhalt has called "demographic inversion."[3] In 1980, it was a typical aging industrial city, with an impoverished core surrounded by relatively prosperous outlying neighborhoods. Today the situation is substantially reversed. The core is the most affluent section of the city, while many communities on the periphery have fallen below the county median.
- The affluent core is a contiguous area that has grown at a steady and fairly predictable pace since 1980, setting aside the sharp rise in median home values evident on the north and northwest sides in 2000. It seems reasonable to describe this as a bubble that had been corrected by 2010.
- High college graduate percentage and high median home value tend to be leading indicators of future high median income. Thus tracts with a high percentage of college grads and high home value in 1990 tend to have high median income in 2000, and likewise for 2000 vs. 2010.[4]

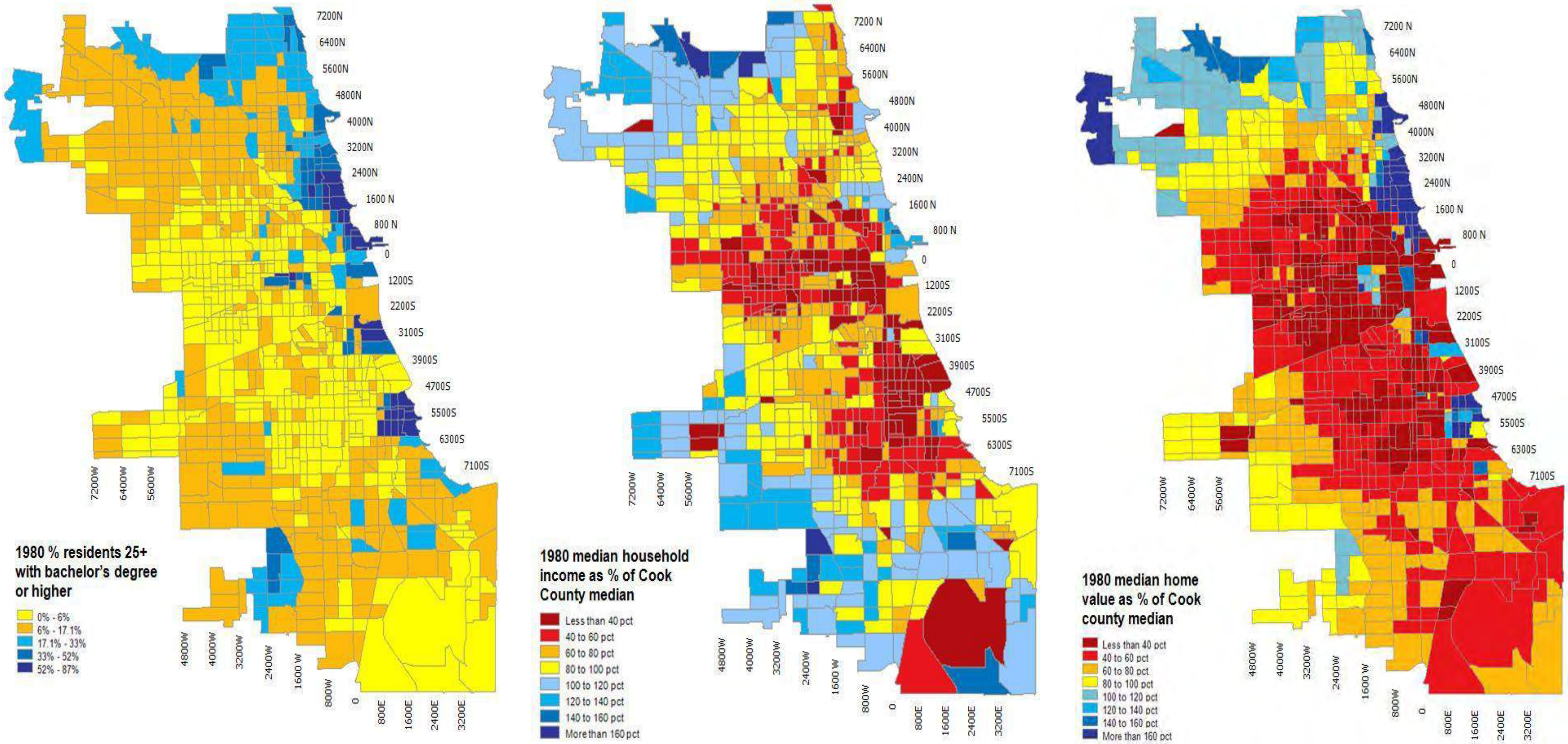


Figure A-3. 1980 Chicago socioeconomic indicators

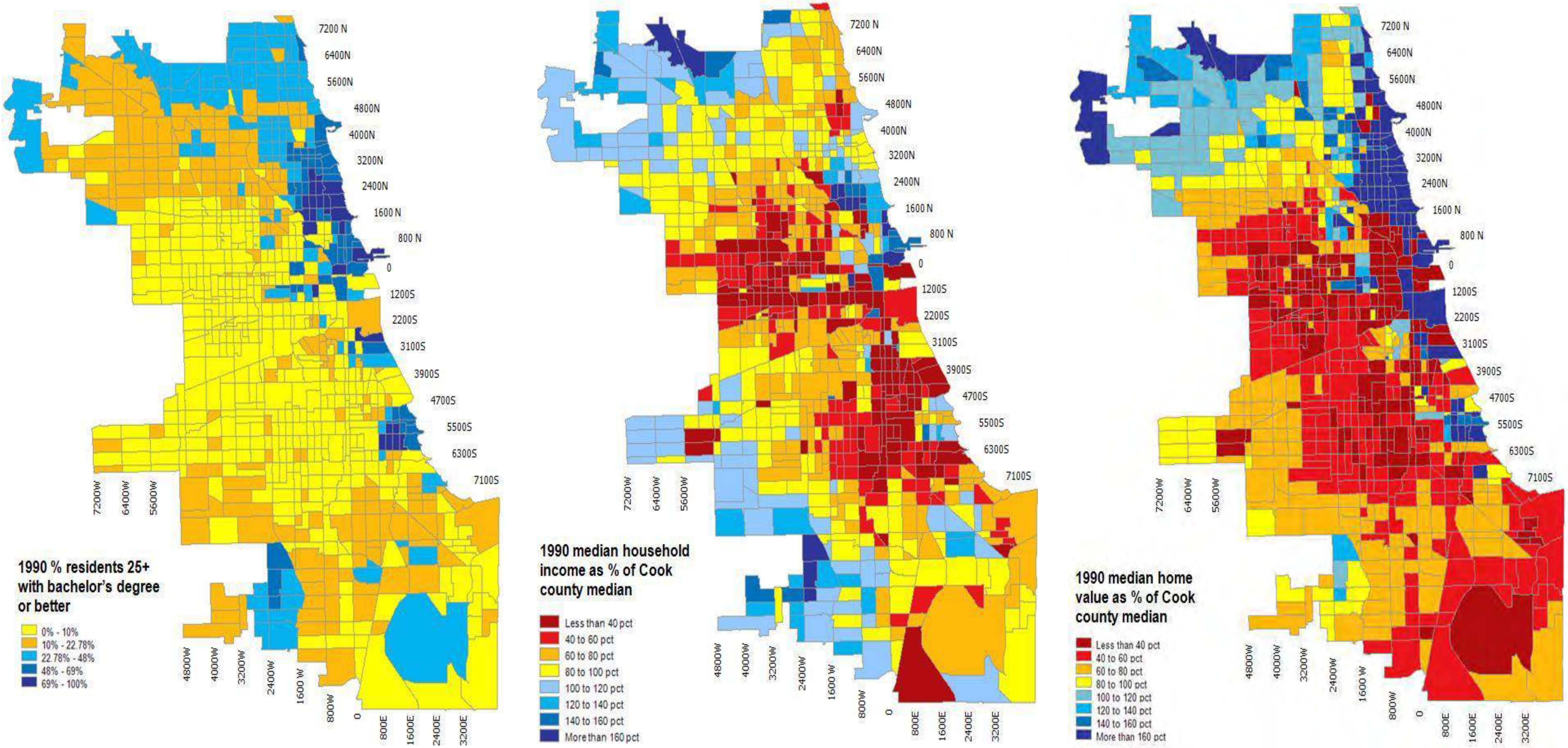


Figure A-4. 1990 Chicago socioeconomic indicators

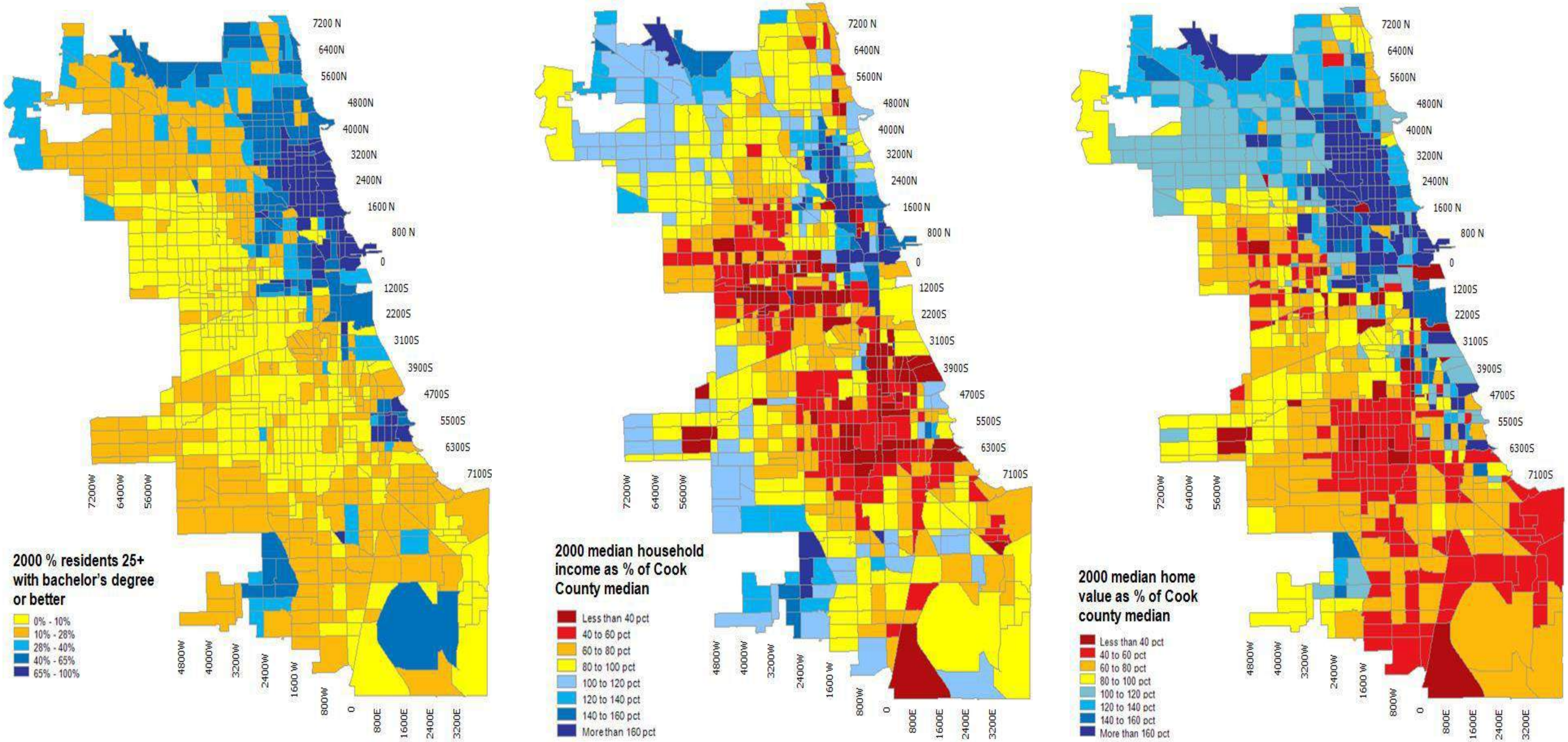


Figure A-5. 2000 Chicago socioeconomic indicators

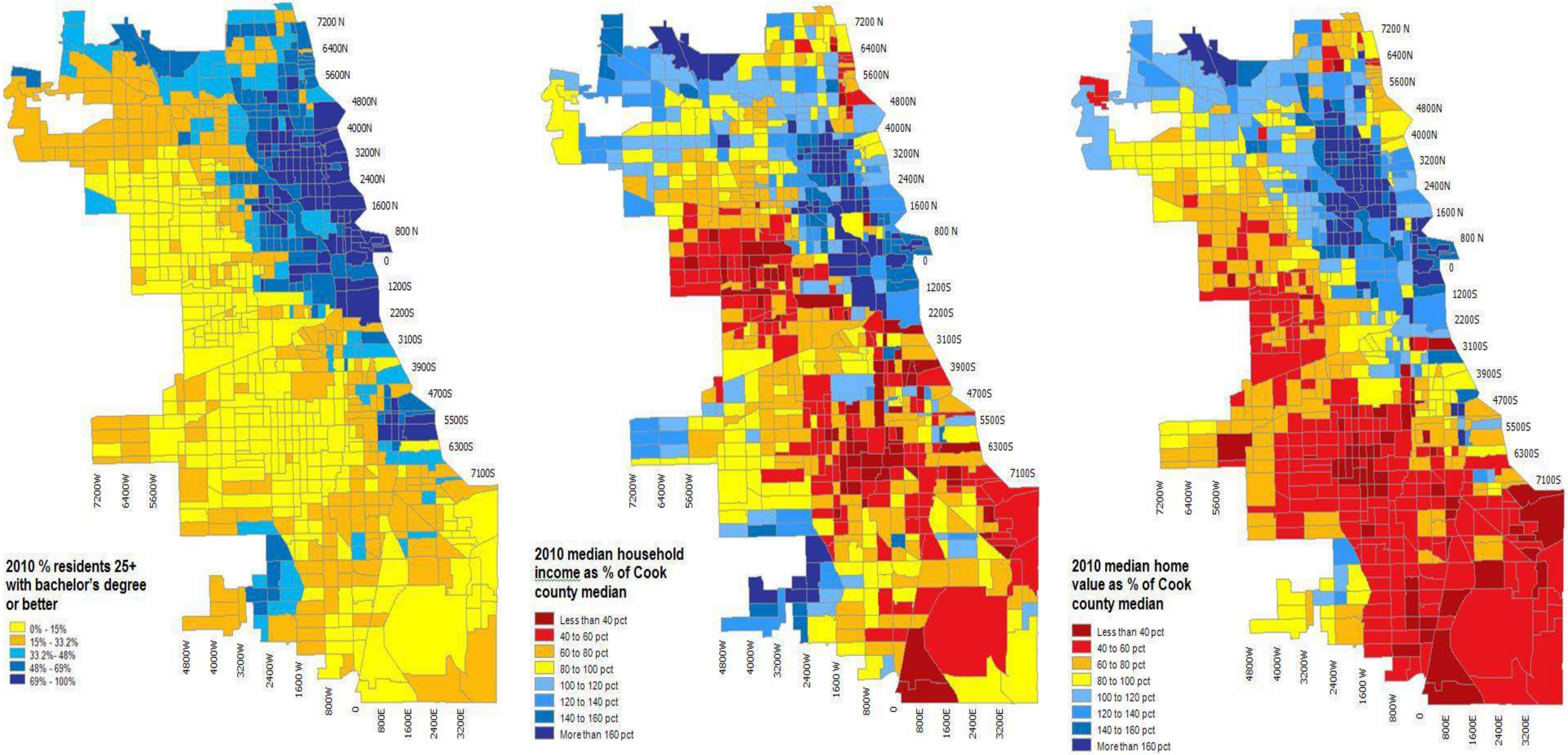


Figure A-6. 2010 Chicago socioeconomic indicators

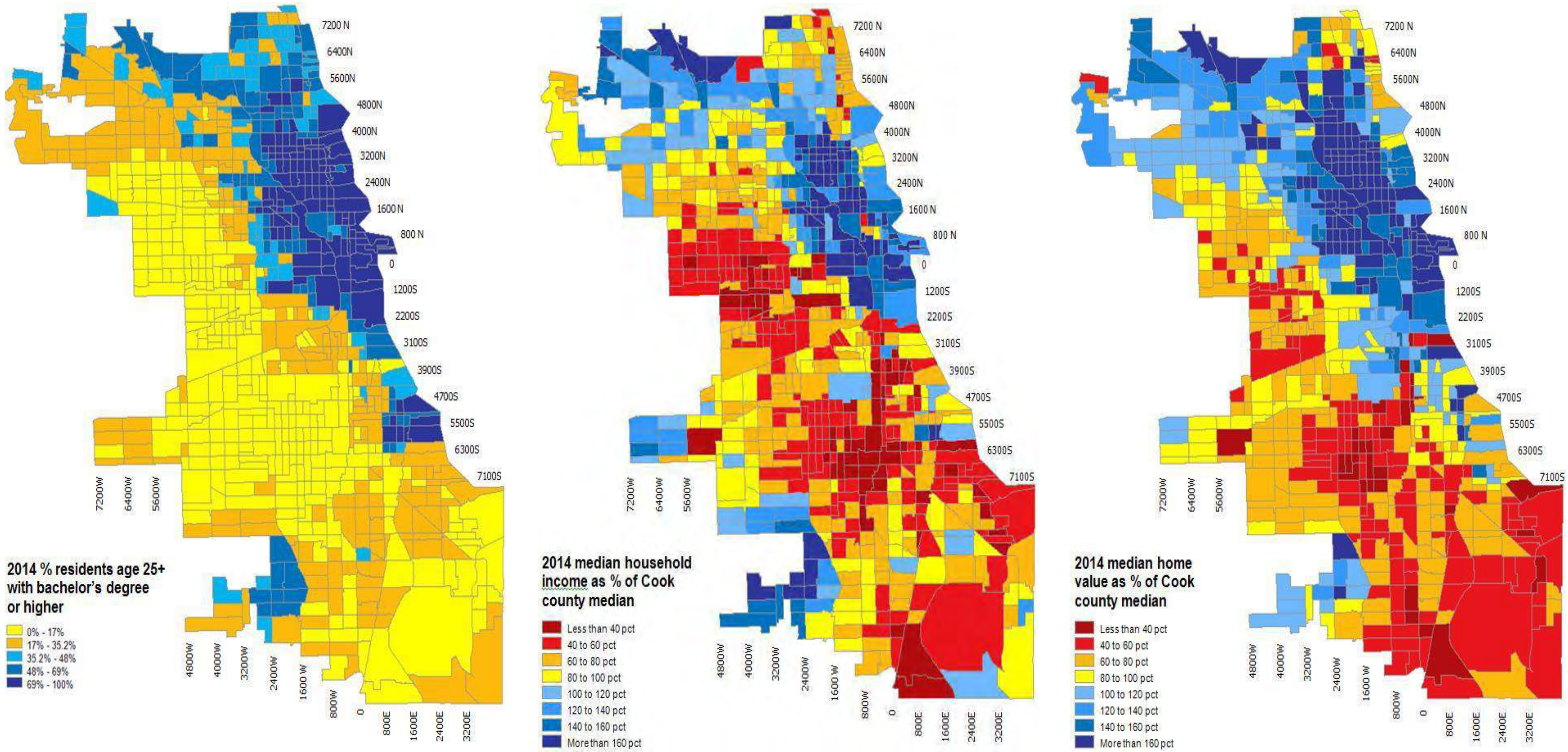


Figure A-7. 2014 Chicago socioeconomic indicators

Summary of Positive Indicators

Figure A-8 summarizes the positive indicators shown in the preceding maps and adds one more. Specifically, it shows census tracts where:

- Median household income exceeds Cook County median, *or if not –*
- Median owner-occupied home value exceeds Cook median, *or if neither of the preceding is true –*
- Percentage of residents in professional occupations exceeds Cook median, *or if none of the preceding is true –*
- Households increased between 2010 and 2014.

Observations:

- Positive indicators are evident on most of the north and northwest sides as well as in the core and adjacent areas, extending out to Western Ave. on the west side, 47th and Ashland on the near southwest side, and 71st St. on the south lakefront.
- Many north and northwest side tracts have multiple positive indicators – that is, high home values and high educational attainment and high median income. This is less true on the south side, where tracts tend to have one or two positive indicators at most and many have none. Nonetheless, it seems evident the revitalized core is steadily pushing south – to a remarkable degree in the case of the south lakefront.
- The southwest side is less affluent than the north side but is seeing growth in households. Although not explored in this report, this is largely due to increasing numbers of Hispanic households plus lesser numbers from other ethnic backgrounds.
- Positive indicators tend to be associated with proximity to a CTA or Metra rail station. South side Metra stations in particular are an underappreciated resource.

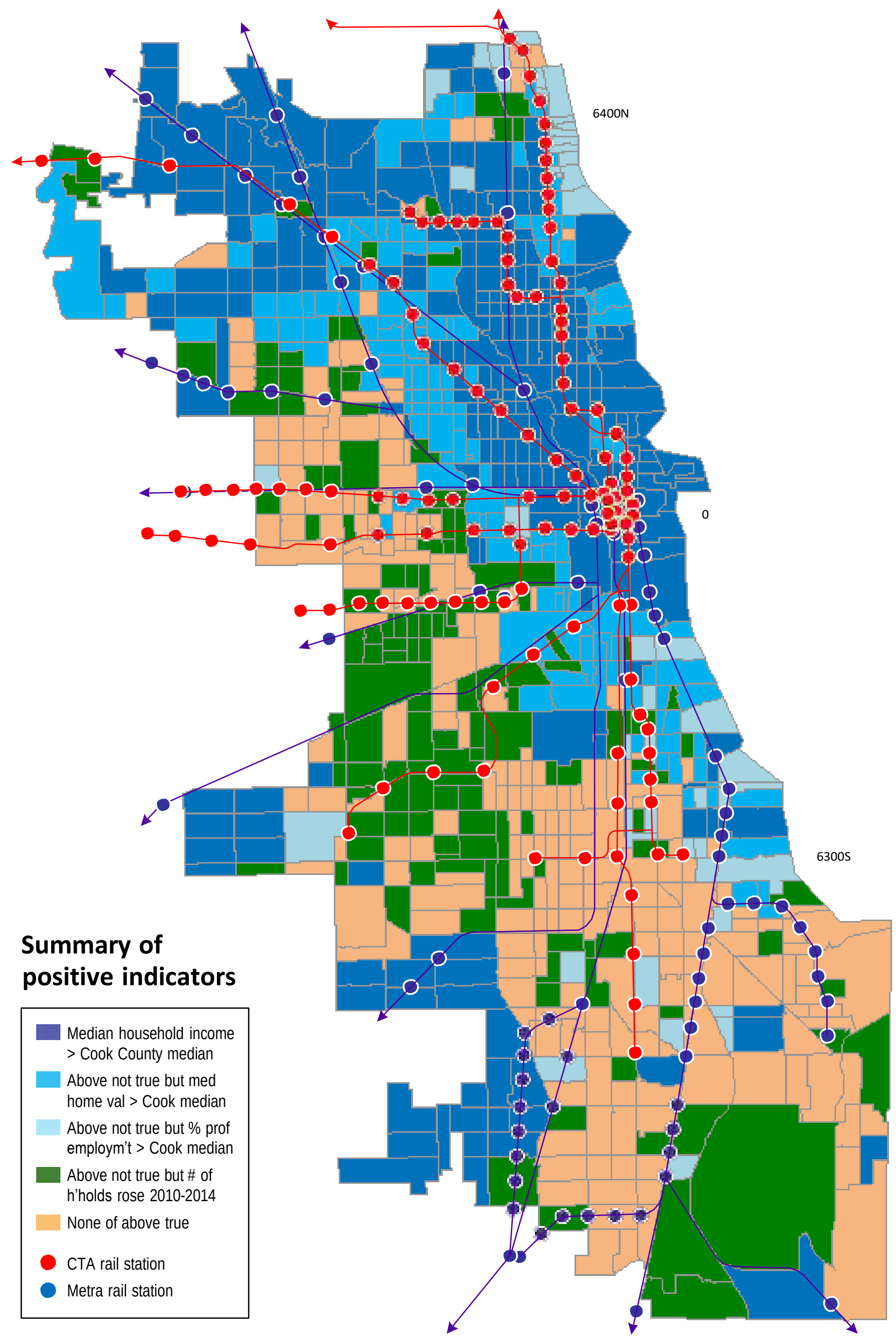


Figure A-8. Summary of positive indicators, 2014

Chicago Population Trends by Sector

After dropping between 2000 and 2010, the city's population has since risen, although parts of the city remain in decline. To analyze the differences, Figure A-8 was used to divide the city into sectors:

- The **north side** – considered to include the near west side for this analysis – is prosperous, as is the **far southwest side**.
- The **central area**, defined as tracts some portion of which is within two miles of city hall, is affluent and growing much faster than the rest of the city.
- The **south lakefront** has positive indicators but fewer than the north side or central area.
- The **southwest side** has few positive indicators but many tracts are experiencing household growth.
- The **far west side** and **far south side** have few positive indicators and few tracts are experiencing household growth.

Population change in each sector for the periods 2000-2010 and 2010-2014 was tabulated using U.S. census data – see Figure A-9. Observations:

- Between 2000 and 2010, the central area gained many residents, but all other parts of the city lost population.
- Between 2010 and 2014, the downward trend largely reversed. Most of the city gained population. The population of the far west side was essentially flat, a change from the drop of the previous decade, suggesting the area is stabilizing.
- The south lakefront is experiencing a turnaround. The population of this once-declining area is growing and many tracts have high home values, income and/or educational attainment. Most residents are minorities but the mix is becoming more diverse, with fewer whites, a slight increase in blacks (the largest group), and more Asians and Hispanics.[5]
- The exception is the far south side, where the population continues to decline sharply at about the same rate as in the previous decade.

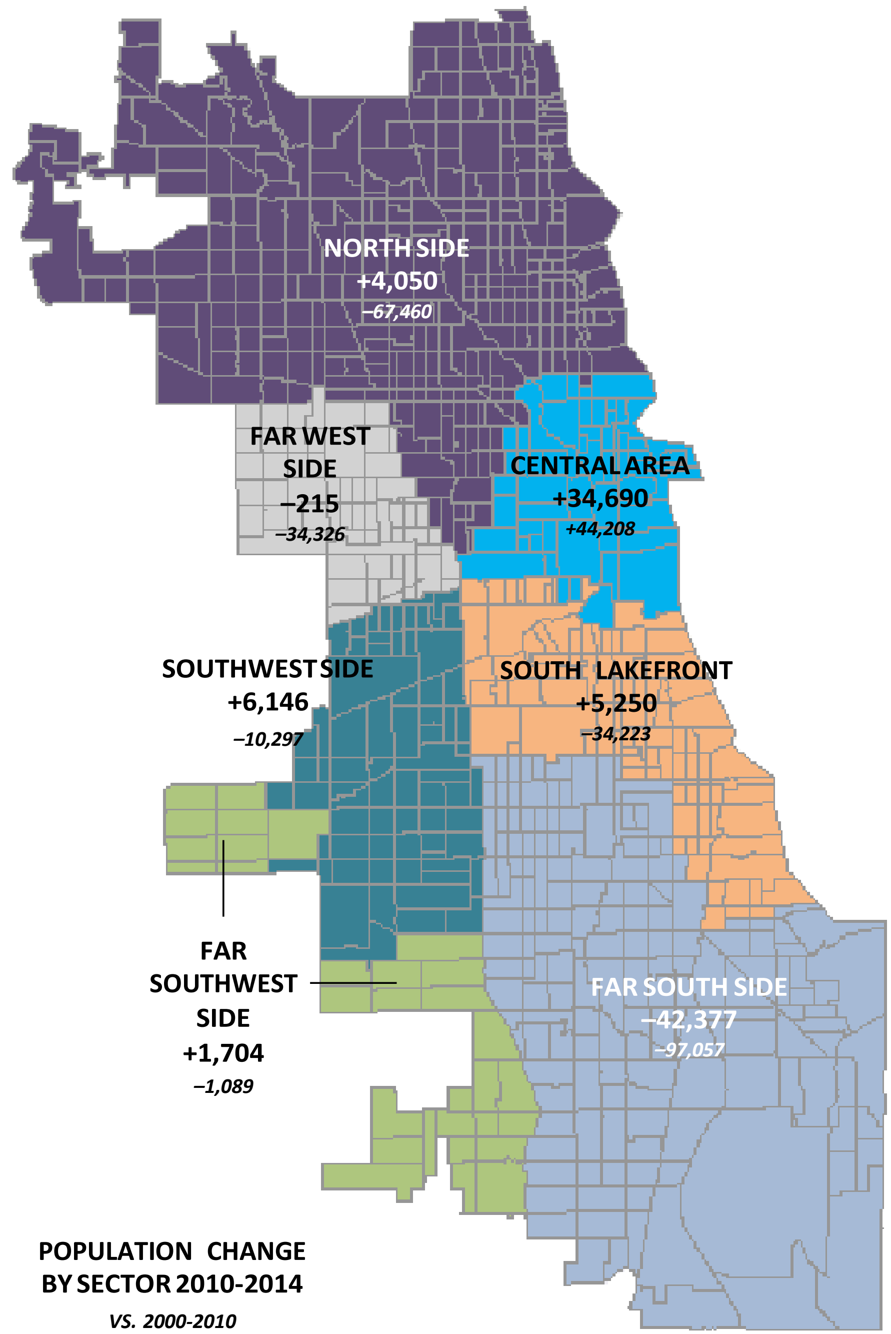


Figure A-9. Chicago population trends by sector

Impact of Rail Transit on City's Spatial Organization

The "L" historically has been a major development driver in Chicago and has again become a focus of growth. As seen in Figure A-10, the most densely populated parts of the city tend to be located near "L" lines. Thinly populated areas (other than industrial districts) are mostly (a) tracts in outlying areas built to suburban densities, and (b) low-income areas on the west and south sides that have lost much of their housing stock (Figure A-11). It is safe to say densities of west and south side neighborhoods near the "L" were considerably closer to north side levels at one time.

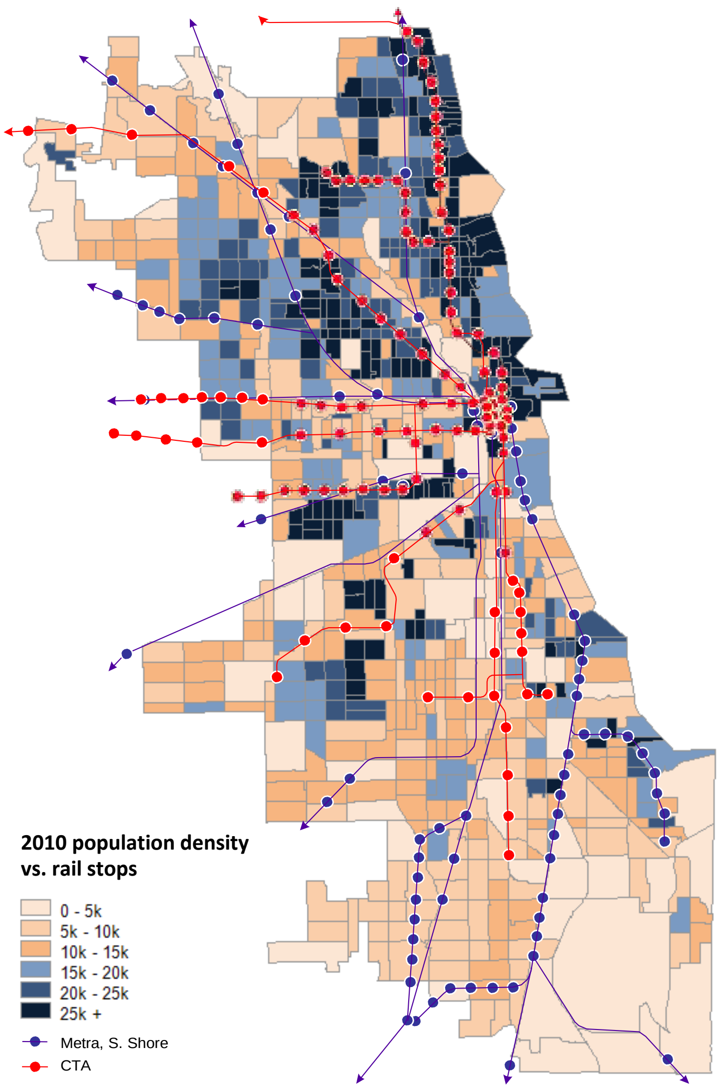


Figure A-10. Chicago population density per square mile, 2010

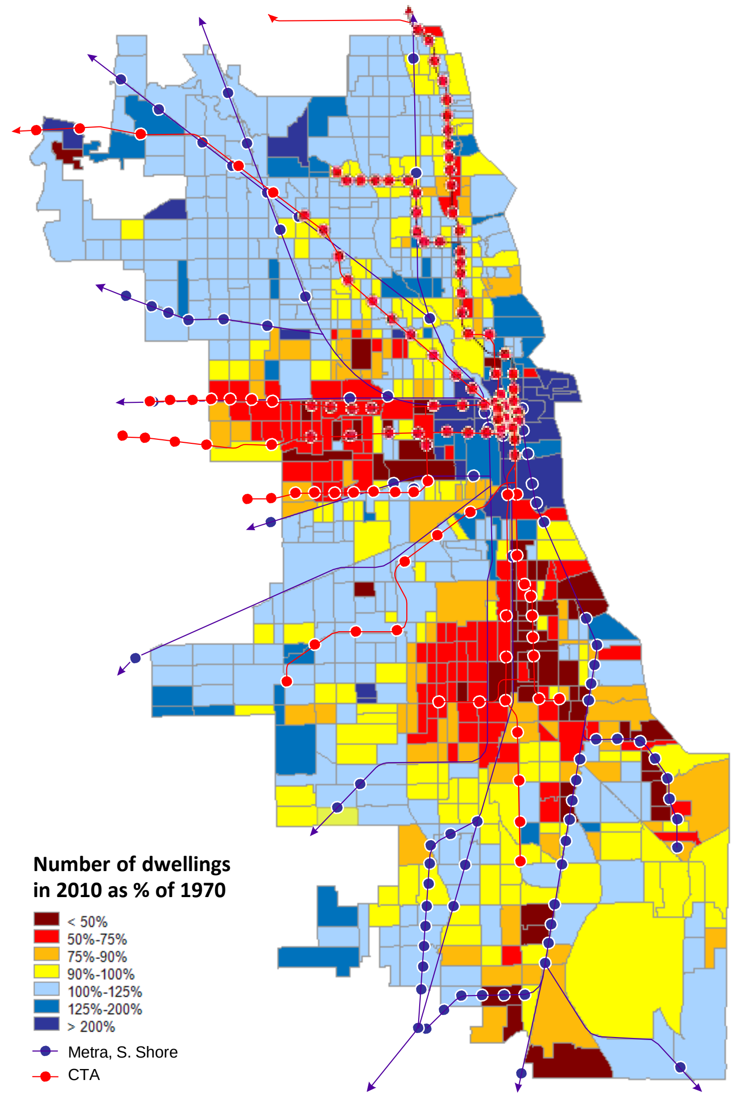


Figure A-11. Change in number of dwellings 1970-2010

For reasons to be explored later in this appendix, Chicago residents and businesses are again gravitating toward the rail system. As seen in Figure A-12, increases in households 2000-2010 closely corresponded to proximity to a rail station, including the “L” and Metra/South Shore. Likewise, as Yonah Freemark of the Metropolitan Planning Council has shown, opening of retail businesses in recent years has been significantly higher within one-half mile of the “L.”[6] This is apparent in Figure A-13, which shows openings (yellow dots) and closings (black dots) of retail food establishments and taverns between 2003 and 2016. New businesses are noticeably more prevalent around “L” lines north, northwest, and west of the Loop.[7]

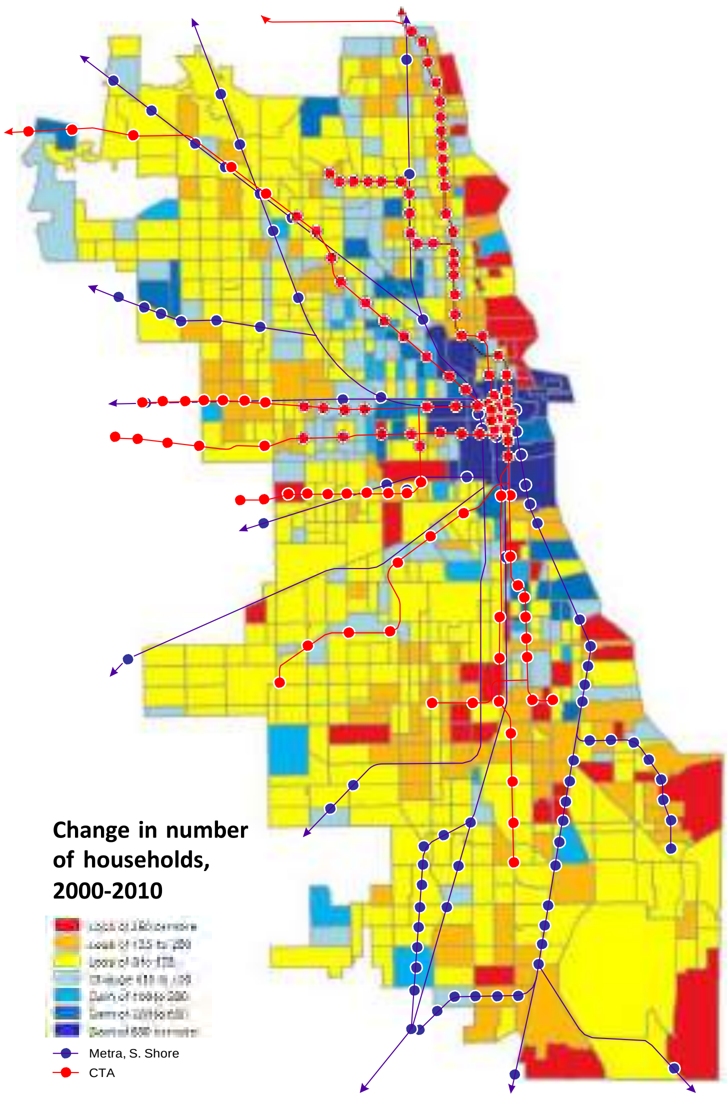


Figure A-12. Household growth vs. rail stops, 2000-2010

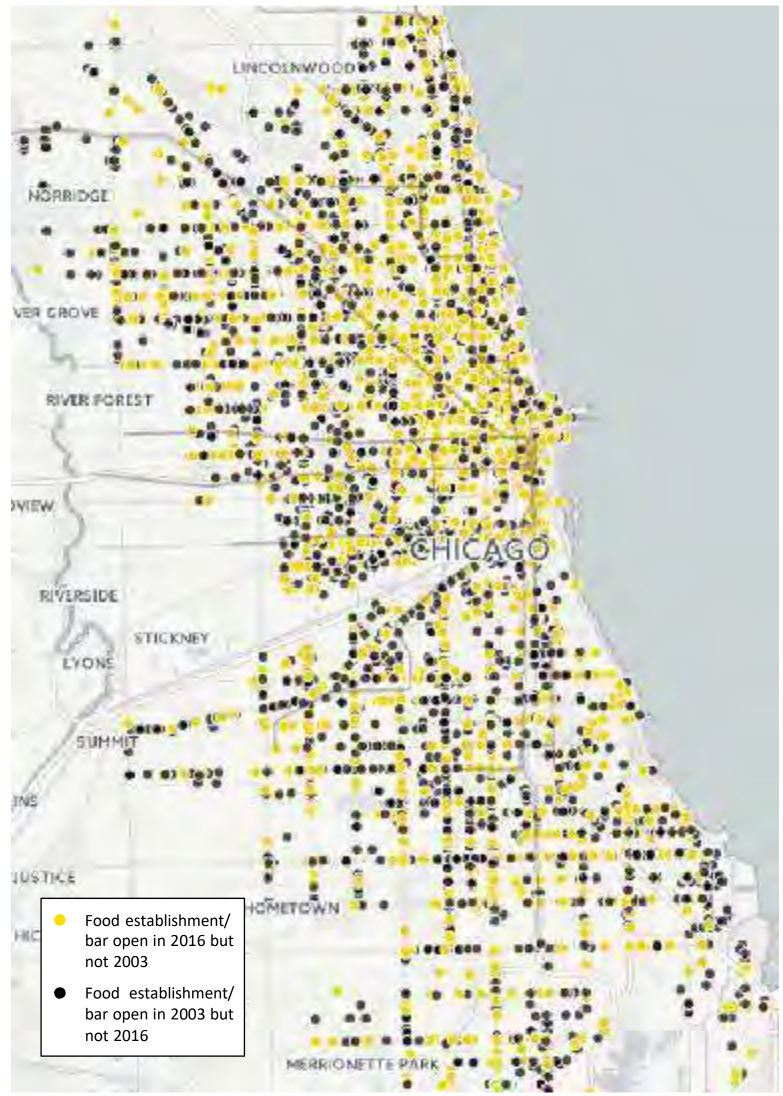


Figure A-13. Food/bar business openings and closings, 2003 vs. 2016

CTA Ridership Trends vs. Central Area Employment

Total CTA ridership has plummeted since 1960, but the loss has been borne mostly by the bus system, as shown in Figure A-14. "L" ridership was relatively steady but fell sharply starting in the mid-1980s, reaching a low point in 1992.[8] Since then it has risen in most years and as of 2015 was at the highest point in modern recordkeeping – see Figure A-15.[9]

The "L" is capturing a growing share of Chicago work trips, as seen in Figure A-16.[10] During a time when the city added 47K jobs, the number of Chicago workers commuting by private vehicle dropped 45K while "L" use rose 52K. Biking and walking rose modestly, bus fell, and other modes remained flat.

The long-term decline in overall CTA ridership correlates inversely with Chicago automobile registration.[11] The increase in rail ridership is more complex. Since the "L" serves the central business district, it might be supposed that ridership and downtown employment would fluctuate at similar rates, but this has not been true in Chicago in recent times. Since 1992, rail ridership has risen 51%; central area jobs have risen just 16%.

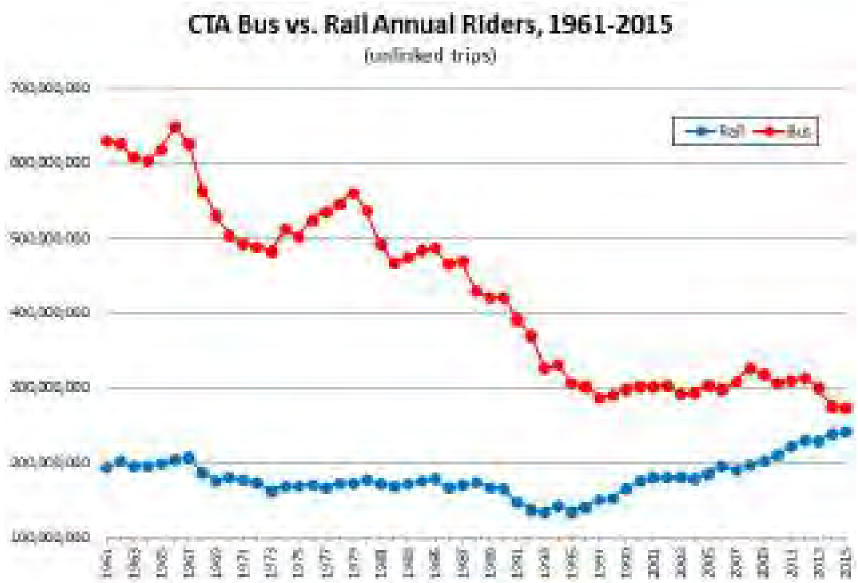


Figure A-14. CTA ridership trend

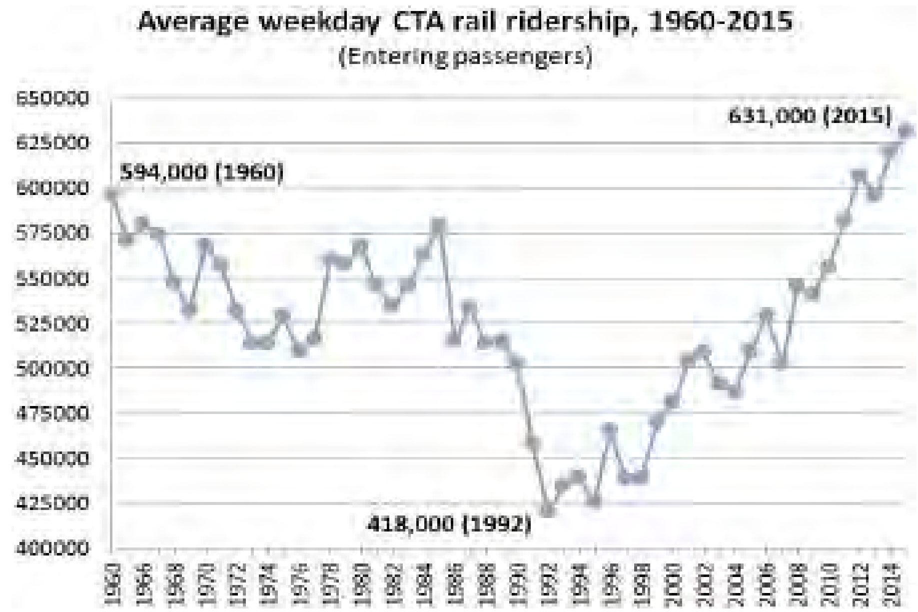


Figure A-15. "L" ridership trend

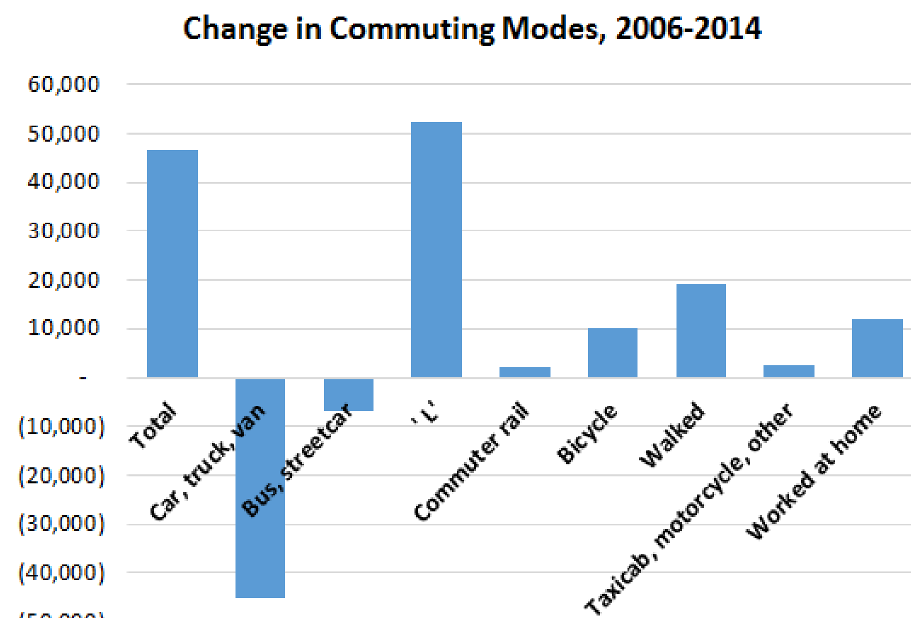


Figure A-16. Change in Chicago commuting modes, 2006-2014

An explanation can be found in the changing composition of central area employment as seen in Figure A-17, based on private-sector jobs data reported by the Illinois Department of Employment Security (IDES).[12]

Methodological issues notwithstanding, several trends are evident:

- Service-sector jobs, including technology, have grown for more than 40 years and now constitute the majority of central area employment.

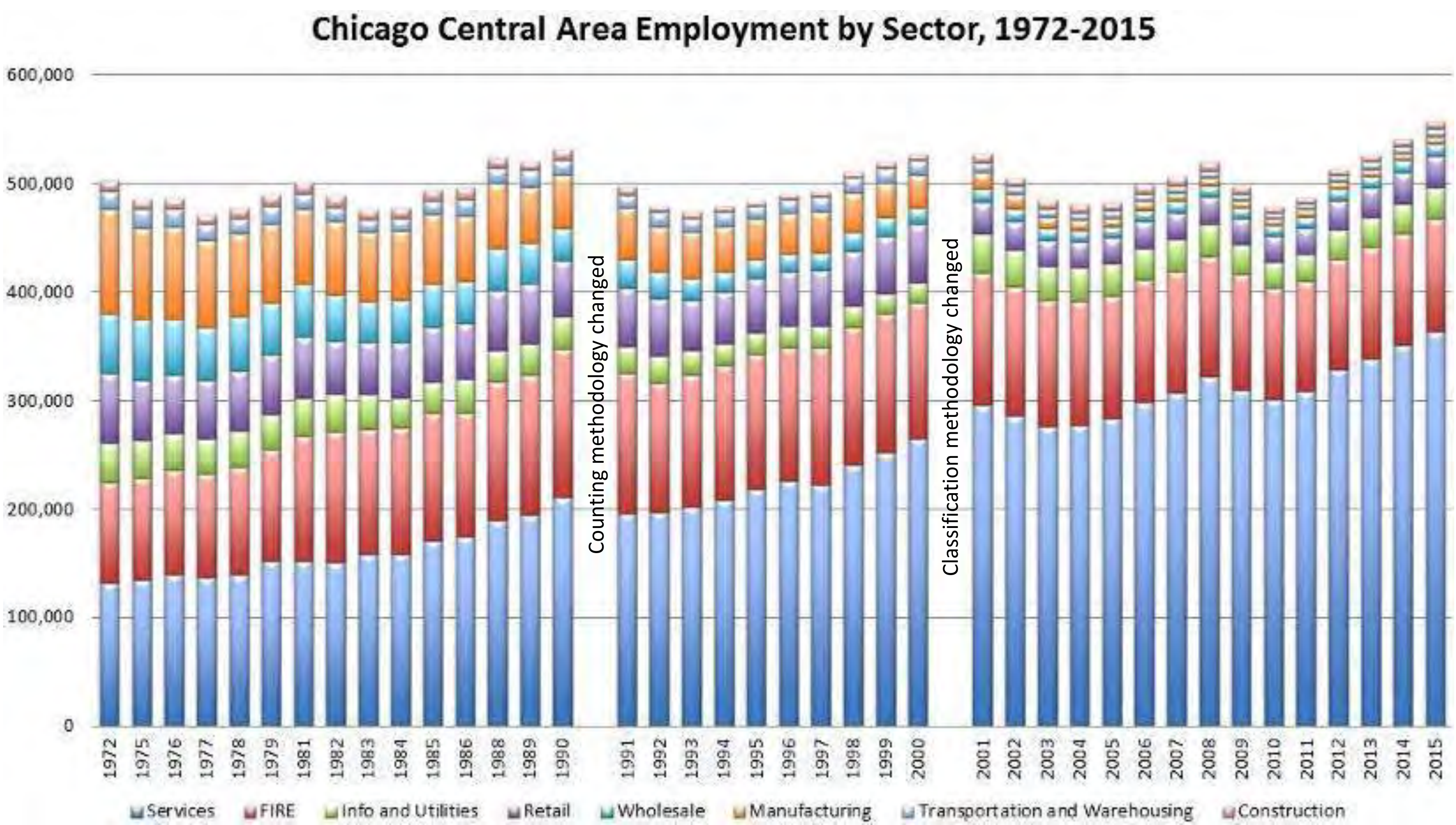


Figure A-17

- Blue-collar employment in the central area has shrunk. Manufacturing was once a major contributor to downtown employment in industries such as printing and apparel making; few such jobs remain. Likewise, wholesaling, transportation and warehousing employment has diminished.

- Finance-insurance-real estate (FIRE) and information and utilities employment (including publishing and broadcasting) has been relatively stable. Retail employment dropped contemporaneously with the closing of Loop department stores but has stabilized.

Not all service-sector jobs are professional, and categories such as FIRE and information also include a high percentage of professional workers. Nonetheless, service-sector jobs may be reasonably viewed as a proxy for professional employment.

The increase in central area professional jobs partly explains the growth in “L” ridership – analysis shows the two tend to rise and fall together. For this study, trends for ridership vs. service-sector employment were charted iteratively for baseline years from 1991 to 2014. The earliest baseline year for which a close relationship between jobs and riders is evident is 1998. Figure A-12 compares the charts for baseline years 1997 and 1998. When 1997 is used as the baseline, “L” rides and jobs loosely correspond. When 1998 is used, the correlation is much closer, and it remains close in the charts for most subsequent baseline years.

However, due to IDES’s change in industry classification schemes in 2001, data for earlier years does not provide an accurate benchmark for predicting growth. The first post-2001 chart in which the jobs/riders correlation is apparent is for 2002; this is the benchmark year used to forecast growth later in this analysis. The 1998 and 2002 charts are shown in Figure A-19 and Figure A-20; a close correlation between jobs and rides can be seen in both. The 2002 chart depicts the correlation more precisely for predictive purposes; the relation of “L” ridership to that of CTA bus and Metra, which is also instructive, is clearer in the 1998 version.

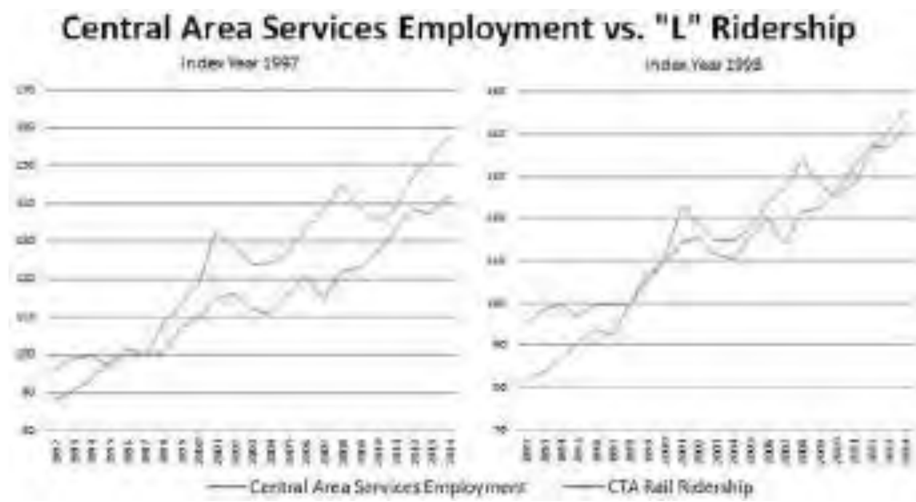


Figure A-18. Services employment vs. “L” ridership, 1997 and 1998

To emphasize, the 2001 methodology change resulted in an offset of unknown but probably small magnitude that did not change the overall data trend. Pending more rigorous investigation, it seems reasonable to say the close relationship between jobs and rides began in 1998.

The increase in professional jobs does not entirely explain “L” ridership growth. Services jobs have grown substantially since 1972; rail ridership was stable or declining until 1992. The likely explanation for post-1992 growth is that a greater proportion of central area workers now lives in the city and takes the “L” to work. This is evident in Figures A-3 through A-7, which show a steady increase in the percentage of residents with college degrees – as we have seen, this is a proxy for professional employment. Declining auto usage and bus ridership and the small increase in Metra ridership since 1998 despite rising jobs argue that the “L” is the commuting method of choice for these workers.

The relationship is further demonstrated by the bubble maps in Figure A-21, which depict the daily ridership at each “L” station overlaid on a map showing median household income in each census tract for 1980 (left), the same for 2015 (center), and percentage of residents in professional occupations in 2015 (right). Tracts in blue exceed the Cook median; yellow and orange are below.

In 1980, the busiest non-Loop stations were terminals – Howard St., Jefferson Park, and 95th St. – serving prosperous outlying neighborhoods. In 2015, traffic was down at the terminals compared to 1980 and higher in the now-affluent core.

As can be seen, in 2015 high "L" ridership correlated with both high income and high percentage of professional employment – perhaps more so for the latter than the former, although rigorous examination of this question was beyond the scope of this study. It is fair to say high ridership at "L" stops closely correlates with positive socioeconomic indicators in nearby areas.

In summary, it is reasonable to believe rising "L" ridership reflects the growing number of professionals who work downtown and live in the city.[14] Moreover, the extent of growth is predictable.

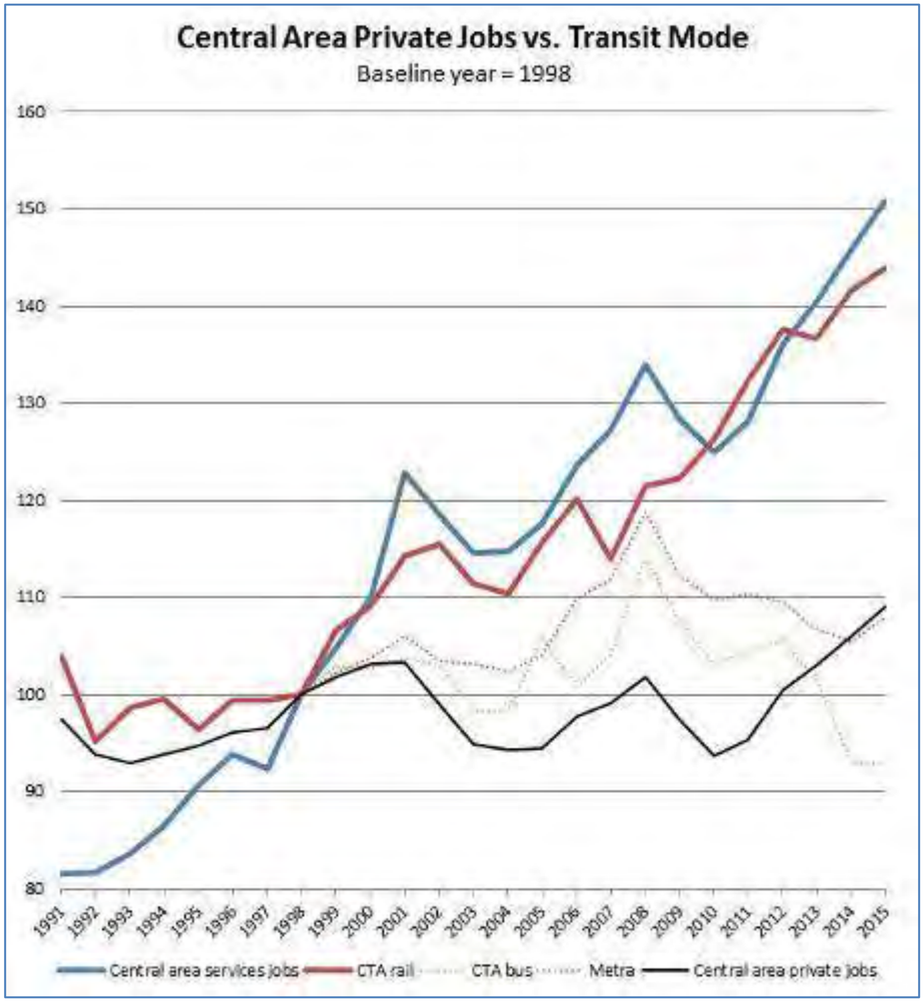


Figure A-19

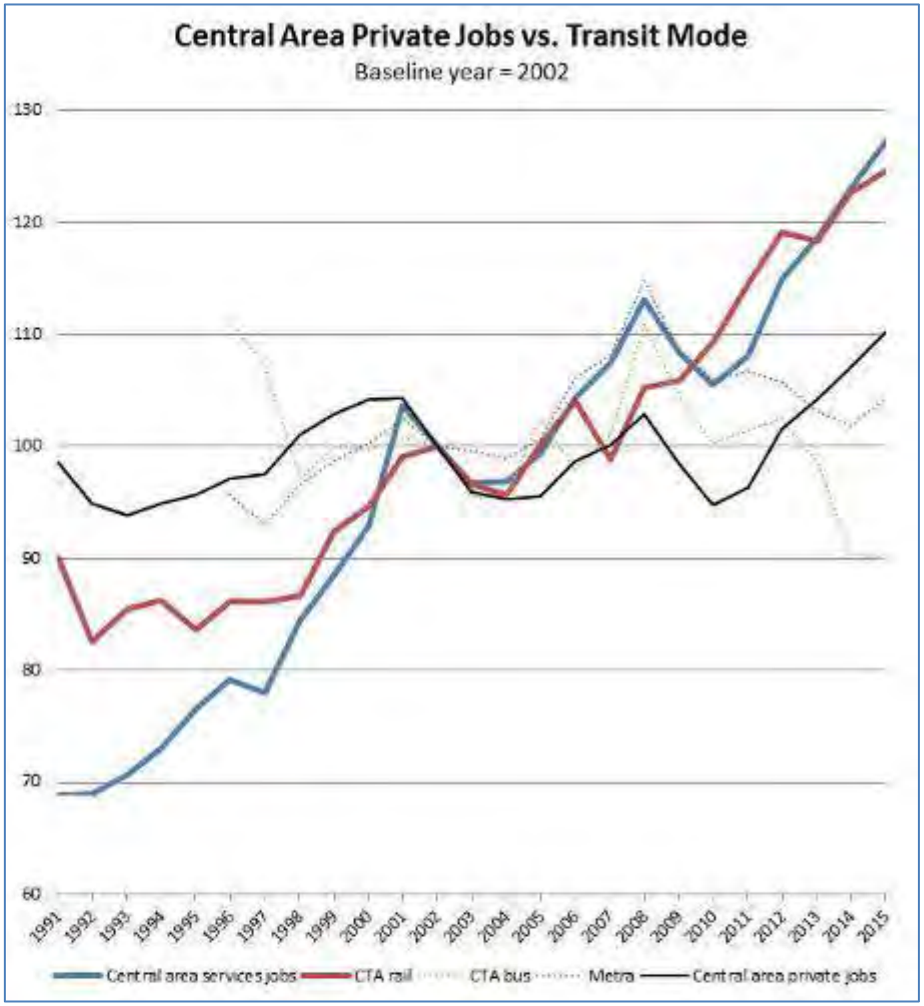


Figure A-20

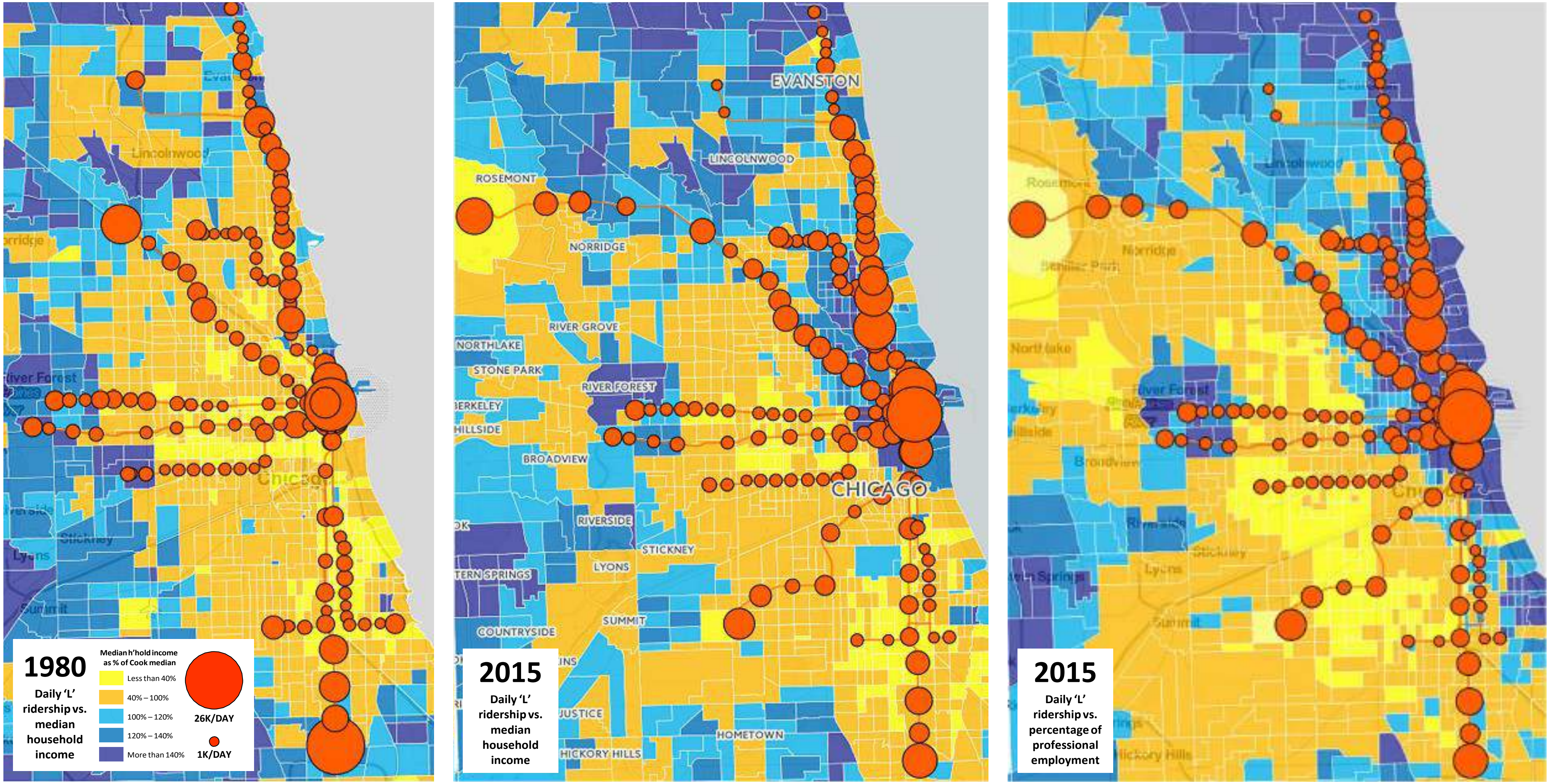

1980
Daily 'L' ridership vs. median household income
Median h'hold income as % of Cook median
Less than 40%
40% – 100%
100% – 120%
120% – 140%
More than 140%
26K/DAY
1K/DAY
2015
Daily 'L' ridership vs. median household income
EVANSTON
LINCOLNWOOD
ROSEMONT
NORRIDGE
RIVER GROVE
NORTHLAKE
STONE PARK
RIVER FOREST
HILLSIDE
BROADVIEW
CHICAGO
RIVERSIDE
STICKNEY
LYONS
SUMMIT
COUNTRYSIDE
HOMETOWN
HICKORY HILLS
2015
Daily 'L' ridership vs. percentage of professional employment

Figure A-21

Projected Employment vs. 'L' Ridership Growth

The relationship between central area services employment and "L" ridership makes it possible to predict jobs and ridership, assuming current trends persist. A complication is that the rate of both rider and job growth has increased markedly since the 2008-2009 recession; the extent to which this reflects a long-term trend vs. the normal cyclical rebound is not yet clear. Accordingly, a range of predictions is offered based on the following:

- Since 1992, the modern low point, weekday "L" ridership has risen 10,800 annually.
- Since 2002, the earliest reliable benchmark year, downtown services employment has grown by 6,000 per year and average weekday "L" ridership has grown by 11,600 per year – a ratio of roughly 2:1. In light of flat or declining auto usage and Metra and CTA bus ridership (see Figure A-16), this suggests most new workers since 2002 have chosen to take the "L" to and from work (i.e., one job = two daily work trips).
- Since 2009, the midpoint of recessionary job loss, central area services employment has increased by 9,000 per year and "L" ridership 19,000 – again a ratio of roughly 2:1.

In light of the foregoing, the following observations seem reasonable:

- The average annual increase in "L" ridership is roughly double the annual increase in service-sector employment.[15]
- A conservative estimate, based on the long-term trend, is that in 10 years service-sector jobs in the central area will increase by 60,000 (as reported by IDES) and "L" ridership will increase by 120,000 per weekday, from 770,000 rides in 2015 to 890,000 in 2025.
- A high-end estimate, based on the trend since 2009, is that in 10 years jobs will grow by 90,000 and ridership by 180,000, to 950,000 in 2025.

To emphasize, predictions of continued robust job and "L" ridership growth are based on long-term trends. Service-sector jobs have been rising for at least 43 years. "L" ridership has been increasing for 23 years. Prudence suggests planning on the assumption that these trends will continue.

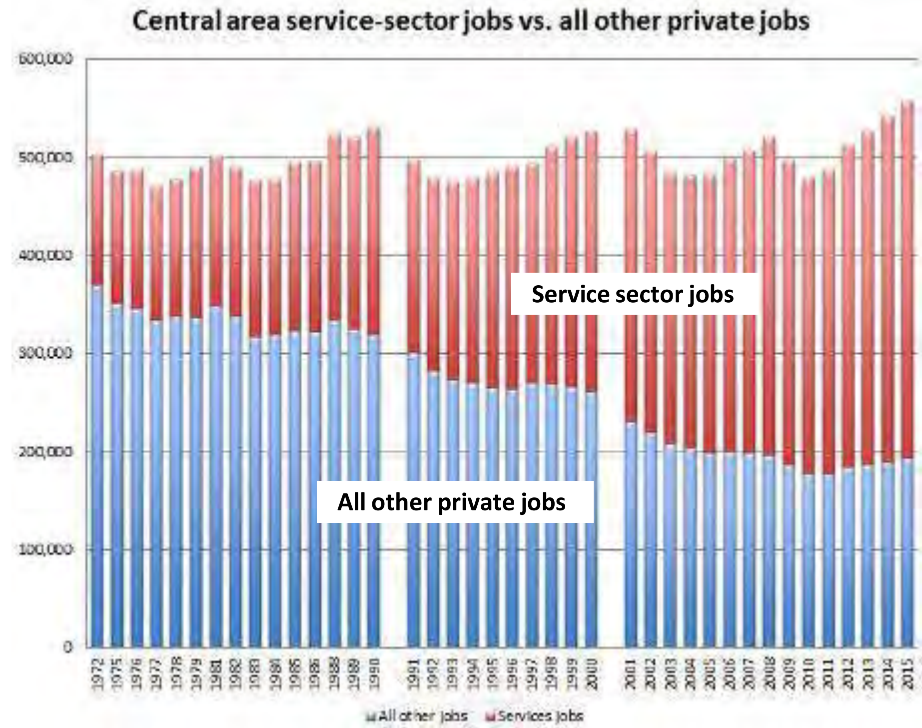


Figure A-22. Central area services jobs vs. all other jobs

The relationship between central area employment and "L" ridership is likely to be clearer in the future. Until 2010, overall central area jobs had changed little since the 1970s, with losses in sectors such as manufacturing offsetting growth in services. In 2010, however, non-service sector employment bottomed out and since then has risen – see Figure A-22.

If this trend continues, overall central area employment, already at a record level, will rise at a faster rate than in the past, and "L" ridership will track with total jobs, not just those in services. This is already evident – since 2009, overall central area employment has increased by 10,000 jobs per year while "L" riders have increased by 19,000, a ratio of approximately 2:1.

The central area accounts for a growing share of city jobs. In 1991, 43.5% of IDES-tracked city jobs were in the central area. In 2015, 49.5% were.[16]

Downtown Users Not Counted by IDES Data

The IDES data used in the analysis above does not reflect the entire universe of downtown users, many if not all of whom are potential transit riders. These users also include:

- Workers not subject to the Illinois Unemployment Insurance Act, including:
  - Government (public administration) employees
  - Railroad workers
  - Contract workers
  - Workers at not-for-profits with fewer than four employees
  - Self-employed individuals
  - Part-time workers receiving less than threshold amounts
- Central area residents
- Students
- Tourists, shoppers and other visitors.

The impact of uncounted users on transit capacity is considered on a case-by-case basis below:

Workers. Total central area employment exceeds the IDES-reported figure by a wide margin. The exact amount is not certain,[17] but it can be said that:

- In a given year, the total number of central area workers likely exceeds the IDES-reported total by 80,000 to 100,000 or more. It is probable that more than 640,000 people worked in central Chicago in 2015.
- The <u>annual increase</u> in jobs reported by IDES is close to that indicated by some sources and is less than others.[18]
- Although the present era of robust central area job growth will not last indefinitely, losses due to recession are likely to be brief, as shown by the swift recovery after 2008-2009 and the steady growth in service-sector jobs since 1972. It is prudent to assume that by 2025 the total number of central area workers will be 700,000 to 730,000 (60,000-90,000 more than now), well above historical levels.

Students. The Chicago Loop Alliance and predecessor organizations have published reports on the number of students enrolled in college and university campuses in downtown Chicago, primarily in the Loop and South Loop. Figures are available for the following years:

- Fall 2002 – 52,458 (19,674 full time, 32,784 part time)
- 2005 – 53,230
- Fall 2008 – 65,499
- Fall 2013 – 58,025.

Students are major users of transit, but the available data does not include schools north or west of the river and the net reported increase in students between 2002 and 2013 was less than 6,000. Accordingly, students do not appear to be a significant driver of incremental transit demand and were not considered in this study.

Residents. A U.S. census analysis found Chicago had the largest gain in downtown residents, in both percentage terms and actual numbers, of any U.S. city from 2000 to 2010 – see Figure A-23.

Metropolitan Statistical Areas With the Largest Numeric Increase and Decline in Population Less Than 2 Miles From City Hall: 2000 to 2010

(For information on confidentiality protection, nonsampling error, and definitions, see *www.census.gov/prod/cen2010/doc/sf1.pdf*)

Metropolitan statistical area[1]	Population less than 2 miles from city hall[2]		Change, 2000 to 2010	
	Census 2000	2010 Census	Number	Percent
Largest Numeric Increase				
Chicago-Joliet-Naperville, IL-IN-WI	133,426	181,714	48,288	36.2
New York-Northern New Jersey-Long Island, NY-NJ-PA	400,355	437,777	37,422	9.3
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	214,760	235,529	20,769	9.7
San Francisco-Oakland-Fremont, CA	336,092	355,804	19,712	5.9
Washington-Arlington-Alexandria, DC-VA-MD-WV	137,064	156,566	19,502	14.2

Figure A-23

Central area residents are potentially major users of transit and their numbers are rapidly increasing, making them important drivers of incremental transit demand. However, most central area residents probably also work there and thus are captured by employment data. Since the major factor in transit capacity is rush-hour work trips, the impact of central area residents was not separately considered for this study. Downtown residents are likely to be an important factor in off-peak transit usage and thus in calculation of overall transit demand, a subject to be explored in the next phase of investigation for this project.

Tourists, shoppers and other visitors. Visitor traffic is difficult to compute, varies seasonally, and on average likely contributes minimally to transit use. That said, visitors to special events are significant drivers of peak demand and must be considered in the next phase of investigation for this project.

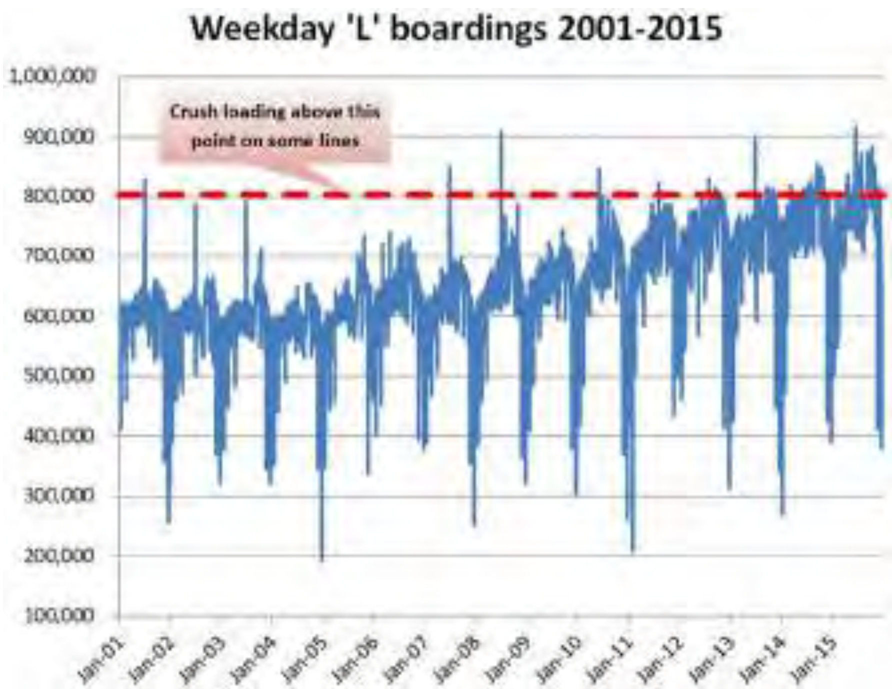


Figure A-24. Weekday "L" boardings trend 2001-2015

Impact of Ridership Growth on 'L' System Capacity

Parts of the "L" are approaching capacity during peak periods. As can be seen in Figure A-24, weekday "L" boardings exceed 800,000 with increasing frequency – the busiest lines are heavily loaded on such days. In the 11 years prior to 2012, only five such days occurred, all in connection with special events. In 2012 alone, 16 days above 800,000 were recorded. In 2015, ridership exceeded 800,000 on 79 days, including most weekdays between Labor Day and Thanksgiving, when ridership is traditionally highest.[19]

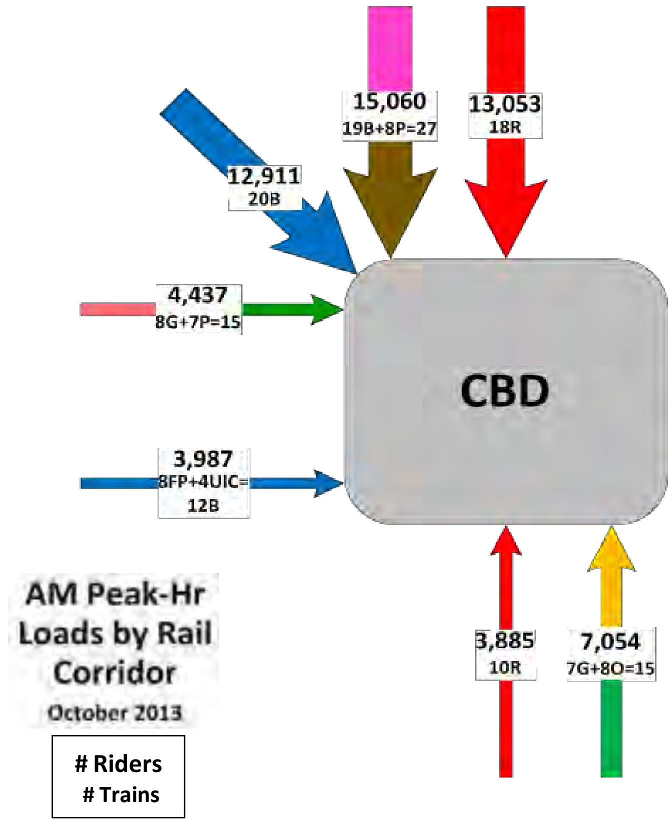


Figure A-25

On 6/18/2015, the day of the Blackhawks' Stanley Cup celebration, the "L" carried 915,000 riders, the one-day record for the 15 years for which daily totals are available. On 10/21/2015, the system carried 882,000 riders, the most in the 15-year record for an ordinary workday (no special event).

Several factors hasten the day when the "L" will reach capacity:

- *North side skew.* Traffic is disproportionately heavy on the lines serving the north and northwest sides, namely the Howard branch of the Red

Line, the O'Hare branch of the Blue Line, and the Brown Line. (Purple Express trains augment Brown Line service during rush hour.) This skew is most apparent during the AM peak (8-9 a.m.), when three of the seven "L" corridors entering the CBD carry two-thirds of the riders (Figure A-25).

- *Limited train capacity.* CTA railcars are among the smallest in mainstream U.S. service, their size restricted by the tight curvature of the Loop elevated. Observed maximum load is 101 to 108 passengers per car depending on type.[20] Given a maximum train length of eight cars, a fully loaded "L" train can hold 808 to 864 riders. In contrast, an eight-car subway train on New York City Transit's "B" division can carry 2,000 riders.[21]
- *Infrastructure constraints.* The flat junction (level crossing) at Clark Street on the north side main line limits the number of peak-direction trains to 44 per hour; this limit was reached in 2013. Storage yards on the Brown and Red Lines are at capacity; some Orange Line trains must be diverted to Brown Line service to fill out peak-period schedules.

The busiest rail corridor during the AM peak is the north elevated, which carries Brown and Purple Express trains. This corridor also saw the sharpest increase in AM peak ridership between 2010 and 2013 (Figure A-20).[22]

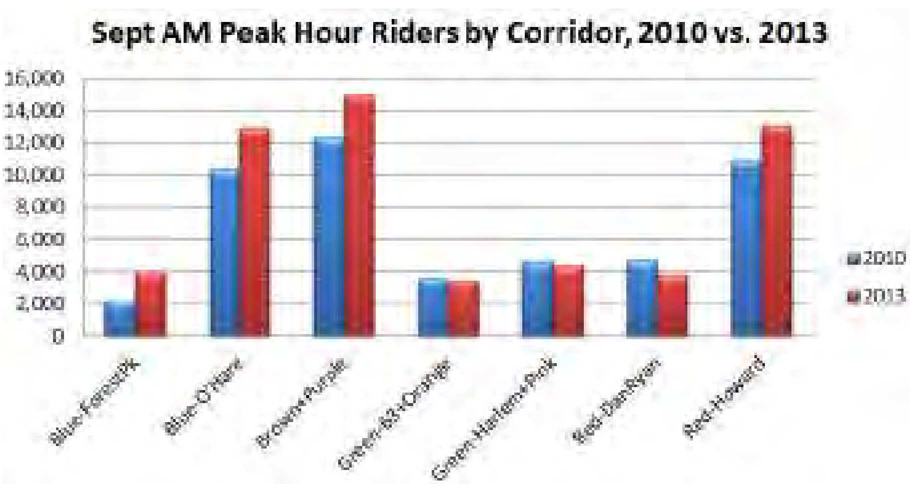


Figure A-26

At the present rate of ridership growth, the Brown/Purple corridor will reach capacity during the AM peak hour in the fall of 2017 (Figure A-27).

YEAR CAPACITY REACHED IF NO CHANGES (AM PEAK HOUR)

Corridor	2015 (est.)	Capacity	Incr/Yr	Yrs till Max	Max Year
Red	14,462	16,160	704	1	2017
Brown-Purple	16,830	19,794	885	2	2018
Blue	14,644	21,816	867	7	2023

Assumptions: (a) max load/railcar=101 except 108/3200-series per CTA; (b) no railcar reassignments; (c) max trains/track/hour=27 (CTA states 26-28); (d) max north main line trains/AM peak hr=20 Red, 18 Brown, 7 Purple (fall 2014); 8-car trains except 6-car Purple. 2015 data extrapolated from 2010-2013; actual unavailable pending update of CTA's analytical tool to reflect switch to Ventra

Figure A-27

As discussed in Appendix B, the CTA has proposed an improvement called the Red-Purple Bypass that would eliminate the flat junction at Clark Street and permit operation of additional trains.[23] If built, this would postpone the year in which capacity is reached on north side lines. Capacity on all three north and northwest side corridors would then be reached between 2023 and 2025, seven to nine years from now – see Figure A-28.

YEAR CAPACITY REACHED IF RED-PURPLE FLYOVER BUILT (AM PEAK HOUR)

Corridor	2015 (est.)	Capacity	Incr/Yr	Yrs till Max	Max Year
Red	14,462	21,816	704	9	2025
Brown-Purple	16,830	21,522	885	9	2025
Blue	14,644	21,816	867	7	2023

Assumptions: Same as above, except once Red reaches capacity, all additional north side riders will use Brown/Purple during AM peak hour at stops served by both corridors

Figure A-28

Also as discussed in Appendix B, the CTA has proposed "Red Ahead" improvements that would permit longer Red and Purple Line trains. The program involves multiple projects requiring extensive construction or reconstruction of tracks, stations and rail yards at a cost of $7B. Given the scope of the work and the present financial situation, a realistic timeframe for bringing additional capacity online as a result of these improvements is 20 years.

Implications for Transit Planning

Taking the above considerations into account, the following is a projection of increases in north side rail capacity relative to expected ridership growth:

Years	Daily "L" Rides	North Side Capacity Improvements
2016-2026	770K > 920K	Red-Purple Bypass = 20% increase
2026-2036	920K > 1.07M	—
2036-2046	1.05M > 1.22M	10-car Red, 8-car Purple = 25% increase

The challenging period will be 2026-2036, when an additional 150,000 daily rides will need to be accommodated with no additions to north side capacity. The Blue/O'Hare branch will also be operating at capacity by this time. Absent other rail expansion, this leaves the following options:

- Ways could be found to pack more people into the trains. Seating could be reconfigured. Patrons may depart earlier or later, or simply learn to put up with more crowding. Such adjustments will need to be made soon – based on the historical pattern, "L" traffic will exceed 800,000 on most workdays within a few years. In 2015, for the first time, days above 800,000 were recorded in all seasons (Figure A-29). There will never come a point at which the transit system can accommodate zero additional riders, but crowding and delays will become steadily worse.
- Riders could find other means of getting to work, all with their own problems. The CTA could add buses, but bus operating expense is triple that for rail – $1.15 vs. $0.38 per passenger mile[24] – and in any case bus patronage is in long term decline in most major markets. Increased auto use is not desirable for environmental reasons and Chicago expressways are already among the most congested in the U.S.[25] Walking and biking are impractical in inclement weather. Cabs are costly. North side Metra lines have few city stops and the terminals are inaccessible to much of the expanded central area.

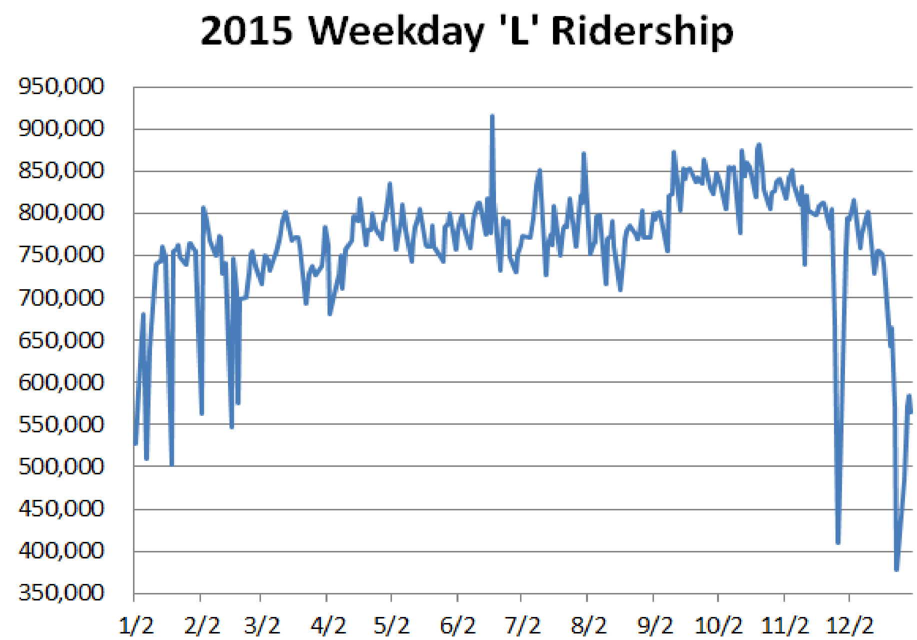
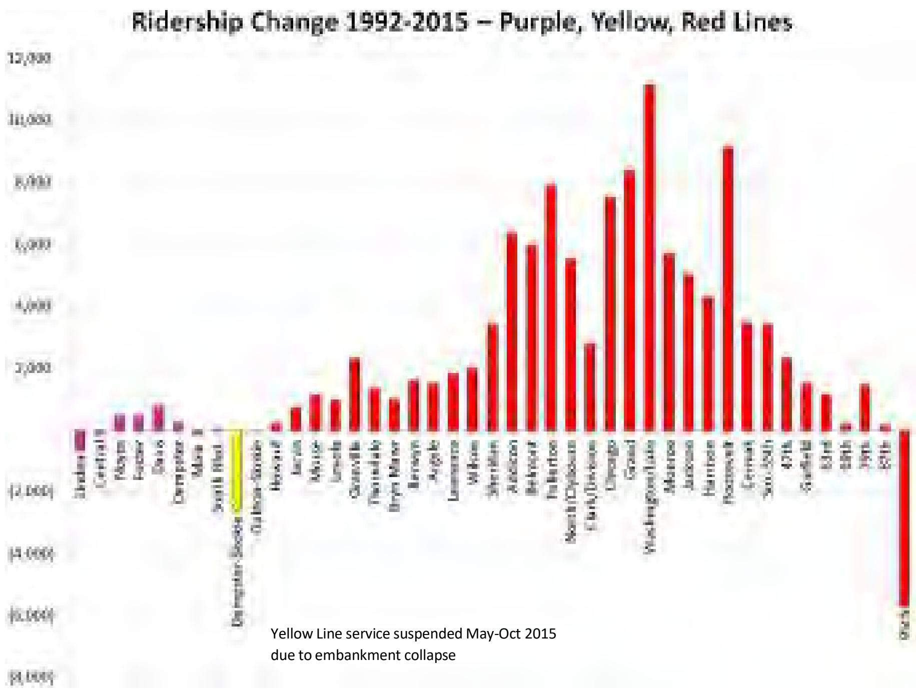
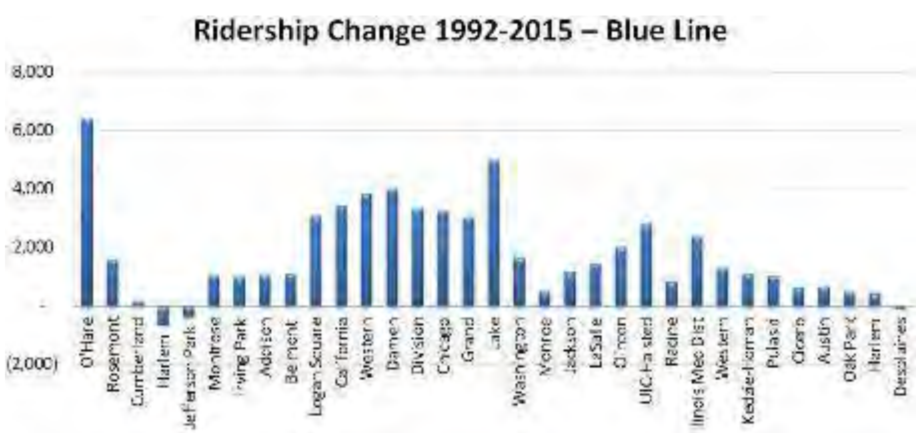


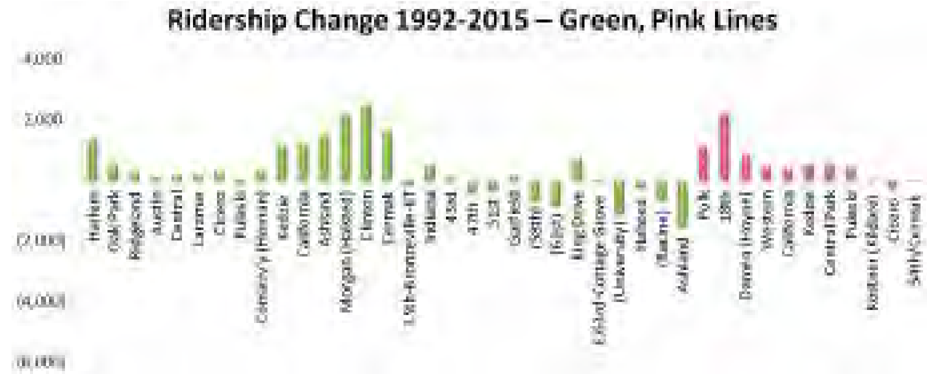
Figure A-29

- More riders could be carried on west, southwest and south side lines, which have ample capacity. The Green and Pink Lines in particular could capture some of the anticipated demand growth at existing and new infill stops in close-in neighborhoods, as shown by the robust traffic at the recently opened Morgan and Cermak-McCormick Place stations.

That said, significant growth at outlying stops would defy the historical trend. This can be seen in the illustrations below. Figure A-30 shows the change in "L" ridership per station between 1992 and October 2015, the busiest month in the 15-year record. With the exception of the airports and the Orange Line (which opened in 1993), ridership has grown only slightly or declined in outlying parts of the system. It is sharply up in the core.







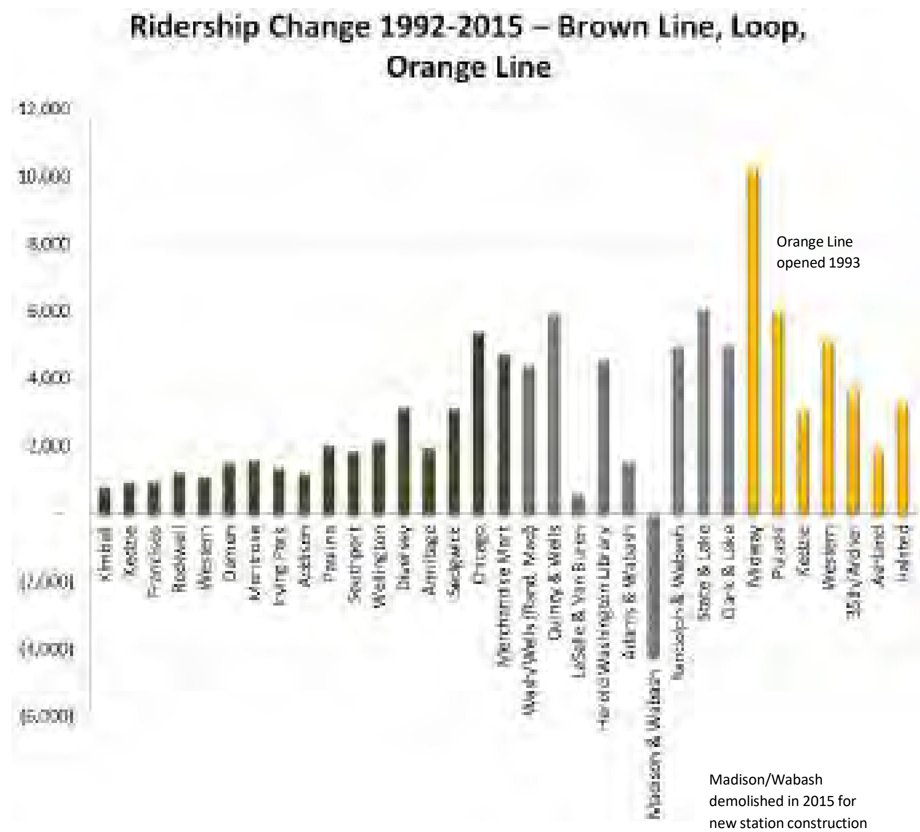


Figure A-30. "L" ridership change by line and station, 1992-2015

The “L” ridership growth pattern reflects the larger trend, namely, that growth in jobs and people in Chicago is overwhelmingly concentrated in the core. The increase in central area employment has already been explored. Change in households between 2000 and 2010, initially seen in Figure A-12, is reprised in Figure A-31 without the rail overlay. Some central area tracts have seen increases in the thousands of units.

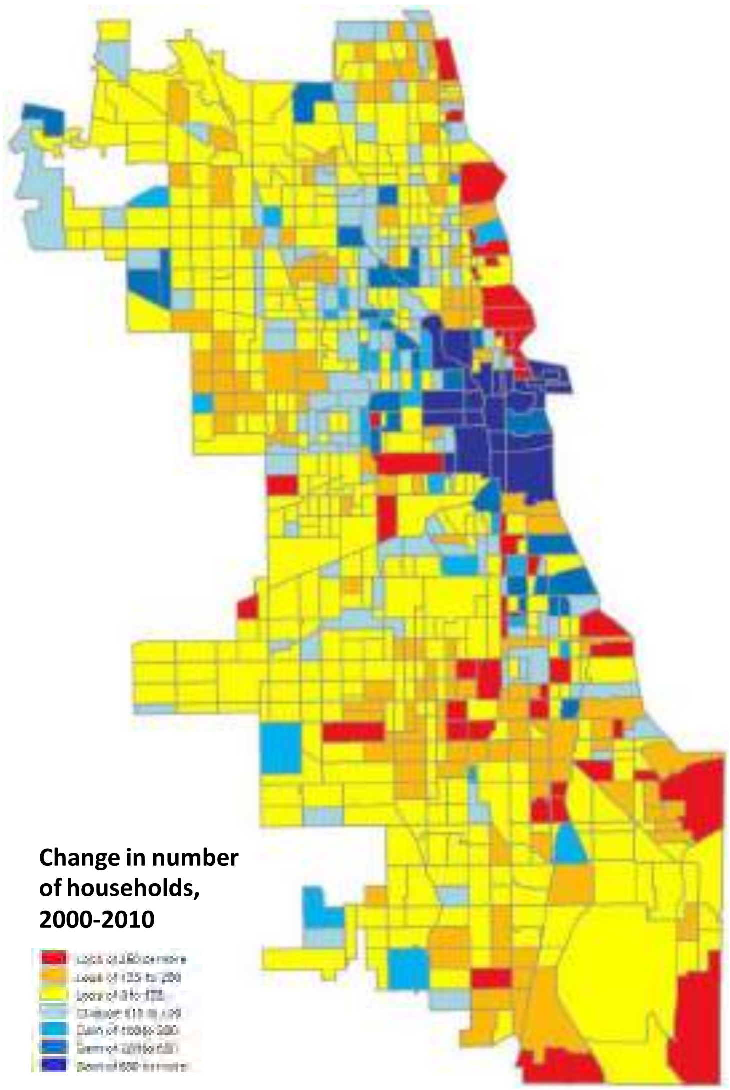


Figure A-31. Household change 2000-2010

Household growth in the central part of the city has clearly had an impact on “L” ridership. Figure A-32 overlays a bubble diagram showing 1992-2015 “L” station ridership growth on a map showing the change in the number of households per census tract between 2000 and 2010. Increases in households correlate with ridership growth at “L” stops throughout the city, but the effect is especially striking in the central area.[26]

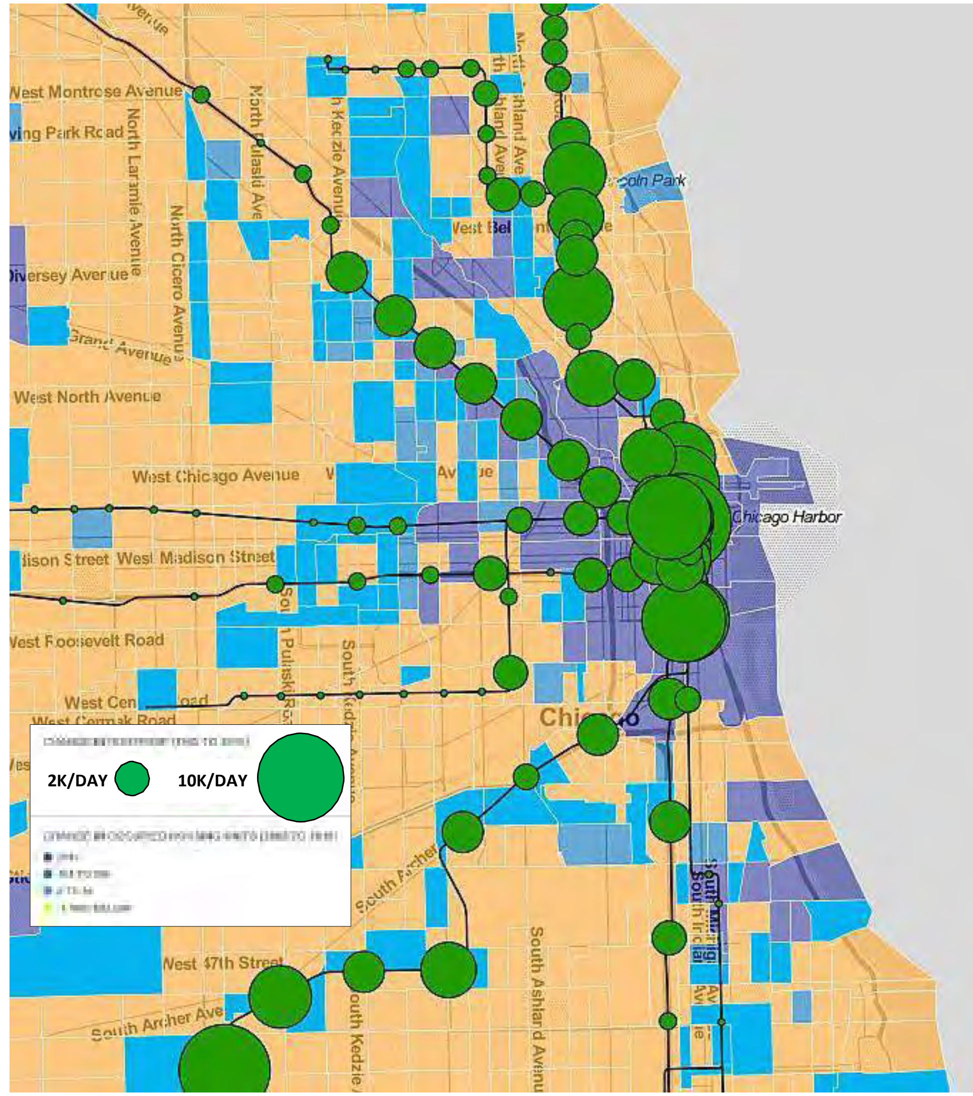


Figure A-32. Household growth 2000-2010 vs. “L” ridership growth by station

Figure A-33, an adaptation of Figure A-8, depicts the relationship between rail transit and selected socioeconomic indicators. Observations:

- Positive indicators in all parts of the city are strongly correlated with proximity to a rail station, either CTA or Metra.
- In 2010-2014 as in the previous decade, Chicago population growth was overwhelmingly concentrated in the core. As seen in Figure A-9, the population of the central area grew by 34,690. According to press reports, 3,100 central area dwellings were completed in 2015[27] and 12,600 more are under construction or planned for 2016 through 2018.[28] Assuming typical downtown household size, this puts the centr a area on track to exceed the growth of 2000-2010 in the current decade for a total of >100K new residents between 2000 and 2020.[29]
- High "L" ridership growth is likewise concentrated in the core and in large part corresponds to household and population growth.

It seems evident that:

- Chicago's prosperity is strongly linked to rail transit. Indeed, with respect to professional employment and household income, it may be said rail access is a <u>necessary though not sufficient condition</u> for growth
- The <u>primary</u> growth driver is proximity to the core. Rail's importance stems from the fact it provides convenient access to the central area.
- With parts of the "L" system close to capacity, expansion is needed if growth is to continue. Given the rapidly increasing number of households and high usage of the "L" in the core, a logical venue for such expansion is the central area. As will be seen in Appendix E, the periphery of the core has abundant vacant land that would support dense development if rail access were provided.
- Though not a focus of this report, proximity to city Metra stops is an underappreciated factor in neighborhood revival. Steps such as better fare integration could help take greater advantage of this resource.

In sum, rail transit expansion in the central area offers a promising path to accommodating expected growth and merits serious consideration.

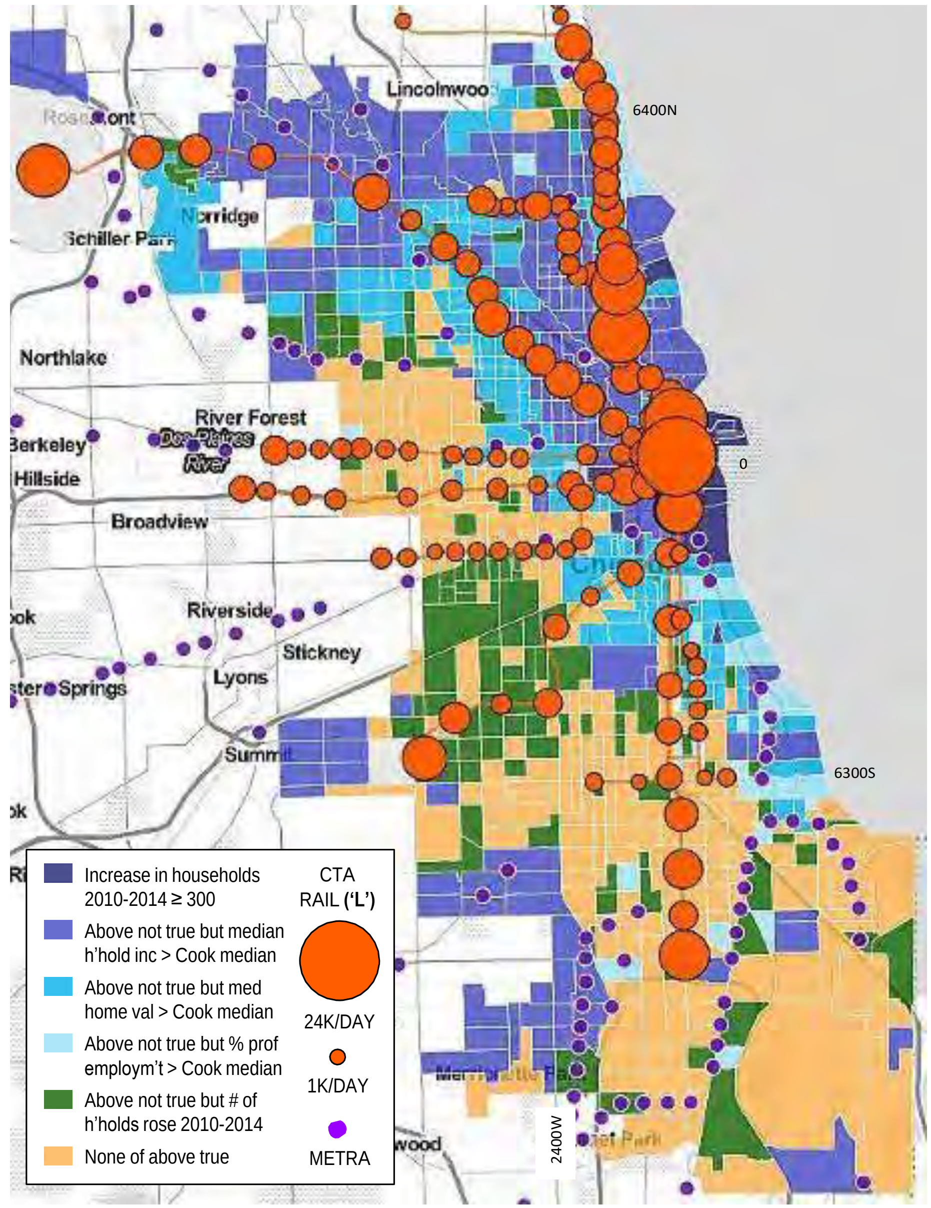
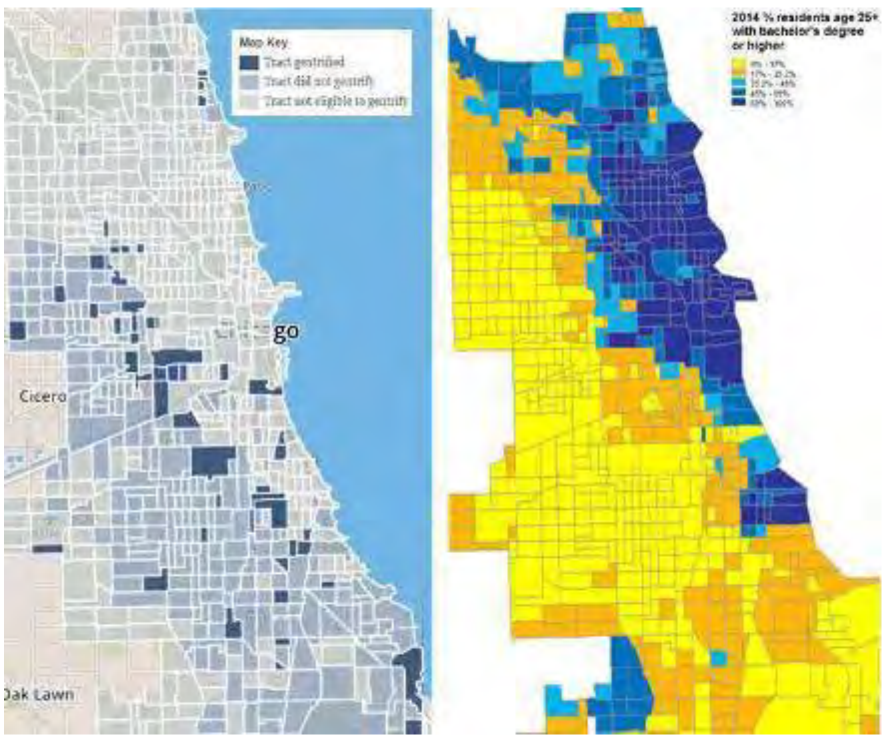


Figure A-33. Rail ridership vs. selected socioeconomic indicators

NOTES

[1] U.S. and Chicago population data cited in this appendix and throughout this report obtained from U.S. Bureau of the Census, primarily via (a) American FactFinder portal, factfinder.census.gov/, and (b) Social Explorer, www.socialexplorer.com/. Data for non-decennial years from 5-year American Community Survey (ACS) except where noted. Chicago Transit Authority ridership data from CTA website, www.transitchicago.com/ridership/, for 1999 and later; from CTA paper reports for earlier years.

[2] *Governing* magazine's web page "Chicago Gentrification Maps and Data" at: www.governing.com/gov-data/chicago-gentrification-maps-demographic-data.html shows Chicago census tracts deemed to be gentrified as of the 2013 ACS. Most are on the periphery of the lakefront region having a high percentage of college graduates as seen in Figure A-7 – see comparison below. *Governing*'s gentrification criteria are bottom 40 percentile tracts experiencing a top-third percentile increase in educational attainment and median home value. Calling such tracts gentrified seems premature, but *Governing*'s methodology may identify future additions to the high-college-grad district.



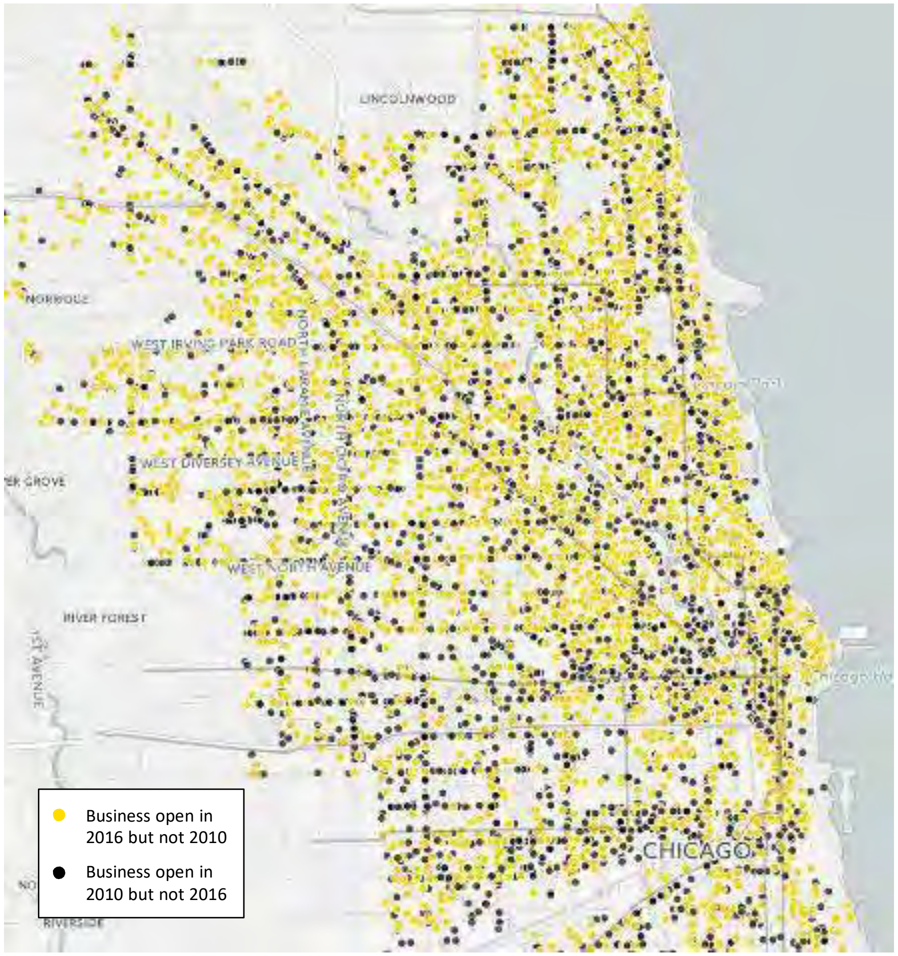
[3] Alan Ehrenhalt, *The Great American Inversion and the Future of the American City* (New York: Knopf, 2012), p.3.

[4] High college graduate percentage is not always a leading indicator of high income. Tracts surrounding institutions such as the University of Illinois at Chicago, the Illinois Institute of Technology and the University of Chicago have had a high percentage of college graduates in all censuses since 1980 but this has not correlated consistently with future high income. This may reflect students who remain in the area for a time after receiving their degrees but ultimately pursue careers elsewhere.

[5] South lakefront population change 2010-2014 by race/ethnicity: whites –895, blacks +389, Hispanics +1,997, Asians +2,481.

[6] Freemark, Yonah, "Talking Transit: Why are our trains more crowded than ever even as population declines in Chicago?" 5/25/2016, www.metroplanning.org/news/7318/Talking-Transit-Why-are-our-trains-more-crowded-than-ever-even-as-population-declines-in-Chicago, accessed 8/6/2016.

[7] Business license data drawn during July 2016 from city of Chicago data portal, data.cityofchicago.org/. The trend since 2010 is even more striking – the map below shows the change in business licenses for major classifications during 2010-2016.



[8] The drop in "L" riders between 1985 and 1992 is not well understood but coincided with an increase in the CBD parking supply. The chart below shows central area parking spaces, as reported in Chicago Plan Commission, *Downtown Parking Policies* (1989), p. 3, relative to "L" ridership. Between 1978 and 1983, 10.8M GSF of office space was built in the CBD and more than 5,000 public parking spaces were lost. "L" ridership in this era trended upward. In 1983 an earlier ban on non-accessory parking facility construction in the CBD was lifted. The parking supply rose and "L" ridership fell.

[9] Data from CTA. Transfer issuance on Chicago rapid transit and surface lines began in 1935 and in most cases was free until 1961 (CTA, General Operations Division, Operations Planning Dept., "Fares – Chronological Order of Changes," OPy-81153, 5/14/81). Acceptance of free transfers was not tracked. Transfer traffic accounted for roughly a third of rail rides in the early 1960s and has been included in ridership reports since 1961. Ridership reported for previous years is for cash fares only and is not directly comparable.

[10] Source: U.S. Census, 1-year American Community Survey for 2006 and 20014, factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml.

[11] Condit, Carl, *Chicago 1930-1970: Building, Planning and Urban Technology,* Table 7 – Revenue Passengers Carried by Chicago Transit Authority and Predecessor Companies, 1906 to 1970 (Chicago: University of Chicago Press, 1974), p. 302.

[12] IDES data from www.ides.illinois.gov/LMI/Pages/Where_Workers_Work.aspx.

[13] Until 2000, IDES used the Standard Industrial Classification system (SIC). In 2001, it switched to the North American Industry Classification System (NAICS).

[14] It is acknowledged that many factors may have had a bearing on rail ridership differences between 1992 and 2014, including but not limited to discontinuation of

A/B skip-stop service, interruption of Red and Blue Line subway service due to the Loop flood of April 1992, conversion of the Douglas branch of the Blue Line into the Pink Line in 2006, closure or partial closure of the Green, Pink and Red/Dan Ryan lines for extended periods for reconstruction, swapping of the south side branches of the Green and Pink Lines in 1993, and closure, opening, or changes in service hours at some stops such as Grand/Blue, Halsted/Green, Morgan/Green, etc.

[15] The 2:1 ratio does not necessarily hold in the short term, and on occasion jobs and ridership trend in opposite directions. For example, between 2005 and 2006, services employment rose while "L" ridership dropped; between 2008 and 2010 the reverse occurred. This is undoubtedly due to the Brown Line platform extension project of 2006-2009, during which north side "L" service was curtailed while stations were rebuilt to accommodate longer Brown Line trains. Service and capacity were gradually increased as the project progressed. In 2009, full service was restored with longer trains; meanwhile bus service, which had been temporarily increased, was reduced. Rising rail ridership throughout the 2008-2009 recession thus largely reflected the return of "L" riders from buses.

[16] Percentages derived from Illinois Dept. of Employment Security, *Where Workers Work* (annual series), Table 8: UI-Covered (Private Sector) Employment in City of Chicago by Geographic Sector, March 1991 vs. March 2015.

[17] The following figures were obtained from various sources for the same ZIP codes used in IDES reports of UI-covered employment in the central area:

- The Longitudinal Employer-Household Dynamics (LEHD) program, a project of the U.S. Census, reports 640,222 jobs as of 2013, of which 53,347 were in government (public administration).
- The ZIP Business Patterns (ZBP) report, also produced by the census bureau, reports 607,051 jobs for 2013 as reported by American Fact Finder.
- Esri, publisher of ArcGIS, a commercial mapping program, reports 666,058 jobs for 2015, of which 39,211 were in public administration.

Some variation may be due to misreporting of work location for public-sector employees (David Bieneman, manager of economic analysis, IDES, personal communication, February 4, 2016).

[18] Between 2010 and 2013, UI-covered central area employment as reported by IDES increased by 47,645; as reported by LEHD via the OnTheMap portal, 47,924; as reported by ZBP via American Fact Finder, 75,556. Esri data for 2010 and 2013 was not available. LEHD data is based in large part on reports by state UI agencies such as IDES, so the similarity in job growth reported by the two sources is to be expected.

[19] Data retrieved from Chicago Transit Authority, "Ridership Reports," dataset "CTA – Ridership – Daily Boarding Totals," www.transitchicago.com/ridership/. Accessed 4/28/2015.

[20] Tara O'Malley and Maulik Vaishnav, "Is This Seat Taken? A Multi-Faceted Research Study to Inform Chicago Transit Authority's Future Rail Car Seating Design" (Transportation Research Board 2014 Annual Meeting), p.2, docs.trb.org/prp/14-4690.pdf. Accessed 4/28/2015.

[21] Cudahy, Brian J., *Under the Sidewalks of New York: The Story of the Greatest Subway System in the World* (Brattleboro, VT: Stephen Greene Press, 1979), p. 151.

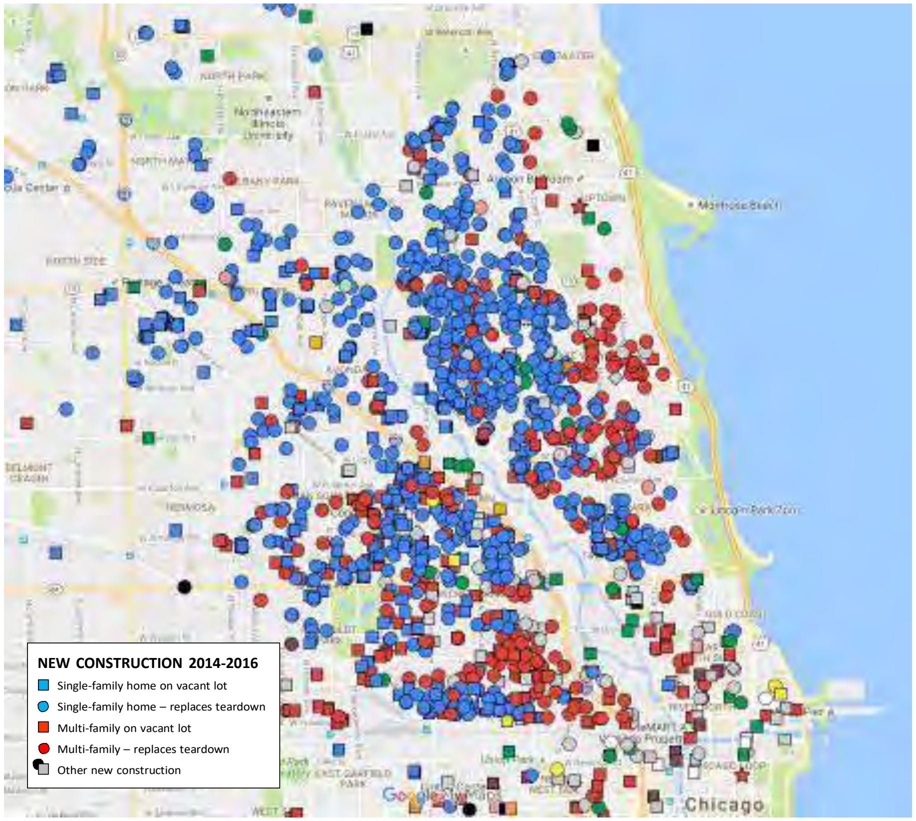
[22] Until 2013, CTA computed peak-hour ridership based on farecard data. The switch to the Ventra card in 2014 rendered the analytical tool used for this purpose inoperative; it had not been updated as of January 2016.

[23] Chicago Transit Authority, "Red-Purple Bypass Project," www.transitchicago.com/news_initiatives/planning/rpm/bypass.aspx. Accessed 4/28/2015.

[24] Federal Transit Administration – National Transit Database, "Chicago Transit Authority (CTA) – 2014 Annual Agency Profile," www.transit.dot.gov/sites/fta.dot.gov/files/docs/50066.pdf, accessed 8/11/16.

[25] Hilkevitch, Jon, "Most congested roads in U.S.? You're probably on one," *Chicago Tribune*, Aug. 25, 2015, www.chicagotribune.com/news/ct-congestion-chicago-worst-roads-met-0826-20150825-story.html. Accessed 4/27/2016.

[26] Despite high ridership growth, households did not increase in most tracts along the north side main line and in many cases declined. Preliminary analysis suggests the drop was due at least in part to consolidation of existing small apartments into larger ones. For example, Lake View lost 2,000 "non-family" (i.e., single person) households between 2010 and 2014 and gained just 69 family households (2+ persons), but also saw a population increase of 778. In Lake View tract 609, which fronts on the lake, studio apartments decreased by 337, larger units increased by 295, and average household size increased from 1.39 to 1.52. The number of dwellings in the tract decreased by 221 while the population grew by 249. The number of 1- and 2-person households decreased by 346; meanwhile, households with 3+ members increased by 125. In short, studio apartments were reconfigured into larger units and singles and childless couples were replaced by larger households, presumably families with children. The same trend can be seen in the map below, based on building permit data from the city data portal. Blue circles represent single-family homes replacing a previous structure; it is likely many such teardowns were small multi-family buildings.



[27] Gallun, Alby, "The hot downtown apartment market could cool off next year. Here's why," *Chicago Real Estate Daily,* Nov. 9, 2015, www.chicagobusiness.com/realestate/20151109/CRED02/151109842/the-hot-downtown-apartment-market-could-cool-off-next-year-heres-why, accessed 4/23/2015.

[28] "Appraisal Research forecasts that developers will complete more than 8,800 apartments downtown this year and next, with another 3,800 on tap for 2018," from Gallun, Alby, "Building boom will test downtown apartment market in 2017," August 15, 2016, *Chicago Real Estate Daily*, www.chicagobusiness.com/realestate/20160815/CRED02/160819981/building-boom-will-test-downtown-apartment-market-in-2017, accessed 8/15/16.

[29] The population of the central area as shown in Figure A-9, defined as census tracts some portion of which was within two miles of City Hall, grew by 44,208 between 2000 and 2010 and by 34,690 between 2010 and 2014. The first number derives from decennial census data and the second from the 5-year American Community Survey. Since the two datasets are compiled in different ways, the two numbers cannot be added, but it seems reasonable to say the central area's population grew on the order of 78K-80K between 2000 and 2014. As indicated, an additional 15,700 downtown dwellings are complete, under construction or planned. If all are occupied by the end of the decade at a household size of 1.793, the average for the four central area community areas combined as of 2014, the central area's population will increase by an additional 28K, for a total of 106K-108K for 2000-2020. It should be noted that the census bureau's computation of 2000-2010 population growth within two miles of City Hall, presumably using data more precise than the tract-level numbers used in this report, was 48,288 (see Figure A-23).

Appendix B – Impact of Current Transit Initiatives on Capacity

Chicago transit initiatives having a bearing on capacity are described below.

CTA Rail

Infill Stations. New “L” stations have been opened on existing lines at the following locations:

Station	Line/Branch	Opened	Oct 2015 Traffic
Oakton-Skokie	Yellow	2012	1,133 (2014)*
Morgan	Green/Lake	2012	2,844
Cermak-McCormick Pl	Green/South Elevtd	2015	1,665
*Yellow Line closed 5/17/2015-10/30/2015 due to embankment collapse.			

Impact on capacity. New stations on existing “L” lines at close-in locations are a fast, economical way to increase utilization of the existing rail system. The Morgan Street station in particular has been credited with helping to spur economic development in the surrounding West Loop neighborhood.[1]

Red Ahead*.* The CTA’s Red Ahead program encompasses several large-scale improvements for the Red Line, the busiest “L” route. These include:

- Red-Purple Modernization (RPM), a long-range plan to rebuild the north side main line between Belmont and Linden. Current initiatives include:
  - Red-Purple Bypass Project. The initiative would replace the Clark St. flat junction north of Belmont with a “flyover” carrying Brown Line trains over the Red and Purple Line tracks, increasing capacity – see Figure B-1. Project cost was estimated at $570M as of 2015.[2]
  - Lawrence to Bryn Mawr Modernization Project. The initiative would rebuild a 1.3-mile segment of the four-track Red-Purple main line. Project cost was estimated at $1.33B in 2015.[3]

  Plans for the remaining portions of RPM have not been announced. The overall cost of the program was estimated at $4.7B in 2013.[4]
- Red Line Extension (RLE), which would extend the Dan Ryan branch of the Red Line 5.3 miles from the current 95th St. terminal to 130th St. In 2014 the CTA announced the selection of a “locally preferred alternative” alignment along an existing freight rail corridor. The cost of the project was estimated at $2.3B as of 2014.[5]

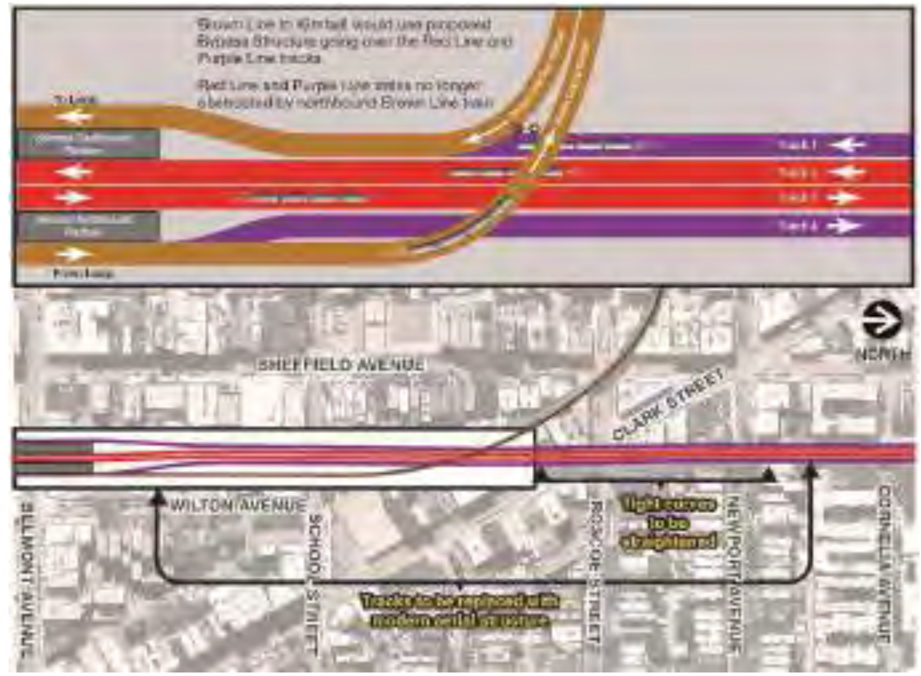


Figure B-1. Proposed Red-Purple Bypass

Impact on capacity. The bypass would permit an increase in the number of peak-hour, peak-direction trains on the north side main line from the current 44 to 52-56 (26-28/track), an increase of ~20%. Additional trains would need to be provided. Although the Kimball, Howard, and 98th St. yards are at capacity, space remains at Linden. In addition, it seems likely more Orange Line trains could be through-routed to the Brown Line at peak times, permitting additional service without an increase in yard capacity.

Ultimately the Red Ahead program would permit Red Line trains to be lengthened from 8 cars to 10 and Purple Line Express from 6 cars to 8, a capacity increase of more than 25%. The program is to be implemented incrementally, but operation of longer Red Line trains would appear to require completion of the following projects at minimum:

- Construction of a new rail yard at 130th St., since the Howard and 98th St. yards are full. This would require completion of RLE, which is known to be a city priority in any case.
- Lengthening of most existing Red Line station platforms. This would require completion of RPM work between Belmont and Howard plus additional work on the Dan Ryan branch.

It thus appears that, once the Red-Purple Bypass has been completed, additional increases in Red Line capacity will require $4.7B (RPM) + $2.3B (RLE) = $7B. Securing federal funds, raising the local match, and carrying out work of this magnitude is a formidable challenge – realistically it would be wise to assume it will take 20 years. The implications of this timeframe for transit planning are discussed in Appendix A.

Your New Blue. This four-year, $492M[6] program of track and station improvements will upgrade the O'Hare branch of the Blue Line and the Dearborn St. subway. Among other projects, the turnback tracks at UIC-Halsted and Jefferson Park will be upgraded to permit additional short turning of trains during peak periods, doubling up service on the busiest part of the line.[7]

Impact on capacity. The Blue Line has fewer capacity constraints than the north side main line. Short turning will make it possible to maximize usage of existing trains, and more could be accommodated in the Rosemont and Desplaines yards. The line has no crossings or other complications that would prevent more frequent service. Should longer trains become necessary, the Forest Park branch already has 600' platforms. Peak-hour usage of the Blue/O'Hare branch is comparable to that of Brown and Red/Howard and has been increasing at a similar pace, but the line should be able to accommodate expected growth over the next ten years – possibly longer if signaling were upgraded to permit >26-28 trains per hour.

Other Rail Projects

- *Station and track work.* Since 2010, existing stations at Grand/Red and Clark & Division/Red have been rehabilitated. Reconstruction of the 95th/Red and Wilson/Red stations is underway and a new station is being built at Washington-Wabash/Loop. Track upgrades are complete or underway on the Brown/Purple, Orange and Green Lines.

- *Blue Line Forest Park Branch Feasibility/Vision Study.* The project's goal is to determine a long-term planning strategy for the Forest Park branch. The study corridor extends from Clinton St. to Mannheim Rd. The study will assess the potential for integrated transit and highway enhancements in coordination with the Illinois Dept. of Transportation.

Impact on capacity. The Wilson station rehab will enable Purple Express trains to stop at this location, permitting equalization of loading between Purple and Red services and thus better capacity utilization. Rehab of Grand and Clark & Division is likely to increase traffic at these stations, which will mean more near-term crowding but in the long run will facilitate the shift of central area residents from bus to rail.

The Blue Line study is an opportunity to rethink not only service on the Forest Park branch but also the physical design of surrounding communities. The number of potential riders within walking distance of close-in stops on the west side is increasing but the pedestrian environment around stations in expressway medians is often inhospitable. Additional storefront retailing on streets near station entrances would help alleviate this problem.

CTA Bus

CTA Initiatives. CTA bus initiatives with the potential to increase transit capacity include:

- Jeffrey Jump. Inaugurated in 2012, this express service runs nonstop between the Loop and the South Shore neighborhood via Lake Shore Drive, then makes limited stops on Jeffrey Blvd. and other streets, using traffic signal priority (TSP) technology, “queue jumping,” lighted shelters, dedicated lanes and other improvements to enhance service.

- Loop Link. Launched in December 2015, Loop Link is a busway providing dedicated lanes and sheltered platforms on several downtown streets between the West Loop Metra stations and Michigan Avenue – see Figure B-2. It is used by the Jeffrey Jump and a number of local bus routes to speed service through the Loop. It also provides a dedicated bike lane. An off-street transit center for Loop Link is under construction near Union Station.

Figure B-2. Typical Loop Link station

- Ashland bus rapid transit (BRT). The CTA and CDOT studied a 16-mile BRT line on Ashland Ave., the city’s busiest bus route, between Irving Park Rd. and 95th St. The line was to include dedicated lanes and sheltered platforms in the center of the street, with stations approximately every half mile. Other possible features included high-capacity vehicles, TSP, and prepaid boarding. The project aroused opposition due to the loss of lanes for auto traffic and was shelved in 2015 in favor of a $30M plan to restore express bus service with TSP on Ashland and Western.[8]

River North-Streeterville Transit Alternatives Study. The Chicago Department of Transportation (CDOT) is currently studying transit improvement options in the River North-Michigan Avenue-Streeterville area. Recommendations are tentatively set to be made in late 2016. Preliminary indications are that the study’s recommendations will primarily focus on improved bus service.

Impact on capacity.

Jeffery Jump. As seen in Appendix A, professional employment is increasing in south lakefront neighborhoods, a trend already evident in South Shore. Although the community is served by the South Chicago branch of the Metra Electric, infrequent service and lack of fare integration with CTA discourage rail ridership. By improving bus service, Jeffrey Jump increases the attractiveness of South Shore to downtown professional workers and can be seen as paving the way for future improvement of lakefront rail service.

Loop Link. When fully operational, Loop Link will reduce travel times between the West Loop rail stations, the East Loop, and ultimately Streeterville. Rail overall is faster and provides greater capacity, but from the standpoint of speeding east-west travel across the Loop, Loop Link may be the long-term solution, given the high cost of underground construction.

Ashland BRT. This project did not advance due to local opposition and illustrates the drawbacks of non-grade-separated solutions in congested areas where transit must share streets with other traffic.

River North-Streeterville buses. Enhancement of near north side bus service is essential to meet near-term increases in demand. Whether buses will be sufficient for the long term is considered elsewhere in this study.

Alternative Transportation

Divvy bicycle sharing program. The Chicago Department of Transportation launched the Divvy bike share program in 2013 and has since expanded it to 4,760 bikes at 476 locations. More than 3.2M rides were taken in 2015. The record for most trips taken in one day was 24,814 on July 4, 2015 during the Grateful Dead shows at Soldier Field.[9]

Impact on capacity. Use of alternative means of transportation has increased in central Chicago since 1990 but remains modest. Work trip mode share by "other" means (taxi, bicycle, motorcycle, walk, other) increased from 4.9% in 1990 to 7.2% in 2010 (42,000 trips/day in the latter year).[10] The role of alternative transportation modes in accommodating the anticipated increase in transit demand is considered in Appendix E.

NOTES

[1] McGhee, Josh, "Morgan Street 'L' Station Helping Fuel West Loop Boom, CTA Says," *DNAinfo,* July 11, 2014, www.dnainfo.com/chicago/20140711/west-loop/morgan-street-l-station-helping-fuel-west-loop-boom-cta-says,accessed5/10/2016.

[2] CTA, "CTA Publishes Environmental Assessment for Proposed Bypass as Part of Phase One of Red and Purple Modernization Program – 5/19/2015," www.transitchicago.com/news/default.aspx?Month=&Year=&Category=2&ArticleId=3423, accessed 2/26/2016

[3] CTA, "Lawrence to Bryn Mawrv Modernization Project – Summary – Chicago, Illinois – April 2015," www.transitchicago.com/assets/1/rpmproject/5-20-15_CTA_LBMM_Project_Summary_WEB_PAGE--S.pdf, accessed 2/26/2016

[4] Federal Transit Administration, "Red and Purple Line Modernization Project – Chicago, Illinois – Core Capacity Project Development – Information Prepared November 2013," www.fta.dot.gov/documents/IL__Chicago_Red_and_Purple_Line_Modernization_Profile_FY15.pdf, accessed 2/25/2016

[5] CTA, "CTA Provides Update on Proposed Red Line Extension from 95th to 130th Street – 8/10/2014," www.transitchicago.com/news/default.aspx?Month=&Year=&Category=2&ArticleId=3327, accessed 2/25/2016

[6] CTA, "Your New Blue improvements to start in March – 2/24/2014," www.transitchicago.com/news/default.aspx?Month=&Year=&Category=2&ArticleId=3273, accessed 2/25/2016

[7] Hilkevitch, John, "CTA moves up Blue Line rehab," *Chicago Tribune,* February 24, 2014, articles.chicagotribune.com/2014-02-24/news/ct-getting-around-cta-blue-line-renovation-met-022-20140224_1_blue-line-rehab-track-work-o-hare-branch, accessed February 4, 2016

[8] Spielman, Fran, "Ashland BRT seems all but dead with return of Ashland, Western express buses," *Chicago Sun-Times,* 8/18/2015, chicago.suntimes.com/auto-show/ashland-brt-seems-all-but-dead-with-return-of-ashland-western-express-buses/, retrieved 5/9/2016.

[9] Chicago Department of Transportation, "Divvy Data Reveals Our Most Popular Destinations of 2015," 2/11/2014, divvybikes.tumblr.com/, accessed 5/10/2016.

[10] Regional Transportation Authority Mapping and Statistics (RTAMS), CTPP Data and Demographics, "Work Trip Mode Share by Area," www.rtams.org/rtams/routesHome.jsp, accessed 5/10/2016. Data is derived from the Census Transportation Planning Package (CTPP), a special tabulation of the U.S. Census for transportation planners. Data for 1990 was collected as part of the decennial census, whereas 2010 data is drawn from the 2006-2010 American Community Survey. The two datasets are collected in different ways and comparisons must be approached with caution.

Appendix C – Lessons of Previous Central Area Transit Plans

Past proposals for downtown transit expansion were too costly, provided insufficient benefit and lacked wide support

The shortcomings of central area transit have been recognized for close to 50 years and multiple proposals for addressing them have been offered. Five plans, two of which resulted in major (though unsuccessful) city initiatives, provide insight into the current situation:

- Chicago Central Area Transit Plan (1968-1979)
- Central Area Circulator (1987-1995)
- Central Area Plan (2003)
- Circle Line (2002-2009)
- Central Area Action Plan (2009).

Chicago Central Area Transit Plan

The Chicago Central Area Transit Plan (CCATP) was the first attempt to address two issues not explicitly recognized by previous generations of transit planners: first, the importance of suburban commuters in the downtown workforce, and second, the growing size of the central area and the importance of improved transit within it.

The CCATP had two major components: first, placing all Loop "L" lines underground, and second, digging a distributor subway under Monroe Street that would have carried "L" riders and suburban commuters to distant parts of the urban core – see Figure C-1.

Figure C-1. 1968 Chicago Central Area Transit Plan

The distributor would have originated near the campus of the present University of Illinois at Chicago and turned east under Monroe to a station at Canal, midway between Union Station and the Chicago & North Western Terminal, Ogilvie's predecessor, where suburban commuters could board. It would then have continued through the Loop in a shallow subway with a continuous platform extending the width of the Loop, enabling riders from downtown elevated and subway lines to transfer (Figure C-2).

The distributor would have split into two branches in the railroad right-of-way east of Michigan Avenue. The northern leg would have stopped at a station in the Illinois Center complex, which in 1968 was in the final stages of planning, and run up to a loop circling the John Hancock Center, then under construction. The southern branch would have extended to McCormick Place.

The CCATP was ahead of its time in some respects. Had the distributor subway been built as first proposed, North Michigan Avenue would likely have emerged as a major office district. On the other hand, the near south side other than McCormick Place consisted largely of railroad facilities and scrap yards and redevelopment was decades away. The south branch of the distributor was soon dropped from the core plan.

A persistent criticism of the project was that it provided insufficient benefit to justify the expense, estimated in 1974 at more than $1.6 billion.[1] With a total length of 15 miles, the proposal would have more than doubled the city's subway trackage. The longest segment, the Franklin Street subway, would have extended from the existing main line near Armitage to the near south side. The northern part of the Franklin line would have been used by Ravenswood and Evanston Express trains (today the Brown Line and the Purple Express), both lightly used at the time. No new service would have been provided; the primary goal was to eliminate the elevated tracks, which were seen as a blight.

The city pursued the CCATP for 11 years, among other things establishing a central area taxing body called the Chicago Urban Transit District (CUTD).

Figure C-2. Monroe Street distributor subway

Figure C-3. Chicago Central Area Transit Plan as revised

However, it was assumed the federal government would contribute the majority of funding, and U.S. transportation officials imposed tight limits. In the face of rising costs, the proposal was scaled back and by 1976 had devolved into two projects – the Monroe distributor and the Franklin subway (Figure C-3). The available funds being sufficient to pay for only one, the city chose the Franklin line, which soon ran into opposition from defenders of the Loop elevated. No progress had been made by the time Jane Byrne was elected mayor in 1979. Mayor Byrne reached an agreement with Governor James Thompson to cancel the Franklin subway and use some of the appropriated funds to pay for other transit projects, including the "L" extension to O'Hare and what became the Orange Line.

In hindsight the CCATP failed because it did not offer enough value to earn public support. Replacing some elevated tracks with a subway was not widely seen as important. The Monroe distributor arguably would have been a better long-term investment but did not solve an immediate problem and lacked a broad-based constituency.

Central Area Circulator

The Central Area Circulator, proposed in 1987 by the Metropolitan Planning Council and championed by the downtown business community, was the first plan to focus solely on expanding public transportation options within the urban core.[2] The need for enhanced downtown transit was more evident than it had been during the CCATP era. North Michigan Avenue, along with the rest of the central area, was enjoying a prolonged building boom, and the near north and near south sides had begun to attract a sizable residential population. Led by real estate developers, the downtown business community obtained City Hall backing for the Circulator by proposing a special service area property tax surcharge on central area commercial buildings to pay one-third of the cost, estimated at $775 million in 1994.[3] Another third was to be funded by the state and the remaining third by the federal government, for a total state and local match of two-thirds, a nationally unprecedented approach at the time.

The Circulator was to have been a light-rail system, seen as a less expensive alternative to a heavy-rail subway (Figure C-4). Although use of existing railroad rights-of-way was explored, the system as finally proposed would have operated mostly on dedicated lanes in city streets, using transit signal priority technology to provide for faster operation than was possible with traditional streetcars.

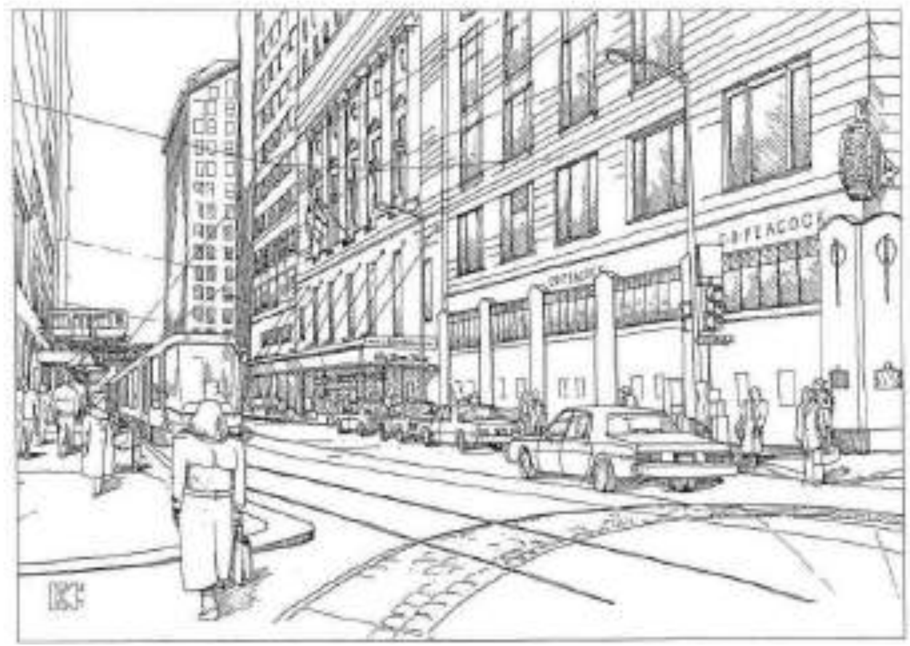


Figure C-4. Early Circulator concept showing Monroe St. alignment

Routing was similar to that proposed for the distributor subway (Figure C-5). One line would have traveled east via Madison Street from the West Loop commuter stations to State Street, where it would have split into two branches, one heading north to Wabash and Walton and the other south to McCormick Place. A novel feature of the plan was a riverbank line extending north from the Metra stations via Canal and Clinton to Kinzie Street, where it would have turned east to Navy Pier. Another line would have served Illinois Center.

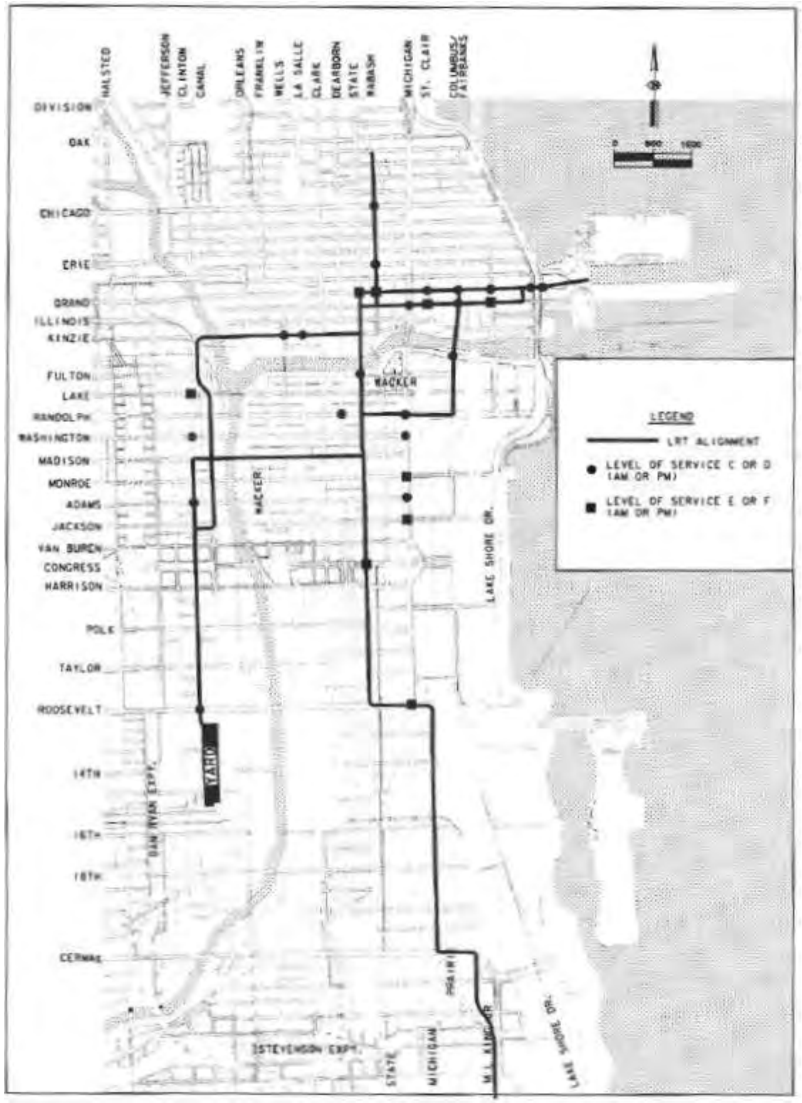


Figure C-5. Central Area Circulator routes

As with the CCATP, the Circulator became embroiled in controversy, much of it stemming from the proposed use of city streets. Downtown property owners and residents were concerned that a light rail system would block garage entrances and loading areas, endanger pedestrians, and add noise and unsightly overhead wires. Plans were revised multiple times to meet these objections.

To build support, the project's backers organized an extensive outreach and community relations effort. Eventually the Circulator was endorsed by all of Chicago's major daily newspapers and by hundreds of business, civic and community organizations. It also obtained all the necessary environmental approvals and reached a full funding agreement with the U.S. Department of Transportation. Efforts to secure public support added at least a year to the project schedule.

A key factor in the project's demise was that in 1995 the Republicans gained control of the House of Representatives in both the U.S. Congress and the Illinois General Assembly. City Hall's relationship with the Republican-controlled legislature turned particularly sour when Mayor Richard M. Daley signed a joint governance agreement for the Chicago and Gary airports with the state of Indiana and the city of Gary. This thwarted efforts by Republican lawmakers to take control of Chicago's airports away from the city. Within weeks new appropriations for the Circulator were killed. Subsequently, due to opposition from the chairman of the U.S. House appropriations subcommittee on transportation, Mayor Daley was unable to obtain a new appropriation for FY 1996. While the appropriation was not essential for the project to proceed, the mayor decided federal and state legislative support was insufficient and cancelled the project. Had the Circulator not lost a year in its schedule, it would have likely gone to construction in 1995. A smaller initial project might have attracted less opposition, avoided delays due to negotiation of alignments, and had a better chance of succeeding.

2003 Central Area Plan

The 2003 Central Area Plan (CAP)[4] offered a range of proposals for central area improvements, with transit projects featured prominently (Figure C-6). The most elaborate scheme was the West Loop Transportation Center, a four-level subway under Clinton Street between Congress Parkway and Lake Street – see Figure C-7.[5] The levels were to be used as follows:

- *Level 1* was a pedestrian concourse with connections to Ogilvie Transportation Center and Union Station.
- *Level 2* was a busway that branched off in several directions. The Carroll Avenue Transitway continued north on Clinton to a little-used railroad right of way that ran east and west along the north bank of the main stem of the river. The transitway was to have been used by buses, which would exit at portals on the near north side and continue to destinations such as Navy Pier and the Water Tower via ordinary streets. The Monroe Street Transitway would have followed the route of the 1968 distributor subway but would also have been used by buses, mostly existing line-haul routes that would benefit from a speedier trip across the Loop. At Columbus, the Monroe transitway possibly would have linked to the existing busway between the near north side and McCormick Place.
- *Level 3* was a heavy-rail subway connecting the Blue Line tunnels at Congress and Lake, thereby creating a “Blue Line loop” envisioned as an underground version of the Loop elevated. The O’Hare, Congress and Douglas branches would have circled this loop independently of one another before heading back to their respective terminals, in the process providing a convenient connection between the West Loop Metra stations and the traditional office core.
- *Level 4* was to be used for high-speed intercity rail.

The CAP was approved by the Chicago Plan Commission but few steps were taken to implement it. The West Loop Transportation Center did not attract support, undoubtedly because of the expense. Though no breakdown was given, the total for all transportation projects in the plan was estimated at \$2.25 to \$3.5 billion[6] – prohibitive given the billions needed to refurbish the existing “L.” Since the transportation center was the linchpin of the transit

Figure C-6. 2003 Central Area Plan – proposed transportation improvements

improvement scheme, none of the other elements was pursued. In hindsight, a wiser approach would have been to devise a series of smaller projects providing incremental benefits that could eventually be knitted into a larger solution.

Figure C-7. West Loop Transportation Center

Circle Line

While work was underway on the CAP, the CTA unveiled its own proposal for expanded central area transit – the Circle Line. As seen in Figure C-8, the Circle Line was to run along the perimeter of the central area, using existing "L" tracks where possible with new trackage to bridge the gaps, shown in orange in the diagram. Convenient transfer points would be provided at each "L" and Metra line the Circle Line crossed, making it easier to navigate the central area.

The Circle Line initially attracted wide interest[7] and was pursued by CTA for some years. In 2006 and 2009 the agency held public open houses on the project as part of the "alternatives analysis" then required by the federal funding process.[8] The plan was understood to consist of three phases:[9]

Figure C-8. Circle Line

- *Phase 1* in essence was the Pink Line, which was launched in 2006. The Douglas branch of the Blue Line was given its own color designation and rerouted via a stretch of unused track called the Paulina Connector to the Green Line near Ashland and Lake. Pink Line trains then used the Green Line tracks to enter the Loop.

- *Phase 2* called for construction of an elevated rail link between the Orange Line and the Pink Line. Circle Line trains would start on the north side, enter the Loop via the Red Line, and then head west on the Orange Line and north on the Pink Line, terminating at Ashland/Lake on the Green Line.

- *Phase 3* entailed construction of a subway north under Ashland Avenue to the Division stop on the Blue Line, then east to the North/Clybourn stop on the Red Line. Once that was complete, Circle Line trains could make a complete circuit of the central area.

The shortcomings of this scheme eventually became apparent. Under the "locally preferred alternative" (LPA) presented by CTA at the 2009 open houses, the Circle Line as initially implemented would conclude with phase 2 – that is, it would terminate at Ashland/Lake at a cost of $1B (2009 dollars).[10] Extension to the north side to permit transfer to the busy Blue, Red, and Brown Lines was relegated to a "long term vision" with an estimated cost of $3.2B – $4.2B. Commenters objected that the LPA's benefits did not justify the $1B expenditure.[11] The CTA did not pursue the Circle Line after 2009.

The Circle Line offers two important lessons:

- Central area transit improvement can generate public support if the perceived benefits extend beyond downtown. Circle Line presentations were well attended, attracted significant media coverage, and elicited many public comments. Although the project had its share of skeptics, it also had vocal supporters. Had implementation been feasible, this base of support would likely have helped sustain the project through difficult times.

- It underscored the wisdom of an incremental approach consisting of a series of reasonably-scaled subprojects, each conferring significant benefits, without the need for multibillion-dollar investments at one go.

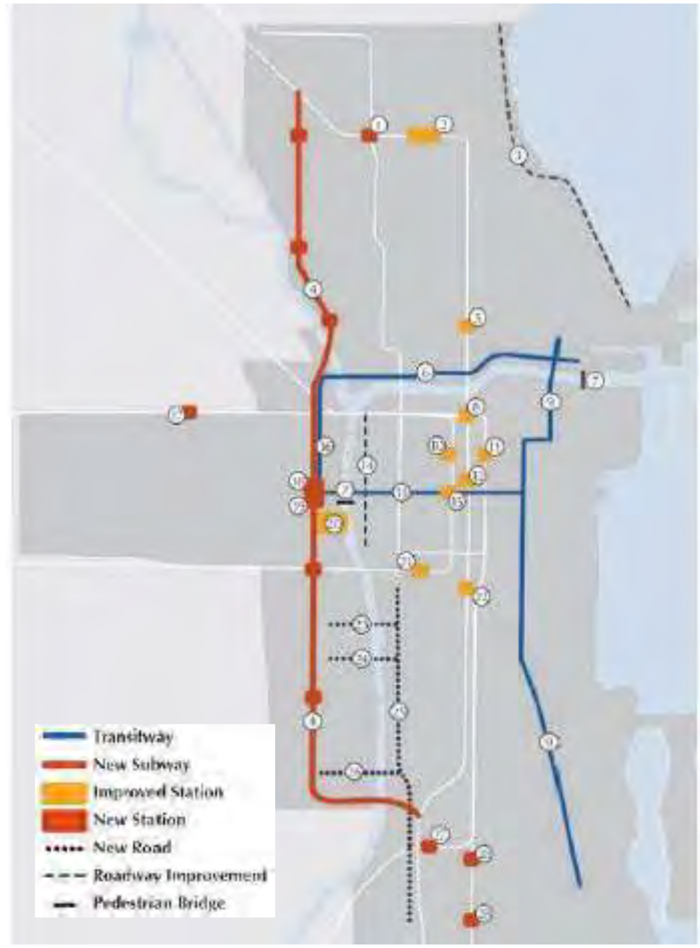


Figure C-9. Central Area Action Plan – Transportation improvements

Central Area Action Plan

The Central Area Plan of 2003 having made little headway, the city prepared an update in 2009 focused on specific projects, which it called the Central Area Action Plan (CAAP).[12] Transit improvement again figured prominently –

see Figure C-9. The West Loop Transportation Center and the transitways (including Carroll Ave. – see Figure C-10) remained from the CAP, but the “Blue Line loop” had now evolved into the “Red Line connector,” a bypass subway between the North/Clybourn and Cermak-Chinatown stops. This had been offered as an option in the 2003 plan but in the CAAP was the primary heavy rail proposal. The plan noted rapidly rising ridership at central area “L” stops; the CTA was then extending Brown Line platforms to permit trains to be lengthened from six cars to eight. The implication was that the Red Line would need additional capacity as well.

Figure C-10. Carroll Ave. transitway as depicted in Central Area Action Plan

Like its predecessor, the CAAP was adopted by the Chicago Plan Commission but no progress was made on the major transportation proposals. The city’s Olympic bid was then in progress and may have diverted attention, but it is safe to say the major obstacle was cost. The CAAP estimated the West Loop Transportation Center at $2 billion and the Clinton subway at $3 billion.

Other Relevant Projects

Chicago was unable to expand central area transit despite multiple attempts during the 48 years from the 1968 downtown subway plan to the present. During this same period, it successfully completed many other large-scale rail projects, including:

- Three new lines or major extensions, including what is now the Dan Ryan branch of the Red Line, the Blue Line extension to O’Hare, and the Orange Line.
- Multiple major refurbishments or upgrades, including reconstruction of the Pink Line, Green Line, and Red Line/Dan Ryan branch; subway construction to reconfigure south side service on the Green and Red Lines; and station replacement (with platform extensions) on the Brown Line.
- Numerous rebuilt or new infill rail stations throughout the system, plus many track and signaling upgrades, several rounds of new rolling stock, two new automatic fare collection systems, and many other improvements.

The line construction or rebuilding projects typically had budgets in the range of a half billion dollars; the budget for the 2013 Red Line South reconstruction was $646 million. The cost of the 700 new 5000-series rail cars was $1.137 billion. The cost of the Circulator, $775 million, was not in itself considered controversial at the time.

In light of this history, several observations seem fair:

- Funding for large projects can be found if the need is thought sufficiently urgent.
- Given existing maintenance needs, the only local funding usable for *new* transit is money that would not be available but for the project.
- Major projects should be seen as offering wide benefits.
- Except in the rare case where all riders benefit, the price tag for any single project or phase should be less than $1 billion.

NOTES

[1] www.Chicago-L.org, "Chicago Central Area Transit Plan – Chicago Urban Transportation District," www.chicago-l.org/plans/CUTD.html, accessed 8/10/2016.

[2] The Circulator's history as presented here reflects substantial input by Steve Schlickman, the project's director and a member of the CCAC executive committee overseeing this report.

[3] U.S. General Accounting Office – Resources, Community, and Economic Development Division, "Chicago Circulator" (report to U.S. House of Representatives subcommittee on transportation), June 2, 1995, www.gao.gov/assets/90/84698.pdf, accessed 8/10/16.

[4] City of Chicago, *The Chicago Central Area Plan: Preparing the Central City for the 21st Century – Draft Final Report to the Chicago Plan Commission,* May 2003, www.cityofchicago.org/city/en/depts/dcd/supp_info/central_area_plandraft.html, accessed 8/10/16.

[5] *Ibid.,* Ch. 2 – Transportation, p. 60-63, www.cityofchicago.org/content/dam/city/depts/zlup/Planning_and_Policy/Publications/Central_Area_Plan_DRAFT/07_Central_Area_Plan_Chapter4_2a.pdf,

[6] *Ibid.,* Ch. 6 – Implementation, p. 142, www.cityofchicago.org/content/dam/city/depts/zlup/Planning_and_Policy/Publications/Central_Area_Plan_DRAFT/19_Central_Area_Plan_Chapter6.pdf, accessed 8/10/16.

[7] Herguth, Robert and Fran Spielman, "Daley likes L proposal, would help find funds," *Chicago Sun-Times,* 3/12/02, http://www.chicago-l.org/articles/CircleLine02.html, accessed 8/11/16.

[8] Chicago Transit Authority, "Circle Line Alternatives Analysis Study," www.transitchicago.com/news_initiatives/planning/circle.aspx, accessed 8/11/16.

[9] www.Chicago-L.org, "Circle Line Plan," www.chicago-l.org/plans/CircleLine.html, accessed 8/11/16.

[10] Chicago Transit Authority, public meeting presentation – Sept. 2009, http://www.transitchicago.com/assets/1/planning/Circle_Line_-_Screen_3_Presentation_9-29-09.pdf, accessed 8/11/16.

[11] Chicago Transit Authority, "Circle Line Alternatives Analysis Study – Screen Three Public Involvement – Public Questions and Comments (Appendix)," www.transitchicago.com/assets/1/planning/Screen_3_Circle_Line_Public_Comments_Appendix.pdf, accessed 8/11/16.

[12] City of Chicago, *Central Area Action Plan,* 2009, www.cityofchicago.org/city/en/depts/dcd/supp_info/central_area_action_plan.html, accessed 8/10/16.

Appendix D – Transit Experience of Other Cities

Chicago's transit growth pattern reflects the U.S. trend, but other cities are doing more about it

The evolution of transit ridership in Chicago echoes the experience of its peer cities in the U.S. Figure D-1 shows the percentage change in ridership between 2001 and 2015 in the seven U.S. cities that have both bus and rail systems and in which rail, including heavy and light rail components, accounted for at least 100 million annual rides in 2015.[1]

TRANSIT MODE DEFINITIONS AS USED IN THIS PAPER

Heavy rail – Grade-separated multi-unit operation, either in subway or on elevated structure or embankment. High capacity, typically 30K riders per hour per track globally, although U.S. systems other than New York are much lower. Frequent service, relatively closely-spaced stops.

Light metro – Grade-separated operation, usually elevated. Shorter, smaller trains, lower capacity than heavy rail – 10K to 15K riders/hour/track.

Light rail – Multi-unit trains operating in dedicated ground-level right-of-way with grade crossings.

People mover – Automated, grade-separated short trains or single cars – typically slower and less capacity than light metro

Streetcar – Mostly single-unit vehicles, sometimes articulated, operating in mixed traffic (transit shares street with other vehicles).

Bus rapid transit (BRT) – Global "gold standard" for these high-capacity bus systems includes dedicated right of way, off- board fare collection, multi-door boarding, limited stops, high-capacity vehicles, etc. No U.S. BRT system meets this standard but all have BRT elements.

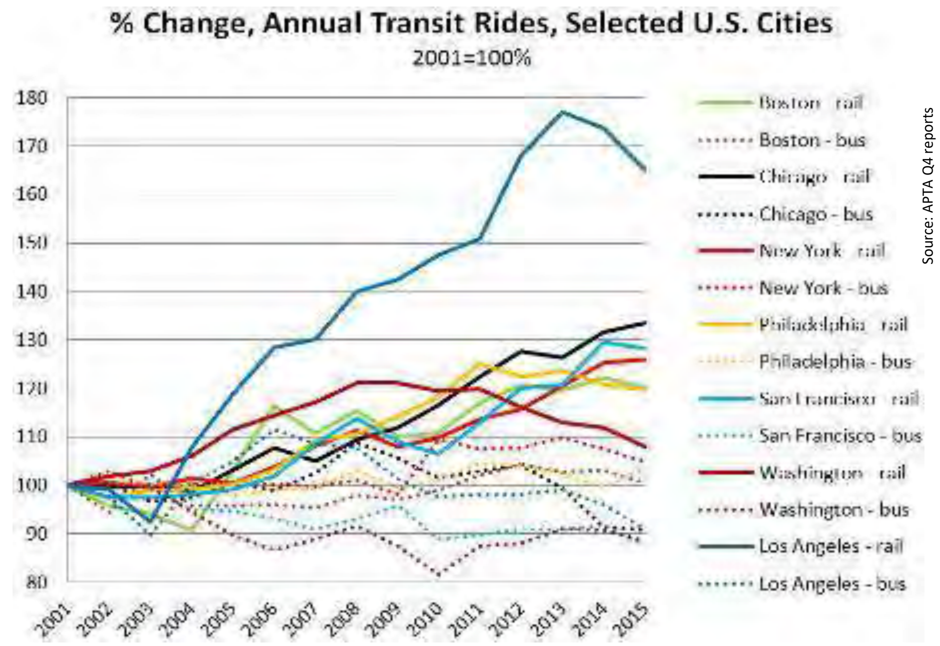


Figure D-1

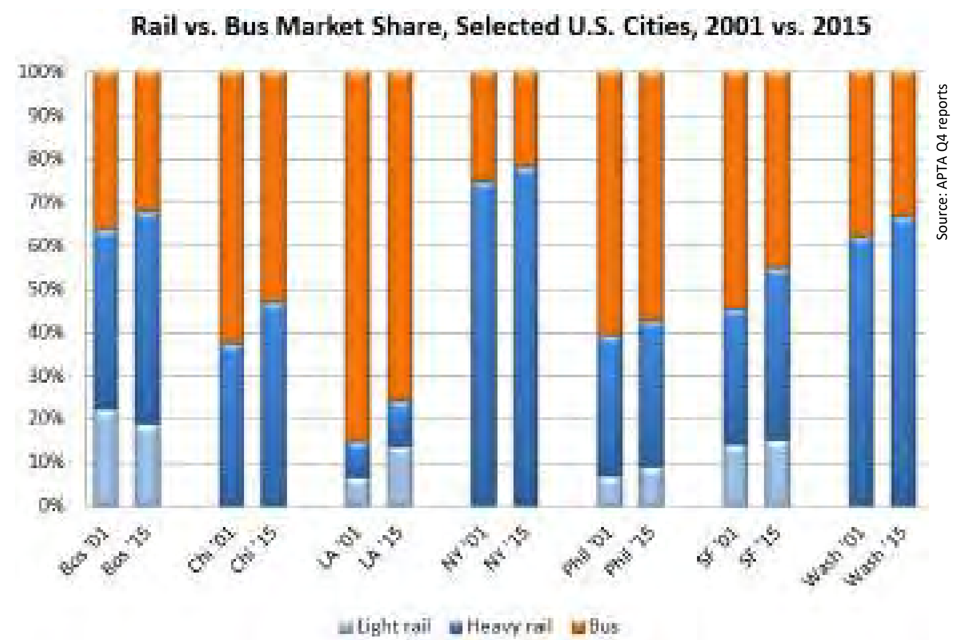


Figure D-2

In all cases rail ridership (solid lines) increased, often dramatically – six of the seven cities, including Chicago, had rail ridership growth of 20% or more. (The higher rate in Los Angeles reflects the addition of new service to a relatively small system; nonetheless, rail now accounts for close to a quarter of LA transit usage.) Meanwhile bus ridership (dotted lines) was stagnant, grew modestly, or declined. As a result, rail increased transit market share in all the cities, and in four of the seven cases now accounts for the majority of rides – see Figure D-2.

At least partly in response to this growth, many U.S. cities currently have major rail transit expansion projects in progress – some have several. Figure D-3 lists U.S. rail projects now under construction with budgets of at least $1 billion; many smaller projects are also underway. Of the seven peer cities, Chicago and Philadelphia are the only two with no major rail expansion projects in the works, although Chicago has one of the highest rail growth rates.

Transit Systems in Other Cities Compared

In considering possible transit expansion in Chicago, it seemed wise to review the experience of comparable cities in the U.S., Canada and elsewhere.[2] Given the large number of systems, the following filters were applied:

- Heavy rail systems were not reviewed. Although the "L" is classified as heavy rail, construction of a traditional elevated line in downtown Chicago seemed improbable and a subway was judged to be prohibitively expensive.

- All U.S. light rail and streetcar systems, as identified in ridership reports published by the American Public Transit Association, were reviewed, as were selected light rail or light metro systems in Canada and the UK.

- Selected U.S. bus rapid transit systems were also reviewed. BRT practices vary widely among U.S. cities and BRT operating data was

U.S. RAIL TRANSIT EXPANSION PROJECTS >$1B UNDER CONSTRUCTION

City	Project	Cost	Start/Finish
Baltimore	Red Line – 14.1 mi light rail	$2.9B	2015/2022
Boston	Green Line Extension – 4.3 mile light rail	$2.2B	2012/2020
Charlotte	Blue Line Extension – 9.3 mi light rail	$1.2B	2013/2017
Honolulu	Honolulu Rail Transit Phase 1 – 20 mi heavy ral	$5.3B	2011/2017
Los Angeles	Crenshaw LAX Line – 8.5 mi light rail	$2B	2014/2019
Los Angeles	Expo Line Phase 2 – 6.6 mi light rail	$1.5B	2012/2016
Los Angeles	Purple Ln Ext. Ph. 1 – 3.9 mi heavy rail	$2.8B	2014/2023
Los Angeles	Regional Connector – 1.9 mi light rail	$1.4B	2014/2020
New York	2nd Ave. Subway Phase 1 – 8.5 mi heavy rail	$4.9B	2007/2016
New York	7 Subway Extension – 1.3 mi heavy rail	$2.4B	2007/2015
Portland	Portland-Milwaukie Light Rail (Orange Line) – 7.3 mi	$1.5B	2011/2015
San Diego	Mid-Coast Corridor Transit – 10.9 mi light rail	$2B	2015/2019
San Francisco	BART Silicon Valley Berryessa Ext. – 10 mi heavy rail	$2.3B	2012/2016
San Francisco	Central Subway – 1.7 mi light rail extension	$1.6B	2010/2019
Seattle	Northgate Link – 4.3 mi light rail	$2.1B	2012/2021
Seattle	University Link – 3.2 mi light rail	$1.9B	2009/2016
Washington	Silver Line Phase 2 – 11.4 mi heavy rail	$2.8B	2014/2018
Washington	Purple Line – 16.2 mi light rail	$2.5B	2015/2020

U.S. heavy rail or light rail projects valued at >$1B only. Commuter rail projects excluded.
Source: www.thetransportpolitic.com, visited 3/17/15

Figure D-3

difficult to obtain. BRT operations from four cities (Boston, Cleveland, Los Angeles, and New York) were cited because they were considered representative of large U.S. cities and data was available.

A table of all systems reviewed ranked by daily ridership per mile may be found on the following page. Descriptions of selected systems may be found in Appendix J. Observations:

- Grade-separated operation offering significant time savings over other means of downtown transportation is strongly associated with high ridership, defined as ≥4K riders/mile. Of the 11 systems in this category, eight have grade-separated operation downtown. The exceptions are in Calgary and New York. In Calgary, trains operate in a downtown transit mall closed to cars, with traffic signals coordinated to obtain average speeds comparable to grade-separated systems. The two New York Select Bus Service operations were heavily traveled local bus routes given some BRT features; ridership has declined since SBS was inaugurated.

- BRT is inexpensive but for the most part does not support high-volume ridership and even in New York does not result in greater transit use.

- The majority of systems reviewed carry <4K riders/mile. Ridership on most of the cited BRT lines was similar to light rail. Both BRT and light rail systems in this group operate mostly on dedicated street lanes with grade crossings, but rail is more expensive to build. This suggests that at-grade light rail is not cost-effective unless, as in Calgary, train speeds can be made comparable to grade-separated systems.

- Grade-separated operation can achieve respectable ridership even in cities not otherwise conducive to transit. Ridership on Detroit's automated people mover exceeds 2K/mile, more than many at-grade light rail systems elsewhere. The Miami Metromover, which uses the same technology, carries >8K riders/mile, placing it 5th among the 41 transit systems reviewed. (The fact that the Metromover is free likely contributes to high usage.)

- Grade separation does not guarantee high ridership. Of 31 systems with <4K riders/mile, 8 have grade-separated operation downtown. Cleveland's light rail lines are grade-separated within the city limits but have among the lowest ridership per mile of any system reviewed.

- In most cities with the highest ridership per mile, auto travel to the city center is discouraged, either by policy or circumstance. Calgary, Edmonton, London and Vancouver have no freeways within two miles of the commercial district served. In Boston and New York, high road congestion encourages transit use. It is fair to to say high transit ridership requires that travel by transit be easy, while travel by auto must be relatively difficult.

To summarize the experience of other cities:

- With few exceptions, grade separated rail systems generally attain the highest ridership.

- Surface (at-grade) light rail in most cases is not cost-effective compared to BRT for the volume of riders carried.

- Except in the atypical case of New York, BRT does not support high-volume ridership in the U.S.

- High-volume rail ridership tends to be associated with public policies favoring transit over auto use.

CITY/SYSTEM	YR OPEN	RDRS/DY	LGTH	STOPS	LINES	MAX TRAIN LGTH	WIDTH	MAX TRAIN CAP	GRADE SEP?	RIDRS/MI	NOTES
London (Docklands LRT)	1987-2011	278,100	21	45	7	(3x91'10")=275'6"	8'8"	852	Y – throughout	13,243	A
Boston (Green Line)	1897-2004	223,300	23	67	4	(3x74')=286'	8'8"	200+ Standing	Y – tunnel dwntn	9,709	B
Vancouver (SkyTrain)	1985	390,600	42.7	47	3	(4x57'9")=231	10'6"	(104 Seats+284)=388	Y – throughout	9,148	A
Calgary Ctrain	1981	333,800	37.2	45	2	3x79'8"=239'	8'8"	264x3=792	N – dedicatd street	8,973	A,C
Miami Metromover (APM)	1986-1994	35,300	4.4	21	1	42'	9'2.4"	(22 seats+83)=105	Y – throughout	8,023	
Toronto (Line 3 Scarborough)	1985	32,000	4	6	1	(4x41'8")=166'8"	8'2"	(68 Seats+132)=200	Y – throughout	8,000	
Edmonton Light Rail Transit	1978-2015	100,760	15.1	18	2	5x79'8"=398'4"	8'8"	264x5=1,320	Y – tunnel dwntn	6,673	A
New York - 34th St SBS (BRT)	2011	15,945	2.5		1				N – dedicatd lanes	6,378	
New York - 1st/2nd Av SBS	2010	49,597	8.5	20	1				N – dedicatd lanes	5,835	
Philadelphia subway-surface	1906	84,829	19.8	16	5	50'	8'6"	101	Y – tunnel dwntn	4,284	D
San Francisco (LRT)	1980	150,300	36.8	120	7	(2x75')=150"	9'	(120 Seats+200)=320	Y – tunnel dwntn	4,084	D
Hudson-Bergen LR	2000	54,434	17	24	3	127'	8'10"	(102 Seats+298)=300	N - ded lanes	3,202	
Los Angeles Metro (LRT)	1990	200,800	64.8	58	4	(2x89'6")=179'	8'8.5"	352	Y – tunnel, elevtd	3,099	E
Portland Streetcar	2001-2007	20,000	7.2	76	2	66'1"	8'1"	36 seats + 127 = 163	N – mixed traffic	2,778	
Minneapolis-St. Paul	2004-2014	62,500	23	37	2	(3x95'5")=286'2"	8'8"	690	N – dedicatd lanes	2,717	
Buffalo Metro Rail	1985	16,500	6.4						N – dedicatd street	2,578	F
Boston Silver Line (BRT)	2002-2004	33,386	13	22	4	60'	8'6"	(57 seats+47)=104	Y – tunnel dwntn	2,568	D
Houston METRORail	2004	55,00	22.7	37	3	(2x96'5")=192'10"	8'8"	(144 Seats+338)=482	N – dedicatd lanes	2,423	
Phoenix	2008	44,800	20	28	1	(3x91'6")=274'6"	8'8.4"	198 seats+ Standing	N – dedicatd lanes	2,240	
San Diego	1981	119,800	53.5	53	3	(3x93.6)=280'10"	8'8"	(204 Seats+486)=690	N – dedicatd lanes	2,239	
Portland (Max Light Rail)	1986-2004	113,900	52	87	4	(2x95'5")=190'10"	8'8.4"	(72 Seats+156)=228	N – dedicatd lanes	2,190	
Cleveland Health Line (BRT)	2008	14,367	6.8	59	0	60'	8'6"	(47 Seats+53)=100	N – dedicatd lanes	2,113	
Detroit People Mover	1987	6,000	2.9	13	1	(2x41'8")=83'6"	8'2"	(68 Seats+132)=200	Y – throughout	2,069	
Seattle (Link Light Rail)	2003-2009	35,200	17.3	18	2	(4x95')=380'	8'8.4"	(296 Seats+504)=800	Y – tunnel dwntwn	2,035	
Denver	1994	86,300	47	46	6	(2x81'5")=162'10"	8'8"	(128+242)=370	N – dedicatd lanes	1,836	
Seattle (Streetcar)	2007	2,200	1.3	11	1	66'	8'	27+ Standing	N – mixed traffic	1,692	
Charlotte (LYNX Blue Line)	2007	15,800	9.6	15	1				Y – elevated dwntn	1,646	
Salt Lake City TRAX	1999-2013	68,500	44.8	50	3	(4x81'5")=325'7"	8'8.4"	(60 Seats+165)=225	N – dedicatd lanes	1,529	
Sacramento	1987	45,200	38.6	50	3	(4x84')=336	8'9"	(256 Seats+177)=241	N – dedicatd lanes	1,171	
Los Angeles Orange Ln (BRT)	2005	25,018	22						N – dedicatd lanes	1,137	
Dallas LRT	1996-2015	101,800	90	62	4	(4x123.5')=494'	8'10"	392+ standing	N – dedicatd lanes	1,131	
St. Louis	1993	49,900	46	37	2	90'	8'9.6"	144 Seats + 212=356	Y – tunnel dwntwn	1,085	
Pittsburgh	1984	27,700	26.20	53	2	90'	8'9.6"	144 Seats + 212=356	Y – tunnel dwntwn	1,057	
New Orleans Streetcar	1893	23,000	22.3		4				N – mixed traffic	1,031	
Baltimore	1992	27,100	30						N – mix traff dwntn	903	
Atlanta Streetcar	2014	2,429	2.7	12	1	82'	8'8"	195	N – mixed traffic	900	
San Jose	1987	35,200	42.2	62	3	(4x123.5')=494'	8'10"	392+ standing	N – dedicatd street	834	
Hampton VA (Tide Light Rail)	2011	5,800	7.4						N – dedicatd lanes	784	
Cleveland Green, Blue Lines	1913	8,900	15.3	34	2	77'1"	9'4"	84 Seats+Standing	Y – in city limits	582	
Oceanside CA (Sprinter)	2008	9,200	22	15	1				N – ded rail ROW	418	
Tampa TECO Line	2002	700	2.7	11	1				N – mixed traffic	259	

A – No freeways within 2 mi of commercial district. B – Mostly grade separated or dedicated lanes in outlying areas. C – Dedicated transit mall, traffic light coordination enable train speeds comparable to grade-separated systems. D – Mostly mixed traffic operation (transit + autos) in outlying areas. E – Blue Line downtown terminal only in tunnel; Gold Line mostly grade separated. F – tunnel in outlying area.

Figure D-4. Comparison of systems in selected cities, ranked by ridership/mile

NOTES

[1] Ridership data from "Ridership Report," published quarterly by American Public Transit Association,
www.apta.com/resources/statistics/Pages/ridershipreport.aspx.

[2] Information about systems obtained from various online sources, including agency and vendor websites, Wikipedia, news accounts, etc.

Appendix E – Central Area Transit Expansion Alternatives

All modes have their uses, but new rail is the best way to meet rising demand and facilitate economic growth

As shown in Appendix A, the central area has been the focus of growth in jobs, population, and rail transit ridership in Chicago for more than 20 years – in the case of jobs, more than 40 years. Since 1998, most new professional workers in downtown Chicago have chosen to live in the city and take the "L" to work. With parts of the rail system nearing capacity, the core is the logical place for additional transit investment so that growth may continue. The question is the most cost-effective way to meet anticipated demand and lay the groundwork for continued economic expansion. Options considered in this report include:

1. Additions to conventional bus service.
2. Bus service using dedicated lanes and limited stops such as Loop Link. When combined with transit signal prioritization (TSP) and off-bus fare payment, this option is sometimes called bus rapid transit (BRT) and will be so referred to in this report.
3. Greater reliance on alternative means of transportation such as walking, cycling, and taxis.
4. Increased reliance on existing underutilized "L" lines, in part through new close-in stops.
5. Street (at-grade) light rail.
6. New rail service using grade-separated, mostly above ground right of way. This option is termed light metro in this report. A typical light metro system is London's Docklands Light Rail – see Figure E-1.

As indicated in Appendix B, options 1-4 have been pursued to varying degrees in Chicago in recent years. Option 5, light rail, would be similar to the Circulator project of the 1990s, discussed in Appendix C. Option 6, light metro, has not been previously proposed.

Figure E-1. Docklands Light Rail, London

Briefly put, the argument presented in this report is that:

- Options 1 through 4 have a role to play in improving central area transit but collectively do not provide sufficient speed and capacity to meet growing demand, nor will they maximize economic growth.
- The drawbacks of option 5, at-grade light rail, outweigh its benefits other than in limited applications.
- **Option 6, light metro, provides the best way to meet rising transit demand and facilitate continued growth in population and jobs.**

This report does not consider heavy rail – that is, subway or elevated lines similar to the "L." Preliminary inquiry suggested that the cost of extensive underground construction would be prohibitive, and public acceptance of a new elevated line like those now in use downtown seemed improbable.

Deficiencies of Current Central Area Transit

In evaluating options for central area transit expansion, it is important to understand the deficiencies of the existing infrastructure, which new investment would offer an opportunity to correct. These include:

- **Slow travel within the central area.** As the densely built-up portion of the central area has expanded, travel within it has become increasingly difficult. Existing downtown bus service is slow – for example, the trip from Union Station to the Hancock Center at Delaware and Michigan via the #151 bus takes 28 minutes during the AM rush, for an average speed of 4½ mph[1]. Rail service is faster but inconvenient for many downtown trips due to the system's hub-and-spoke design, with all routes converging on the Loop. Any location in the traditional core is close to a rail station, but access is inconvenient or nonexistent in outlying areas such as Streeterville or the South Loop. In contrast, in cities with mature transit systems such as London, the rail lines form a grid – see Figure E-2. Virtually any location within the urban core is easily reachable by rail from any other part with at most one transfer.

Figure E-2. Hub-and-spoke route pattern (Chicago, left) vs. grid (London, right)

- **No link between "L" and Metra commuter rail.** Chicago is the only major U.S. city, and may be the only city in the world, lacking convenient downtown connections between its rapid transit and suburban commuter rail systems.[2] Buses are not well suited for such connections – due to traffic congestion, bus speeds to and from Metra terminals can be as slow as 3-5 mph.[3] As a result, a large fraction of Metra commuters arriving downtown walk the remaining distance to their jobs – 78% in the case of the ~100K using Union Station.[4] Historically most Chicago office buildings have been built within walking distance of the four terminals – see Figure E-3. Visitors arriving at one of the four Metra terminals can walk to the Loop but cannot easily reach most other parts of the central area.

Figure E-3. Loop office core (center) vs. commuter rail walksheds (1,200m)

- **Major downtown destinations inaccessible by rail.** Many downtown destinations outside the Loop are not served by Metra, the "L," or both, including North Michigan Avenue, the River North entertainment district, Navy Pier, the museum campus, McCormick Place, and major institutions such as Northwestern Memorial Hospital and the downtown campuses of Loyola University, Northwestern University, and the University of Chicago.

- **Development sites in the traditional core are becoming scarce.** As shown in Appendix G, the Loop-centered core, which is well served by rail, historically has been such a magnet for development that it has few sites left. New development increasingly will be forced into less accessible areas, increasing project risk.
- **Much land on the edge of the central area is vacant or underutilized due to lack of rail access.** Some large tracts have been empty for decades. As established in Appendix G, parts of the central area without rail access account for 42% of the central area but attracted only 15% of development between 1996 and 2015.

If the central area is to continue to grow at its current pace, the problems identified above must be addressed. Two sets of choices must be made: first, selecting a transit technology, and second, choosing a route.

Evaluating Technology Options

The first task is to determine the optimal transit technology. The options listed at the beginning of this appendix will be evaluated in the order below:

1) Better utilization of existing "L"
2) Alternative transportation, e.g., bicycling, walking, taxi, etc.
3) Conventional bus
4) Bus rapid transit
5) Street (at-grade) light rail
6) Light metro – that is, grade-separated light rail.

1. Better utilization of existing "L"

The four CTA rail corridors entering the CBD from the west, southwest and southwest sides have ample capacity and offer the most cost-effective way of meeting expected demand growth. In 2013, the four corridors carried ~20K riders total during the AM peak hour; on the assumption that the practical limit is 21K per corridor (see Figure A-22), these lines are physically capable of accommodating >60K additional riders during the AM peak hour, and many times that number for the entire day. Given the historical trend, it is not realistic to expect underutilized lines to absorb all demand growth, but they can carry a substantial portion of it. The largest ridership increases likely will be at close-in stations – indeed, as seen in Figure A-24, this is already occurring. Construction of new stations such as Morgan and Cermak-McCormick Place on the Green Line is accelerating this trend. For planning purposes, it seems reasonable to assume the existing "L" can absorb half of expected demand growth – that is, 75K of the anticipated 150K new weekday riders.

2. Alternative transportation (bike, walk, etc.)

As seen in Figure A-16, alternative means of transportation such as bicycling and walking have become more popular in recent years, in the former case partly because of the city's investment in bike lanes and the Divvy bike sharing program. The fact that residential growth is primarily occurring in the central area – meaning new downtown employees tend to have short journeys to work – makes it likely reliance on alternative transportation will continue to grow.

Figure E-4 shows the change in central area commuting habits between 2000 and 2014.[5] Traffic-bound modes (car, bus, taxi) lost share while non-traffic-bound modes ("L," Metra, bike, walk) gained, no doubt partly due to increased congestion in the core.

	Workers	Car	Bus	"L"	Metra	Bike	Walk	Taxi
2000	100,574	41,854	14,753	10,659	930	768	21,183	5,961
% Total	100%	42%	15%	11%	1%	1%	21%	6%
2014	144,617	52,892	19,160	17,136	2,309	2,956	34,718	5,580
% Total	100%	37%	13%	12%	2%	2%	24%	4%
Change	44,043	11,038	4,407	6,477	1,379	2,188	13,535	(381)

Figure E-4. Central area commuting by mode, 2000 vs. 2014

Since walking's share increased the most, it might be supposed that a large fraction of the projected increase in work trips could be accommodated on foot. This seems unlikely for reasons apparent in Figure E-5. Although alternative commuting modes are becoming more popular in much of the city and account for a large share of work trips in the central area, they are dominant primarily in a small sector bound by Division St. (1200N), Halsted St. (800W), and Roosevelt Rd. (1200S) – a situation that changed little between 2000 and 2014. This no doubt reflects the fact that (a) most

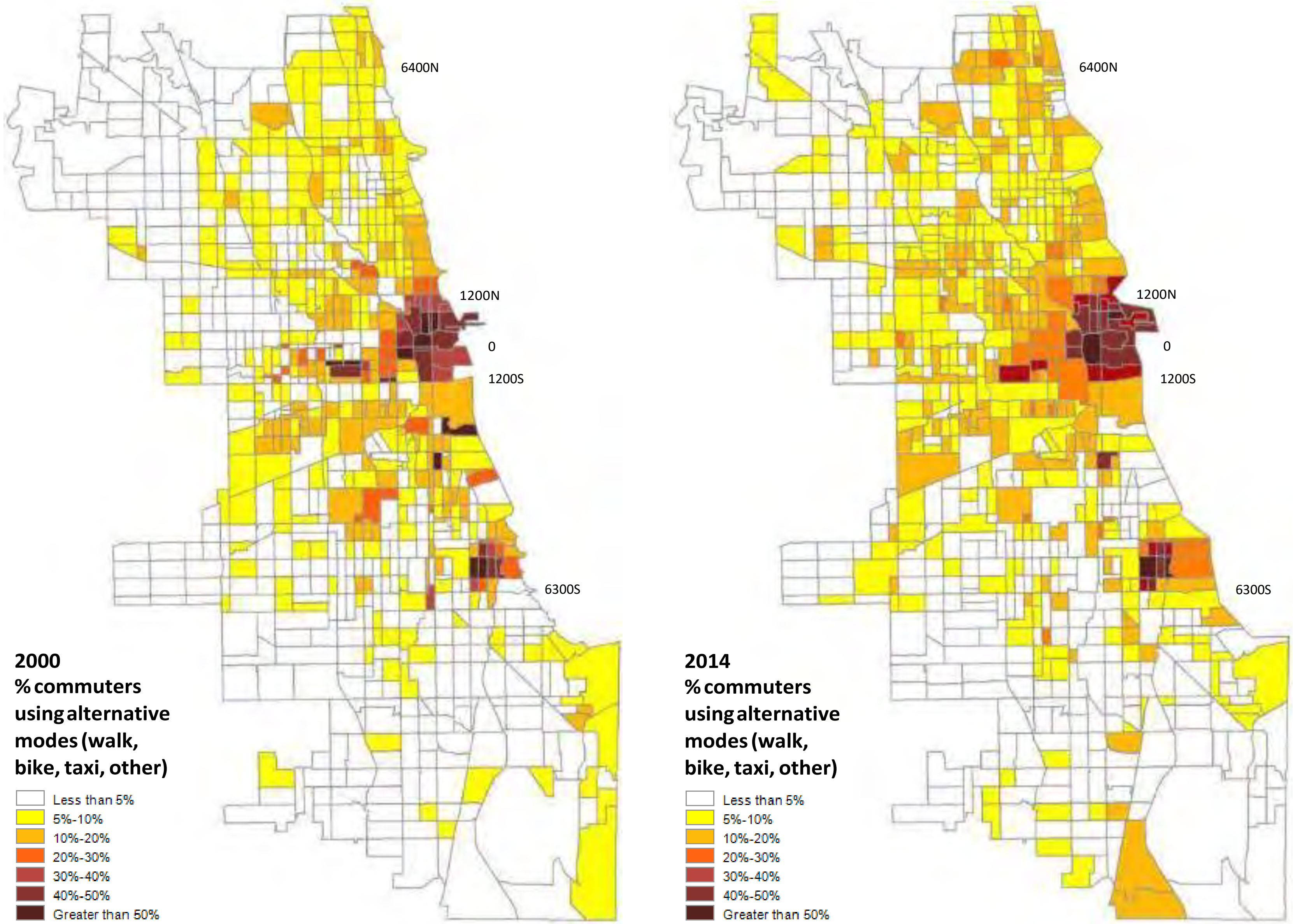


Figure E-5. Percentage of commuters using alternative modes, 2000 vs. 2014

alternative central area commuters walk, but (b) few are willing to do so for trips longer than a mile. The vacant sites likely to see large-scale residential development are mostly on the periphery of the core; for most residents of these future neighborhoods, walking to work is likely to seem impractical. Thus it seemed wise not to count on alternatives modes to handle any specific number of new work trips for the purposes of this study.

3. Conventional bus

Augmenting existing bus service by adding vehicles and routes is a fast and relatively inexpensive way to increase transit capacity. In the short run, more bus runs will undoubtedly be needed to carry the overflow from crowded rail lines. However, it seems unlikely buses offer a permanent solution, for the following reasons:

- *Too slow.* As indicated, downtown buses average 3-5 MPH during peak periods, about the same speed as walking.

- *Not enough capacity.* U.S. transit buses on average can carry 75 passengers.[6] Accommodating 75K daily work trips would require an additional 1,000 daily bus trips on downtown streets that are already congested. This does not seem practical.

- *Too expensive.* CTA bus operating expense per passenger mile is triple that for rail – $1.15 for bus vs. $0.38 for rail as of 2014.[7] This is primarily a function of labor expense – carrying 75,000 riders requires 1,000 bus trips but only 150 rail trips using trains carrying 500 passengers.

- *Declining popularity with riders.* The data suggests riders prefer rail. For CTA bus routes serving downtown, ridership dropped 13% between 1999 and 2015 despite record central area employment; entering traffic at downtown "L" stops rose 49% during the same period.[8]

For these reasons, conventional bus (as distinct from bus rapid transit) does not seem a viable long-term solution and will not be considered further in this paper.

BRT, Light Rail, and Light Metro

The three remaining technologies – bus rapid transit (BRT), street (at-grade) light rail, and light metro (grade-separated rail) – would appear to be the most promising options for expanded central area transit. They have many characteristics in common:

- Dedicated right-of-way – at minimum, designated lanes on city streets.
- High-capacity vehicles or consists.
- Widely spaced stops, generally at least one-quarter or one-half mile apart. Stations often have distinctive architectural treatment and amenities such as canopies, lighting and posted schedules and maps.
- Off-board fare payment and multi-door boarding for reduced "dwell time" (standing time in stations).

Unique characteristics of each mode are briefly described below.

4. Bus rapid transit (BRT)

Figure E-6. Bus rapid transit (BRT) – Cleveland Health Line

BRT as implemented in the U.S. generally uses articulated buses having a capacity of about 100 riders – see Figure E-6. BRT vehicles travel primarily on dedicated lanes but can be routed around obstructions and where necessary can operate in mixed traffic. Crossings are at grade; traffic signal prioritization (TSP) technology is sometimes used to prevent stoplight delays.

5. Street (at-grade) light rail

Light rail is an evolution of streetcar technology. Vehicles operate on rails in dedicated right-of-way. This may be a dedicated lane in a city street (sometimes an entire street used for transit only) or a private ROW such as that used by railroads. Vehicles typically are powered by overhead electric wire – see Figure E-7. Vehicles can be trained together, their length limited by the distance between cross streets at station locations to avoid blocking traffic during boarding. Capacity varies in consequence but typically is in the range of 250 to 450. Crossings usually are at grade without gates; TSP is sometimes used. In many cases there are no barriers between the tracks and adjacent streets or sidewalks.

Figure E-7. Light rail – Minneapolis

Stations often have distinctive architectural treatment but in most cases are ungated (no turnstiles). Riders purchase proof-of-purchase tickets at vending machines and display them to roving fare inspectors on demand.

6. Light metro

Light metro is similar to light rail except that the right of way is mostly or entirely grade separated (no level crossings) – see Figure E-8. Grade separation provides many benefits:

Figure E-8. Light metro – Vancouver SkyTrain

- Higher speeds – trains do not need to stop for traffic lights and can be operated at rapid transit speeds (50 MPH+) when station spacing and other factors permit.
- Stations can be gated and enclosed, with platform-edge doors that align with vehicle doors when trains berth, providing weather protection – see Figure E-9.
- Since pedestrians and motor vehicles cannot gain access to tracks, centrally controlled automated operation is feasible. Some systems such as the Vancouver SkyTrain have no operators aboard trains, reducing labor cost.

Figure E-9. Platform-edge doors

In other respects light metro is similar to light rail. Trains are short and the vehicles are similar in appearance. If desired, light metro vehicles can be equipped with rubber tires to reduce noise.

BRT, Light Rail and Light Metro in Other Cities Compared

BRT, light rail and light metro operations in other cities were reviewed in Appendix D and summarized in Figure D-4. To recap:

- **Light metro carries the most riders.** Systems with the highest ridership per mile were primarily rail with grade-separated operation downtown (at least). Of the ten busiest systems, eight were grade-separated rail – i.e., light metro as defined in this report.
- **At-grade operation sharply reduces ridership.** Regardless of technology (BRT or light rail), systems operating at grade downtown (i.e., on city streets) have much lower ridership than grade-separated lines – typically one-half to one-quarter as many riders per mile.
- **At-grade light rail is not cost-effective.** Street light rail lines as a class do not carry more riders than BRT and often carry fewer. For example, Cleveland's Health Line, a BRT operation, carries 2,100 riders/mile compared to 600/mile for the city's two light rail lines. Given that at-grade light rail typically costs three times as much to build per mile as BRT ($100M/mi vs. $35M/mi), it is difficult to avoid the conclusion that light rail often does not justify the investment.[9]
- **BRT's chief advantage over light metro is lower construction cost.** BRT carries fewer riders per mile but is less expensive to build.[10]

There can be little doubt light metro offers the most robust transit solution, but it also has the highest capital cost. The difference in construction costs between transit technologies is explored in the next part of this report.

Figure E-10. Loop Link dedicated bus lanes

BRT Construction Cost

BRT construction cost varies but is lower than for rail. The Loop Link busway, launched in December 2015, consists of dedicated bus lanes extending 1.25 miles from Union Station to Michigan Ave. with raised platforms every two or three blocks (Figure E-10). Loop Link cost $32M, or ~$26M/mile. This is typical of U.S. BRT systems, which cost $20M-$35M/mile.

Rail Construction Cost

A preliminary estimate of rail cost was made based on comparable projects in Chicago and other cities:

- CTA Howard-Dan Ryan realignment (built 1985-1988, opened 1993)
- CTA Orange Line (opened 1993)
- Buffalo Metro Rail light rail line (opened 1984-1986)
- Vancouver SkyTrain – Canada Line (opened 2009)
- Minneapolis Metro Green Line (opened 2014)
- CTA Red Line extension to 130th St. (planned).

CTA Howard-Dan Ryan realignment. The Chicago Dept. of Transportation constructed a 4,400' track segment connecting the State St. subway with the Dan Ryan branch to create what is now the CTA Red Line. The northern portion consisted of a subway between the existing stub tracks at 13th St. and a new portal south of 16th St.; the balance was on embankment. The work was largely complete by 1988 although the tracks were not placed in service until 1993. The cost in 2015 dollars was $142M, or $170M/mile.[11]

Several factors simplified the project:

- The connection to the State St. subway was already in existence, having been provided in the 1930s for a never-built Archer Avenue extension.
- Most of the subway was constructed across then-vacant former railroad property – costs for property acquisition and utility relocation were low.
- The aboveground portion was likewise built on vacant land with ample room for construction access.
- Station construction and additional rolling stock were not required.

Accordingly, the Howard-Dan Ryan realignment should be seen as representing the lower bound of subway construction cost in Chicago.

CTA Orange Line. The Orange Line, which opened in 1993, involved construction of 9.2 miles of track, eight stations and a rail yard between Midway Airport and the existing elevated structure south of the Loop (see Figure E-11). The line, which is grade-separated and above ground for its full length, was built primarily on existing railroad embankments with connecting aerial structure. Minimal property acquisition was required. The cost in 2015 dollars was <$100M/mile.[12]

Figure E-11. CTA Orange Line at junction with existing elevated

Buffalo Metro Rail. Completed in 1986, Buffalo's Metro Rail line is 6.4 miles long, of which 5.2 miles, or more than 80%, is in subway (see Figure E-12). It can thus be characterized as light metro as defined in this report and may be taken as indicative of the cost of rail construction in a downtown environment. Adjusted for inflation, the cost of the Buffalo project per mile equates to $164M/mi in 2015 dollars.

Figure E-12. Buffalo Metro Rail

Canada Line – Vancouver SkyTrain. The Vancouver SkyTrain is an automated, grade-separated light metro system. The newest addition to the system, the Canada Line, was completed in 2009 and carries 136,000 riders per day. Of the line's 11.8 mile length, 5.6 miles is in tunnel (including both deep-bore and cut-and-cover), 5 miles is on elevated structure, and the remainder is at grade or on bridge.[13] The line's reported cost was of $1.89B in 2003 Canadian dollars,[14] or $155M/mile in 2015 U.S. dollars.

METRO Green Line (Minneapolis-St. Paul). The METRO Green Line, which opened in 2014, is an 11-mile light rail line between Minneapolis and St. Paul, with 9.8 miles newly constructed and the remainder shared with an existing line. The line operates at grade in an existing right of way. The project includes some bridge construction as well as infrastructure modification in downtown Minneapolis and St. Paul. The cost of the project in 2015 dollars was $962M, or $98M/mile.

CTA Red Line Extension to 130th. The estimated cost of the planned 5.4-mile extension is $180M/mile in 2015 dollars (yard/shop not included).[15]

Construction costs for the six systems are compared below.

Project	Construction type	2015 $/mi
CTA Howard-Dan Ryan realignment	Subway	$170M
CTA Orange Line	Existing rail embankment	$100M
Buffalo Metro Rail	Subway	$164M
Vancouver SkyTrain – Canada Line	Subway, aerial structure	$155M
Mpls-St. Paul Green Line	At-grade	$98M
CTA Red Line Extension to 130th	Aerial structure, at grade	$180M

These results suggest the basic capital cost of North American rail transit is $100M to $200M/mile, with projects involving subway construction at the high end of the range. The relatively high per-mile cost of the Red Line extension, which has no underground portions, may partly reflect the fact that fixed costs are spread over a shorter project. It should be noted that U.S. rail construction costs vary widely and the price of some projects has been exorbitant.[16] Nonetheless, the foregoing analysis suggests that:

- Use of existing rail ROW can greatly reduce costs.
- Underground construction is more costly than aboveground but not unreasonably so.

BRT, Light Rail and Light Metro Compared in Chicago

A comparison of BRT, at-grade light rail and light metro as they would likely be implemented in Chicago is provided in Figure E-13. Information in the table is drawn from the above cost analysis plus research conducted for Appendix D with adjustments based on the project team's knowledge of Chicago, including previous projects such as the Circulator.

As indicated, grade-separated light metro systems generally attain the highest ridership per mile, while at-grade light rail systems typically do no better than BRT. If grade-separated rail can be had for the same money as surface rail – as was true of the CTA Orange Line vs. the Minneapolis METRO Green Line – there seems no reason to choose the latter. Use of existing rail ROW, the key to the low cost of the Orange Line, thus warrants serious consideration.

COMPARISON OF TRANSIT TECHNOLOGIES AS THEY WOULD LIKELY BE IMPLEMENTED IN CHICAGO

Criterion	Bus Rapid Transit	Surface Light Rail	Light Metro
Right-of-way	Dedicated street lanes with ungated grade crossings and traffic signal prioritization.	Dedicated street lanes, presumably similar to proposed Circulator route	Dedicated guideway in or adjacent to existing rail ROW where possible, in some cases using aerial structure. Gated crossings needed in Carroll Ave.; possible surface operation to Navy Pier, Near North
Construction cost	\$20M – \$35M/mile	\$20M – \$100M/mile	\$100M – \$200M/mile
Method of operation	Manual	Manual	Potentially automated
Operating cost/passngr mile	\$0.46 (LA) – \$1.25 (NY)	\$0.63 (LA) – \$0.92 (Boston)	\$0.38 based on CTA rail
Speed of operation	Likely 9 MPH downtown; 13 MPH end-to-end (Cleveland)	9 MPH downtown, 19 MPH end-to-end (Minneapolis)	15.5 MPH downtown, 18 MPH Navy Pier to 18th/Pink (see Appendix K)
MOS end-to-end speed	13 min (9 MPH)	13 min (9 MPH)	7:47 (17 MPH)
Max vehicle/train length	60’ articulated bus	300’ Near North E-W blocks; 190’ Near North N-S blocks	225’ in Carroll Av.; 190’ if Near North street operation
Max riders/vehicle or train	100 per 60’ bus	200/95’ vehicle x3=600; likelier 200x2=400	160/75’ vehicle x 3 = 480
Typical ridership/mile	1.1K (LA) – 2.1K (Cleveland); 6.4K in NY atypical	800 San Jose – 3.2K Hudson-Bergen Light Rail	8K Miami – 13k London DLR; 2K Detroit anomalous
Max riders/hour	100x20 buses/hr = 2K	600x12 trains/hr=6K; more likely 400x10 trains=4K	480x20 trains/hr=9.6K
Development stimulus potential	Limited – not easily extended to outlying vacant sites	Limited – not easily extended to outlying vacant sites	Good – easily extended to outlying sites
Weather protection	Bus shelters	Bus shelters	Platform-edge doors
Political prospects	Fair – dedicated lanes on Kinzie would face opposition	Fair to poor – based on Circulator experience, Kinzie St. ROW would face strong opposition	Good – preliminary reaction positive. Howard/Dan Ryan realignment, Orange Line, Red Line extension supported by public
Fare collection	POP off-board ticketing	POP off-board ticketing	Gated throughout
Extension prospects	Limited – no easy thru routes	Limited – no easy thru routes	Good within 3-4 mile radius; potential capacity issues if used for long-haul service due to short trains

Figure E-13. Comparison of transit technologies

Could Large-Scale BRT Work in Chicago?

Although the factors reviewed to this point would appear to favor light metro, a question that must be asked given the city's financial situation is whether there is any credible scenario in which BRT could significantly increase Chicago transit capacity. The following observations are offered:

1. The two cited Select Bus Service routes in New York, which have BRT-like features, carry ~6K riders/mile. This is much higher than the other U.S. BRT systems surveyed and reflects the high ridership of all New York transit modes. Nonetheless, it shows that U.S. BRT implementations can carry heavy passenger loads under the right circumstances.

2. The immediate challenge in Chicago is to relieve overloading of north side "L" lines. Michigan Avenue north of the river is the city's busiest bus corridor; the 10 local and express routes that travel on some portion of the street carried 84K riders/day as of October 2015.[17] If BRT or dedicated bus lanes could be implemented on Michigan Avenue and North Lake Shore Drive – surely the most promising corridor for high-volume BRT due to population density – a large fraction of the overflow from north side "L" lines potentially could be accommodated.

3. However, it is difficult to see how this would work as a practical matter. If it is assumed that an additional 75K daily trips were to be carried by an LSD/Michigan Avenue BRT operation, total daily bus ridership in the corridor would approach 160K, or 1,600 busloads using high-capacity vehicles. Providing dedicated lanes on Lake Shore Drive and Michigan Avenue to accommodate this volume of traffic would require construction of new lanes or banning of autos from existing ones, neither of which seems politically likely. In addition, providing sufficient bus operators would be costly.

No doubt there are situations in which BRT can be beneficial, such as Loop Link and Jeffrey Jump. But it does not seem plausible that BRT could accommodate demand growth on the scale required, namely 75K daily trips. While BRT is an improvement over conventional bus, it has many of the same limitations, namely low speed and capacity relative to rail. Moreover, to stress a point made earlier, a bus-based solution flies in the face of the long-term trend. As shown in Appendix D, the shift from bus to rail is a nationwide phenomenon. Chicago surface ridership (i.e., on buses and previously streetcars) is at its lowest since at least 1906.[18] In 2014, rail ("L," Metra, and South Shore) overtook bus as the major provider of Chicago transit trips – more than 1M rides (Figure E-14). If the present trend continues, "L" ridership will surpass CTA bus ridership in a few years. It seems clear that, while BRT or increased bus service may be useful as an interim measure, neither is a long-term solution.

The remainder of this analysis assumes that light metro is the preferred technology for expanded central area transit.

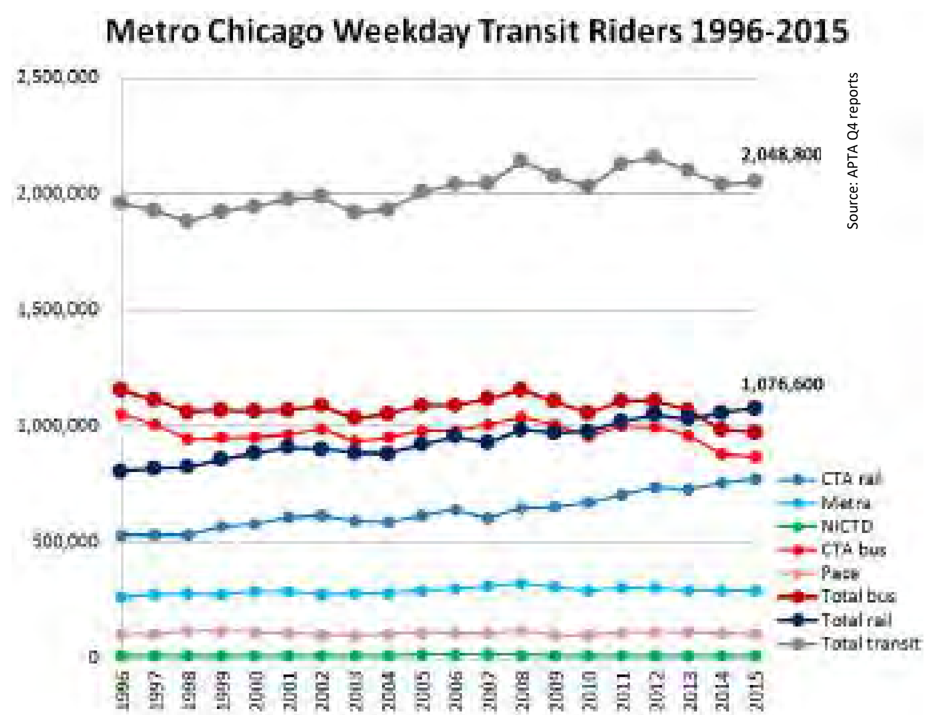


Figure E-14. Bus vs. rail trend

Evaluating Route Options

Once a technology has been selected, a route must be chosen. The first step is to identify likely corridors. Since central area transit has been extensively studied, the task of the present investigation was primarily to review corridors previously proposed. Several additional corridors were also identified. Potential corridors are shown in Figure E-15 and discussed below.

Corridor	From	Remarks
1 – North	CAAP	Bypass for overtaxed north side 'L' lines; would open large vacant tracts to development
2 – Kinzie/ Carroll	CAC	Links near north side to West Loop Metra stations
3 – North Michigan	CCATP	Desirable but challenging – high foot, bus traffic, but local opposition, area fully built out
4 – Navy Pier	CAC	Navy Pier a logical endpoint; alignment a challenge
5 – Clinton/ Canal	CAP	Serves West Loop Metra stations
6 – Cross-Loop	CCATP	Highest foot traffic, but surface traffic congested, underground expensive, aerial impractical. Served by recently launched Loop Link BRT
7 – Central Lakefront	CCATP	Right-of-way available, serves tourist attractions, but duplicates Loop rail service, corridor already has high development interest
8 – Congress	New	Segment from Clinton to LaSalle needed for link to LaSalle Street Station
9 – South Canal	CAAP	Crosses low-density industrial district reserved for support uses
10 – Wells/ Wentworth	CCATP	N/S route a long-time city goal; opens vacant riverside tracts to development
11 – Roosevlt	New	Needed for museum campus link, 'L' transfer
12 – Nr South Lakefront	CCATP	Easiest route to McCormick Place – key destination, high development potential, Metra Electric connection
13 – Cermak	New	Alt route to McCormick; potential development corridor
14 – S Lakefrt	New	Long-term development opportunity
15 – 16th St.	New	Underserved corridor, potential yard site
CCATP – 1968 Chicago Central Area Transit Plan. CAC – 1987 Central Area Circulator. CAP – 2003 Central Area Plan. CAAP – 2009 Central Area Action Plan		

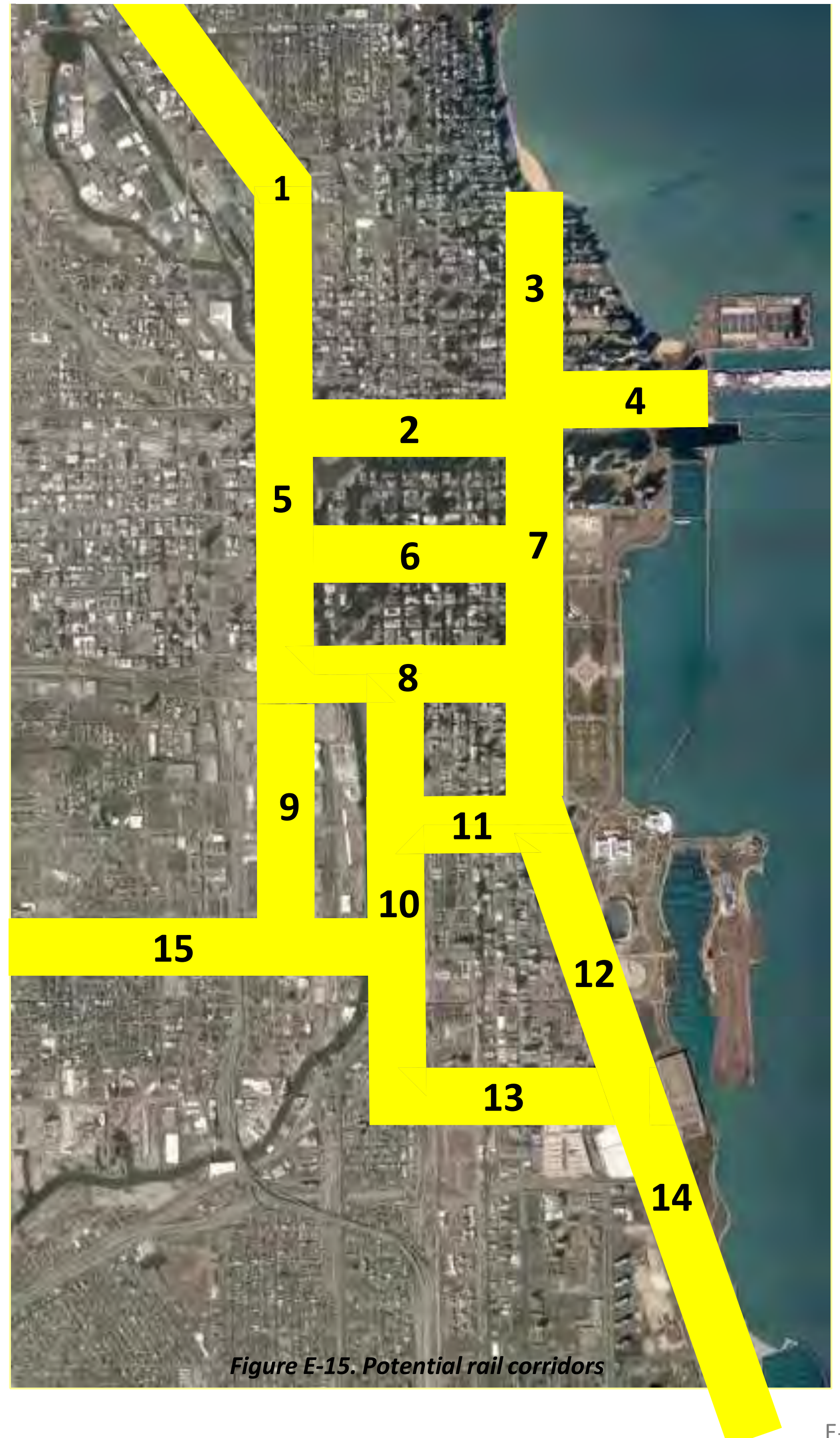


Figure E-15. Potential rail corridors

Figure E-16. Proposed Connector route

In evaluating potential routes, it was judged that a new central area transit line should meet the following criteria:

1. Ease crowding on the busiest CTA rail lines.
2. Link all four downtown Metra operations to CTA rail.
3. Provide easy transfer to all existing downtown "L" lines.
4. Improve access to downtown destinations currently difficult to reach via the "L," Metra or both.
5. Improve circulation within the urban core.
6. Provide access to vacant or underutilized parts of the central area.
7. Provide dedicated right-of-way and grade separation to the extent practical for higher speed and capacity.
8. Provide underserved communities with better access.
9. Include provision for a storage yard and maintenance facility.
10. Reinforce the river and south lakefront as high-quality development corridors.
11. Be buildable in phases.

Based on these criteria, the route plan shown in Figure E-16 was devised. The chart below indicates the manner in which the proposed line, called the Connector, meets the indicated criteria:

No.	How Proposed Connector Meets Criterion
1	Red/Brown bypass at North/Clybourn – Brown Line stop to be built.
2	Links Ogilvie, Union, LaSalle St. stations plus Metra Electric 23rd St. stop.
3	Transfer points at most locations where new line crosses existing "L."
4	New line serves River North, North Michigan Avenue, Streeterville, Navy Pier, the West Loop office district, the Museum Campus, and McCormick Place.
5	Places most of central area within walking distance of rail stops.
6	Provides access to large vacant tracts on near north and south sides.
7	Much of route in or adjacent to existing rail ROW, public property, or vacant land, providing opportunities for grade-separated operation.
8	Provides access to Cabrini redevelopment sites, Pilsen, and Bronzeville.

No.	How Proposed Connector Meets Criterion
9	Yard site identified adjacent to 16th St. viaduct in Pilsen.
10	Line parallels river or lakefront for most of its length.
11	2-mile “minimum operable segment” identified – see below.

Route Selection Notes

Future lakefront line. Lakefront service using the existing railroad right of way between Roosevelt and Randolph and continuing north via the North Michigan Avenue corridor was considered but not included due to the abundance of existing transit and alignment challenges north of the river. However, a lakefront line would serve many popular attractions and the rail right of way is available, making this an option worthy of further study.

Loop crossing. An east-west Loop crossing at Monroe was considered but deemed impractical for the following reasons:

- A subway beneath Monroe was proposed in 1968 (see Appendix C) and since then the alignment is said to have been kept free of underground utilities (presumably major sewers; some manholes are visible). However, preliminary inquiry indicated the cost would be prohibitive.
- Aerial construction did not seem practical because of the Loop elevated and would not be aesthetically desirable.
- At-grade light rail was proposed as part of the Circulator project (Appendix C) but was strongly opposed by some major commercial property owners. Investigation of light rail in other cities suggests that at-grade lines generally have slower operating speeds and lower ridership than grade-separated systems, and are not cost-effective relative to BRT for the traffic volume typically carried (Appendix D).
- The Loop Link bus facility was already under construction and seemed the most practical way to speed east-west Loop travel.

Notwithstanding the above, if rapid transit were to be established in the existing lakefront rail corridor, a Monroe St. subway would provide an advantageous point of entry into the CBD. Accordingly it is recommended

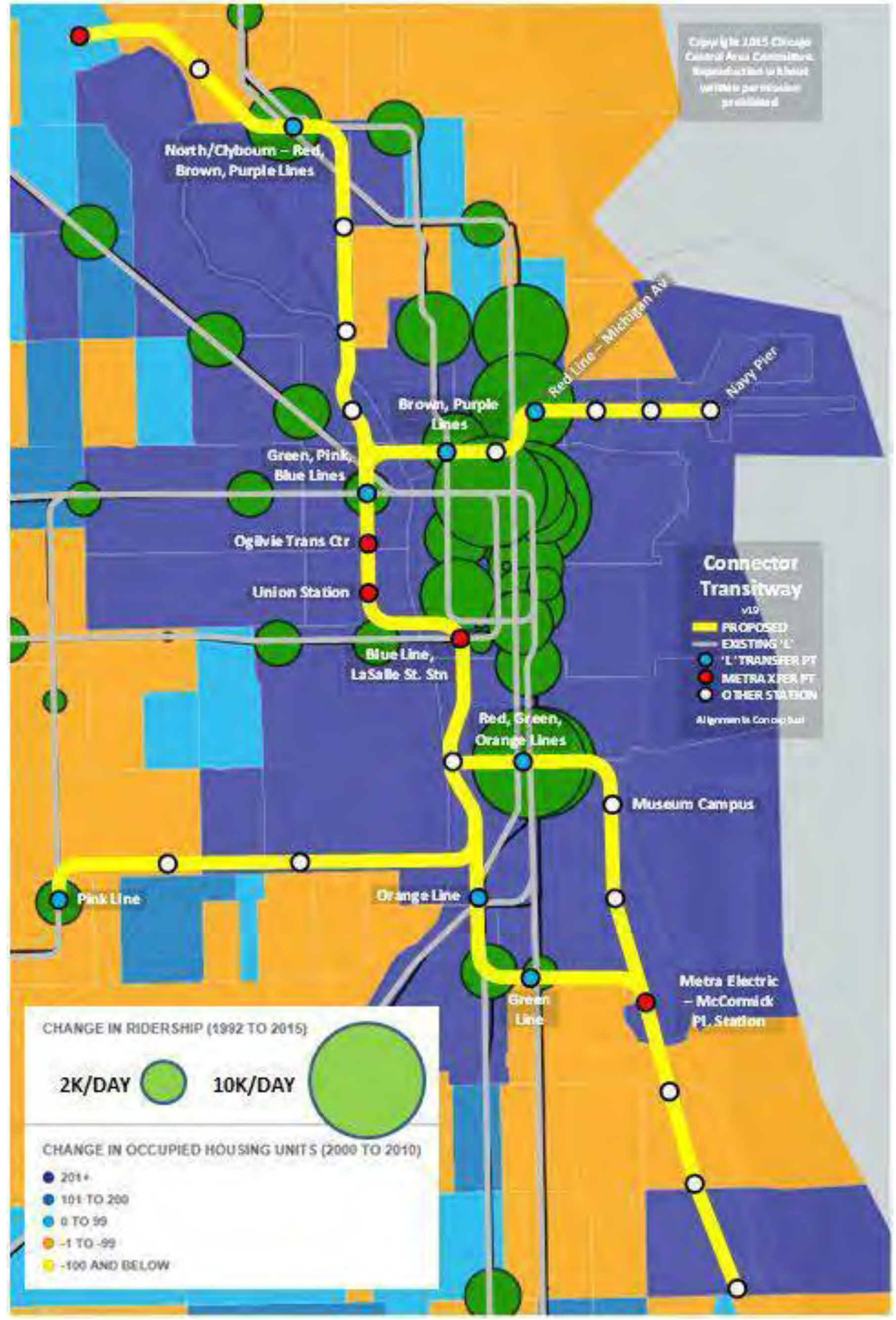


Figure E-17. Proposed Connector route vs. household, “L” ridership growth that the city continue to discourage underground utilities or other construction that would impede such use.

Correspondence of proposed route to household growth. When the proposed route diagram is overlaid on a map of central area census tracts experiencing household growth, it is apparent the two correspond to a remarkable degree, particularly in outlying areas – see Figure E-17. Although not an explicit goal in devising the route, this correspondence suggests the Connector has a good probability of success in facilitating development in

these locations.

Reconfiguration of "L" as a grid. As shown in Figure E-18, the Connector would represent a significant step in transforming the current system of radial "L" lines into a grid, improving access to underserved areas and

Minimum Operable Segment

A key criterion in devising a route is that it be buildable in phases to simplify financing. Federal funders tend to favor projects with a relatively inexpensive first phase, known as a minimum operable segment (MOS). As explained in the main text of this report, the proposed MOS for the Connector would extend from Union Station to Columbus/Illinois, a distance of approximately two miles (Figure E-19).

MOS ridership. An initial attempt to estimate ridership was unsuccessful due to the limitations of the tool used, the FTA's STOPS program – see Appendix I. Ridership will be estimated using more suitable tools in the next phase of this study. Ridership for systems comparable to the proposed Connector (see Appendices D and J) varies widely, from fewer than 1,000 weekday riders/mile to more than 13,000 (London's Docklands Light Rail); the busiest North American systems carry 6,500-10,000/mile. All these systems benefit from policies, conditions, and design features conducive to transit use.

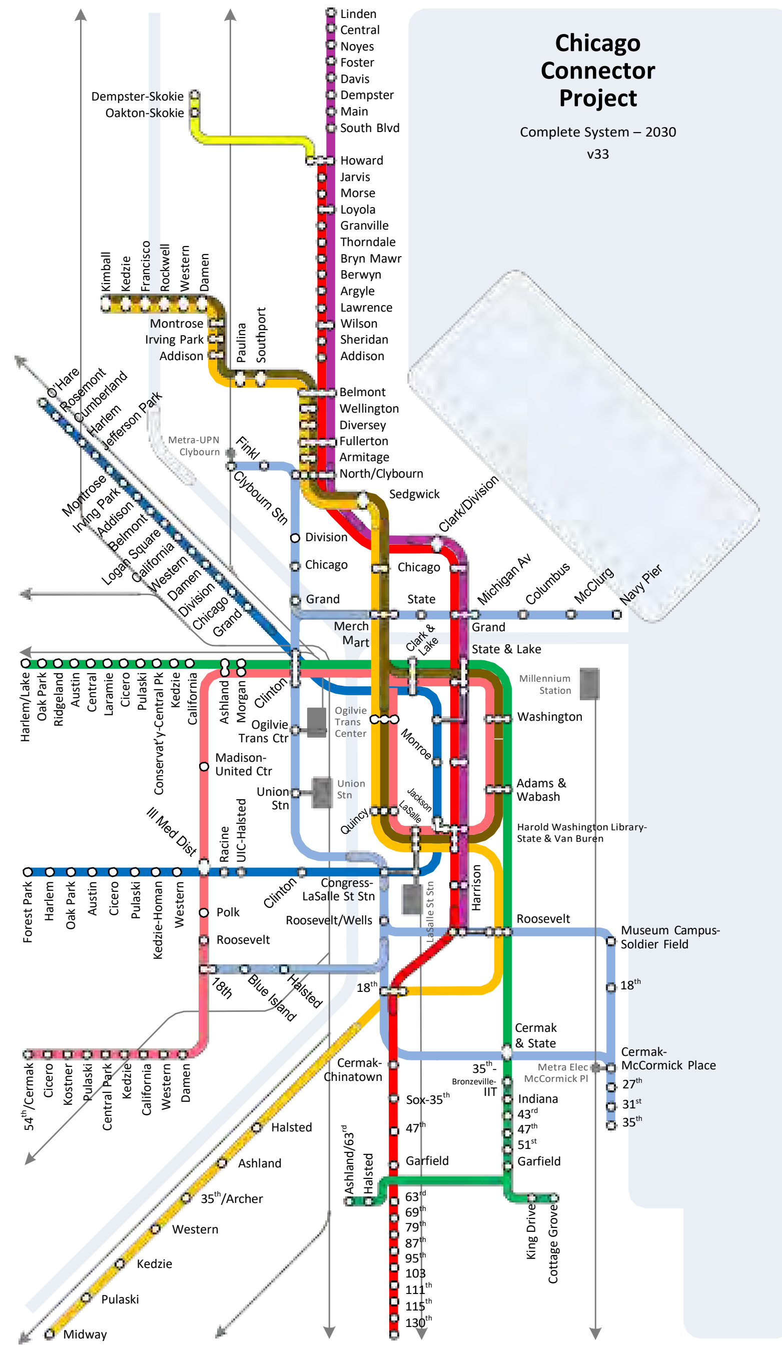


Figure E-18. CTA rail system on completion of Connector

Figure E-19. Minimum operable segment (MOS)

Pending further investigation, it seems reasonable to believe weekday ridership in the range of 13,000-26,000 represents the upper bound of what is attainable on the two-mile MOS if a favorable environment can be achieved – in particular, dense residential and commercial development within the corridor, grade-separated operation, and integration with existing rail facilities, ideally including some degree of fare integration with Metra.

MOS running time. As described in Appendix K, Connector running times were estimated using a computer model developed by Mott MacDonald. Assuming grade-separated operation, the MOS route as depicted in this document, vehicle operating characteristics similar to those of CTA rail cars, and 20-second dwell (standing) time in stations, the model calculates that the trip from Union Station to Illinois/Columbus would take 7 minutes and 47 seconds via light metro under baseline conditions (moderate load) vs. 13 minutes for BRT. The BRT running time is based on systems in other cities with less congested conditions and is likely optimistic.

Operating Revenue and Expenses

Estimation of operating revenue and expenses of the proposed improvement was beyond the scope of this study and will be investigated in the next phase of planning. Pending such study, it is believed the Connector's fare recovery ratio and operating expense per passenger mile will be comparable to those for CTA rail based on the following assumptions:

- The Connector will be integrated with CTA from an operating and fare standpoint. CTA personnel will operate and maintain the system, the fare will be the same as that for CTA rail, and free transfer with connecting CTA rail lines will be provided.
- Maintenance of way costs will be comparable to those for CTA rail; however, see discussion of signaling below. Vehicle maintenance costs will be higher than for CTA rail at the outset, since rolling stock will be different, a separate maintenance facility and parts inventory will be needed, and CTA maintenance personnel will require additional training. (Property between the UP and BNSF viaducts at 16th and Ashland is proposed for the Connector maintenance facility.) It is expected that the basic technology used by Connector vehicles (electric traction) will be similar to that of the "L," and no additional trades will be needed; over time, Connector vehicle maintenance costs should approach those of the "L."
- Costs for information technology (IT) and signaling will be higher, since the Connector will utilize automatic train control, which is not used by CTA. Although ATC is a proven technology, adaptations will need to be made to accommodate motor vehicle operation and service access in the Carroll Ave. ROW. Since the Connector will be expanded

incrementally and train control will become increasingly complex, ATC development and support will be a cost item for an extended period.

- The principal source of new fare revenue for the MOS will be (a) Metra riders who previously reached their final destinations by means other than CTA; (b) central area residents and others making trips to, from or within the MOS catchment area that previously involved means other than CTA; and (c) new trips generated by development within the MOS corridor.

- All stations will have controlled access (turnstiles) and at least one attendant, as with CTA rail. Ungated stations as seen on many light rail and light metro systems are not considered feasible since anticipated free transfer to the "L" would invite fare evasion. Unstaffed entrances using rotogates are in service at some "L" stations now; it may be possible to operate some outlying Connector stations on a gated-but-unstaffed basis depending on traffic volume.

- It is not assumed free transfer from Metra will be provided. However, a degree of fare integration is desirable – for example, a Ventra-type fare card usable on both Metra and CTA.

- Trains will be under automatic control but for safety reasons will require an onboard attendant on the MOS. London's Docklands Light Rail, though automated, is staffed by attendants who operate trains underground and remain on board at other times. If later extensions of the Connector are fully grade separated with enclosed platforms as now contemplated, it may be possible to require attendants on the north bank leg of the MOS only; this will reduce labor costs, which are the largest component of operating expense. In 2015, CTA labor costs accounted for ~77% (>$1B) of operating expenses before depreciation, etc., of ~1.35B.[19]

  The Vancouver SkyTrain has no attendants and typically recovers >90% of its operating costs from fares. It seems unlikely this can be achieved on the Connector due to the requirement for some attended operation. However, when fully built out the line's fare recovery ratio (operating revenue over operating expenses) should be significantly better than CTA's 2015 ratio of 35% ($631M/$1.82B).

To be clear, the Connector will not be a profit center and operation will entail some additional outlay, as is true of most transit. However, there is reason to believe grade-separated light metro, if it can be achieved, provides the most economical and practical means of accommodating expected demand growth of any available technology.

Advantages of Proposed Light Metro System

The light metro system described in this report offers the following benefits:

- **High speed.** Light metro would use a largely grade-separated right of way and would be capable of significantly higher average speeds than technologies such as BRT or light rail that operate on city streets. Preliminary feasibility of grade-separated operation has been established for the north bank leg of the MOS, the most challenging segment.

- **Reasonable construction cost.** A preliminary MOS construction budget of $750M, or $375M/mile, is provided in Appendix F. The MOS is the most complex part of the proposed system. Assuming advantage can be taken of existing rail ROW and vacant property for extensions into outlying areas, the per-mile cost of subsequent phases should be less.

- **Low operating cost.** Light metro systems such as the Vancouver SkyTrain are fully automated, with no operators aboard trains, and recover a high percentage of their operating costs from fares. Because of grade crossings, driverless operation is not expected to be practical in the MOS but would be possible in later stages if grade-separated operation can be achieved.

- **Weather-protected operation.** Platforms can be enclosed, with platform-edge doors that align and open in tandem with doors on vehicles. Automated operation is required to ensure precise alignment.

- **Higher capacity.** The envisioned light metro system could accommodate 450-600 riders/train, depending on train dimensions. The typical BRT vehicle is an articulated bus with a capacity of 100 riders. Surface light rail vehicles can be coupled into trains but length is limited by city block size (so cross traffic is not blocked when a train is stopped at a station); a typical light rail consist carries about 250 riders.

- **Greater development stimulus.** Developers generally prefer rail over bus since rail service cannot be easily withdrawn.

- **Relatively short construction timeframe.** Assuming no major issues emerge during final scoping, it is reasonable to believe the MOS could be brought online within 7-10 years, in time to avert the overcrowding scenario described in Appendix A.

- **Easy extension.** Assuming the grade-separated solution described in this document can be achieved, the system can be more readily extended to outlying neighborhoods than surface solutions, which would be slower and more likely to face local opposition.

- **An easier sell.** At-grade solutions are highly visible, potentially affecting hundreds of property and business owners, and often generate strong opposition. The north bank leg of the MOS, in contrast, would be largely hidden from view and would directly affects about two dozen properties. Property owners and managers contacted to date are supportive.

- **Congestion-proof.** As seen in Appendix A, the central area population is likely to grow by ~100K (57%) between 2000 and 2020. More downtown residents will surely mean more motor vehicle traffic, slowing any surface solution. Grade-separated rail is immune to this problem.

Based on the foregoing, light metro as defined in this document appears to offer the most advantages and is recommended for further study. Models for the system envisioned include London's Docklands Light Rail and the Vancouver SkyTrain, and to a lesser extent the Miami MetroMover (see Appendix J).

NOTES

[1] Derived from Google Maps Transit Trip Planner (travel time), Google Earth (distance).
[2] Joseph Schwieterman, director, Chaddick Institute for Metropolitan Development, DePaul University, cited in Joe Cahill, "We need a transit system that works for our economy, not pols," *Crain's Chicago Business,* Sept. 4, 2013, www.chicagobusiness.com/article/20130904/BLOGS10/130909964/we-need-a-transit-system-that-works-for-our-economy-not-pols, accessed 2/10/2016
[3] Chicago Dept. of Transportation, "Central Loop BRT (East-West Corridor)," presentation, www.cityofchicago.org/content/dam/city/depts/cdot/CDOTProjects/Central_Loop_BRT_Presentation_5.12.pdf, accessed 2/10/2016.
[4] Chicago Department of Transportation, *Chicago Union Station – Existing Conditions Report for Street-Level Operations,* November 2011, www.unionstationmp.com/wp-content/uploads/2012/05/Appendix-B-Street-Level-Operations.pdf, accessed 5/17/2006, p. 12.
[5] 2000 numbers derived from decennial U.S. census; 2014 numbers from 1-year ACS. Since these datasets are collected in different ways, direct comparison of quantities (e.g., subtracting a figure for 2000 from one for 2014) is inadvisable and is done here solely to give a sense of scale.
[6] Transit Research Board, *Transit Capacity and Quality of Service Manual, 2nd Edition,* Part 4 – Bus Transit Capacity, Ch. 1 – Bus Capacity Fundamentals, Exhibit 4-17, "Characteristics of Common Bus Transit Vehicles – United States and Canada," onlinepubs.trb.org/onlinepubs/tcrp/tcrp100/part%204.pdf, accessed 5/10/2016.
[7] Federal Transit Administration – National Transit Database, "Chicago Transit Authority (CTA) – 2014 Annual Agency Profile," www.transit.dot.gov/sites/fta.dot.gov/files/docs/50066.pdf, accessed 8/11/16.
[8] Based on analysis of 1999 vs. 2015 data from CTA, "Ridership Reports," *op.cit.,* for bus routes entering or "L" stations within district bounded by lake, North Ave., Ashland Ave., and Stevenson Expressway.
[9] This finding is consistent with that reported by the U.S. General Accounting Office in "Mass Transit: Bus Rapid Transit Shows Promise," Report to Congressional Requestors #GAO-01-984, September 2001, www.gao.gov/new.items/d01984.pdf, accessed 5/14/2016: "The Bus Rapid Transit systems generally had lower capital

costs per mile than the Light Rail systems in the cities we reviewed ... [T]he largest Bus Rapid Transit system [had] ridership about equal to the largest Light Rail ridership. Finally, Bus Rapid Transit routes showed generally higher operating speeds than the Light Rail lines in these cities."

[10] BRT operating costs may be higher than those for rail but the available data as reported to the Federal Transit Administration's National Transit Database does not permit a firm conclusion to be drawn. The following data for the four agencies with BRT described in Appendix D is from the NTD's *2014 Annual Agency Profile* for each agency, www.transit.dot.gov/ntd/transit-agency-profiles, viewed on 8/11/16. CTA included for comparison.

OPERATING EXPENSE PER PASSENGER MILE				
Agency	**BRT**	**Bus**	**Heavy Rail**	**Light Rail**
Boston (MBTA)	$1.11	$1.38	$0.54	$0.92
Cleveland (GCRTA)	$0.53	$1.15	$0.75	$0.80
Los Angeles (LACMTA)	$0.46	$0.65	$0.52	$0.63
New York (NYCT)	$1.25	$1.64	$0.45	—
Chicago (CTA)	—	$1.15	$0.38	—

The reasons for the variation in BRT costs require investigation but may reflect slower operating speeds in Boston and New York.

[11] Based on analysis of project records kindly provided by EJM Engineering, Chicago.

[12] Washburn, Gary, "Midway 'L' Finally Ready to Roll," *Chicago Tribune,* October 31, 1993, articles.chicagotribune.com/1993-10-31/news/9310310190_1_orange-line-chicago-transit-authority-rail, accessed 5/17/2016.

[13] InTransitBC, "Canada Line Fact Sheet No. 26," April 5, 2007, www.worksafebc.com/news_room/news_releases/assets/nr_07_10_03/canadaline_factsheet.pdf, accessed 5/17/2006.

[14] Canada Line Rapid Transit Inc., *Canada Line Final Project Report – Competitive Selection Phase,* April 12, 2006, http://www.partnershipsbc.ca/files-4/documents/Canada-Line-Final-Project-Report_12April2006.pdf, accessed 5/17/2016, p. 15.

[15] Chicago Transit Authority, *CTA Red Line Extension Alternatives Analysis – Locally Preferred Alternative Report,* August 2009, www.transitchicago.com/assets/1/planning/Red_Line_Extension_Locally_Preferred_Alternative_Report.pdf, accessed 5/17/2016, p.88-89.

[16] See for example Smith, Stephen, "U.S. Taxpayers Are Gouged on Mass Transit Costs," Bloomberg View, August 26, 2012, www.bloombergview.com/articles/2012-08-26/u-s-taxpayers-are-gouged-on-mass-transit-costs, accessed 2/11/2016.

[17] Based on data from CTA, "Monthly Ridership Report – October 2015," www.transitchicago.com/assets/1/ridership_reports/2015-10.pdf, accessed 5/17/2016.

[18] Chicago surface ridership from 1906 to 1970 available in Condit, Carl, "Table 7 – Revenue Passengers Carried by Chicago Transit Authority and Predecessor Companies, 1906 to 1970," *Chicago 1930-1970: Building, Planning and Urban Technology* (Chicago: University of Chicago Press, 1974), p. 302. Bus ridership from 1961 to 2006 obtained from CTA, "Annual CTA Ridership, 1961 to Current," provided July 24, 2007 in response to FOIA request. Subsequent bus ridership from CTA, "Ridership Reports," www.transitchicago.com/ridership/.

[19] Chicago Transit Authority, "Financial Statements and Supplementary Information – Years Ended December 31, 2015 and 2014," www.transitchicago.com/assets/1/finance_budget/CTA_-_Financial_Statments_-_Final_-_12-31-15.pdf, accessed 8/12/16.

Appendix F – Financing the Minimum Operable Segment

The central area tax base is large enough to support a grade-separated rail solution

A broad-brush review of grade-separated rail construction costs was provided in Appendix E. Although a detailed cost analysis must await the next phase of investigation, a goal of this report was to determine whether sufficient local resources were available to fund the minimum operable segment (MOS). The project team developed the first-pass MOS estimate below based on (a) costing prepared by the CTA for the Red Line extension to 130th Street in 2009[1] and (b) typical transit industry practices and pricing:

COST ITEM	$(M)	REMARKS
Guideways and track elements	100	$50M/mi
Stations and terminals	300	7 stations
Sitework and special conditions	60	Inc. viaduct, bridge work
Systems (power, signals, etc.)	50	
Right-of-way, land acquisition	25	
Maintenance facility	12	
Vehicles	72	16 vehicles @ $4.5M
Professional services	112	15% of contract
Unallocated contingency	19	
TOTAL	**750**	
Capital cost per mile	375	

Note:

- The MOS is defined as Union Station to Columbus/Illinois (~2 miles).
- All costs and revenue amounts in this report are in 2015 dollars to facilitate comparison and have not been inflated for year of expenditure. Nominal dollar expenditures should the project proceed will be greater than shown here.
- The MOS cost of $750M is order of magnitude only. Sitework and land acquisition costs are speculative. Per-mile MOS cost is higher than for the system as a whole due to the complexity of downtown construction, close-spaced stations, and fixed costs spread over a small base.

Local Funding Approach

Numerous funding sources were considered. It was concluded that:

- The federal government could be expected to cover 50% of the project cost at most, and it was imperative that the project not tap U.S. funding sources needed for the maintenance backlog at the CTA and other local agencies. See "Federal Funding Strategy" below.
- A funding mechanism for the local share of the project that would capture some of the increase in property values catalyzed by the proposed improvement was desirable because (a) it would make the project self-funding with respect to the local share and (b) the cost would be borne by the property owners who directly benefited. The two value capture mechanisms well established in Illinois are:
  - Tax increment financing (TIF), in which a public work is funded using bonds repaid by the increase in property taxes generated by the project. The General Assembly recently revised the Illinois TIF law to provide for "transit TIF" districts having a 35-year lifespan reflective of the longer time needed to implement and amortize transit improvements. Transit TIFs are currently restricted to four projects: (1) Red Purple Modernization, (2) the Red Line Extension, (3) Blue Line Modernization, and (4) the Chicago Union Station Master Plan. The first three projects are described in Appendix B.
  - A special service area (SSA), in which the improvement is funded by a special tax on property within a defined district benefiting from the project. As property values within the SSA rise, so does the SSA tax yield.

- Both mechanisms have their advantages. A transit TIF district can be readily created by the City; an SSA places the tax burden on those who benefit. In addition, the SSA tax levy applies to the existing tax base and as such is favored by the capital markets. Downtown commercial property owners had agreed to a special service area to fund the Circulator project in the 1990s (see Appendix C). Since expanded central area transit would directly benefit central area property owners, it seemed reasonable to tax them to pay for the project.
- The project team found support for an SSA in meetings with property owners along the MOS. A likely capital structure for the Connector would involve a combination of an SSA, a transit TIF and a mix of federal grant and credit enhancement programs.

Funding Analysis

We examined whether the central area tax base was large enough to fund the project if an SSA were created. An analysis of the likely yield was conducted using the following procedure:

1. Assessed value for all central area real estate as computed by the Cook County assessor was fed into a geographical information system (GIS) containing a database of all downtown land parcels.
2. The location of proposed stops on the Connector transitway was also input into the GIS and used to map "walksheds" – that is, all parcels any portion of which was within a five-minute walk (400 meters) and a ten-minute walk (800 meters) of each stop. The resulting map is shown in Figure F-1.
3. The GIS was then used to calculate aggregate assessed value for three scenarios:

    a. Parcels within a five minute walkshed of a Connector stop.

    b. Parcels within a ten minute walkshed.

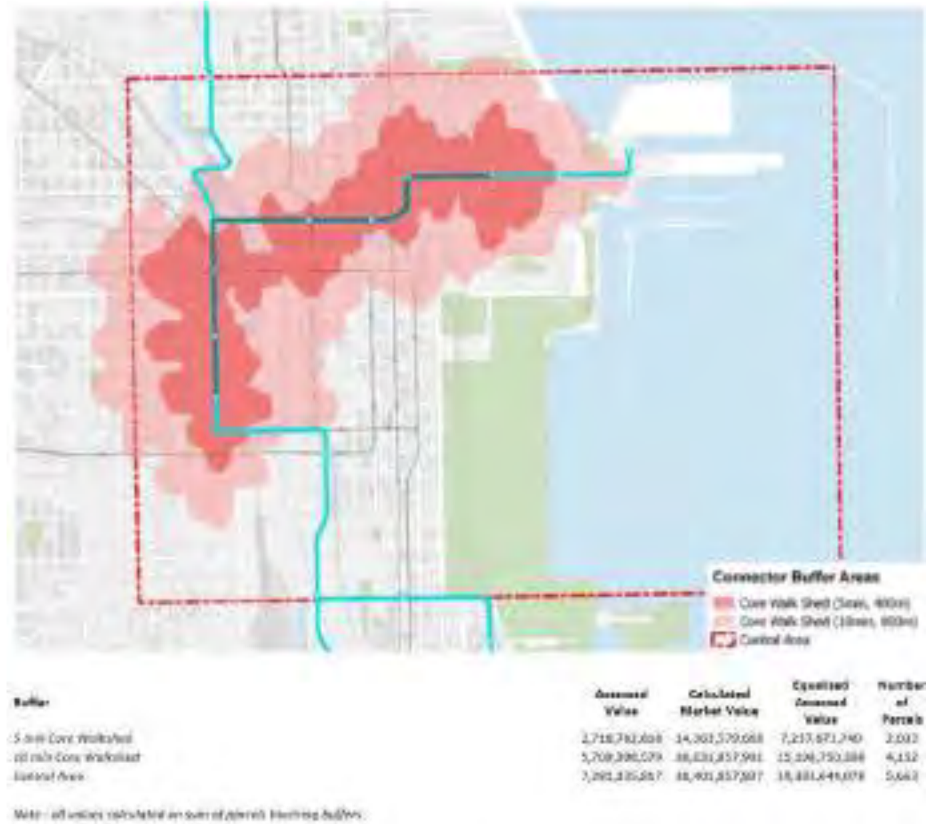


Figure F-1. MOS walksheds

    c. Parcels within the central area, defined as Chicago Avenue on the north, Roosevelt Road on the south, Halsted Street on the west, and Lake Michigan on the east.

    The totals for the three scenarios are shown in Figure F-1.

4. Net bond proceeds were estimated based on various SSA boundary scenarios and tax rates – see Figure F-2. **NOTE:** The SSA projections indicated do not exclude properties in overlapping TIF districts.

Net Bond Proceeds of 30 Year SSA Financing in 2017 $s

	Contribution Area		
SSA Tax Rate	5 Minute Walk Area	10 Minute Walk Area	Central Area [1]
0.25%	$181,000,000	$380,000,000	$484,000,000
0.50%	$362,000,000	$760,000,000	$969,000,000

[1]Chicago to Roosevelt; Halsted to Lake Michigan

Notes:

SSA Cash Flow Projection Assumptions

Projections are based on existing EAV only and assume 2% annual EAV inflation applied triennially

Projections are conservative as they do not assume any new value from development

Bonding Assumptions

5% interest rate on 30-year revenue bonds

175% Debt Coverage

Issuance costs and debt service reserve are assumed to be 13.6 % of net proceeds

Figure F-2. Projected SSA proceeds

Conclusion: Assuming $750M MOS cost and 50% local share, the existing tax base is sufficient to cover the cost of light metro construction on conservative assumptions (only properties within 10 min of a stop are taxed at a rate of 0.25%).

Federal Funding Strategy

Having consulted with public agencies, the white paper project team agreed transit expansion, while desirable, must not tap funding sources that CTA relies on to fund its capital projects. The following observations were made:

- Either a TIF or an SSA would generate a funding stream that would not exist if not for the project. This would be used to generate the local share of the project's cost.

- The project would be eligible for federal funding under at least two programs:

  – Transportation Infrastructure Finance and Innovation Act (TIFIA), a low-cost loan program. TIFIA is expected to have sufficient funding to meet the needs of both the Connector and CTA. If a TIFIA loan were obtained, a means to pay it back could be structured using a combination of an SSA and a transit TIF.

  – Federal Transit Administration (FTA) New Starts, a discretionary grant program that funds new rail transit systems and extensions of such systems. CTA will likely also apply for New Starts funding for various projects. Agreement would need to be reached regarding the timing and prioritization of funding requests.

TIFIA, FTA New Starts, and other federal transit funding programs are described in Appendix H. Use of the various local and U.S. funding tools will need to be carefully calibrated to ensure all essential city transit projects are completed in a timely manner. Nonetheless, preliminary analysis suggests sufficient resources are available.

NOTES

[1] Chicago Transit Authority, *CTA Red Line Extension Alternatives Analysis – Locally Preferred Alternative Report – August 2009,* www.transitchicago.com/assets/1/planning/Red_Line_Extension_Locally_Preferred_Alternative_Report.pdf, accessed 5/15/2016, p. 88-89.

Appendix G – Analysis of Rail Transit's Development Impact

Rail is critical to downtown development, but the existing core is nearing full buildout. New rail would add needed land

A goal of this report was to quantify the degree to which rail transit had shaped Chicago development and to use this as a guide to projecting the impact of new rail. These questions were analyzed by a team from S.B. Friedman Development Advisors (SBF), Skidmore Owings & Merrill (SOM), and the engineering firm of Mott MacDonald (MM). Conclusions:

- Rail transit is a major driver of central area development. Of 92M GSF built since 1995, 85% was within walking distance of a rail stop.
- More than 90% of <u>office</u> development, and 46% of <u>all</u> development, occurs within the "rail hub" – that is, the portion of the central area within walking distance of both the "L" and Metra.
- Lack of rail access deters development. Parts of the central area without rail account for 42% of the land area but only 15% of development.
- The rail hub has sufficient sites to absorb ~38M SF of additional space of all types. Given the scale of development projected for 2016-2035, the hub will be fully built out within 13-17 years. Development after that point will be relegated to sites with currently inferior rail access.
- If the proposed Connector were built, the portion of the central area within walking distance of a rail stop would increase from 58% to ~80%, and the rail hub would be enlarged by 95%. Land made rail-accessible by the Connector ultimately would support 184M SF of development.
- Given the scarcity of sites in the traditional core, land within walking distance of the Connector could be expected to capture 50%-60% of expected development over the next 20 years, or 50M-80M GSF.

The team arrived at these conclusions using the following resources:

Figure G-1. Study area – existing rail walksheds in yellow

- The comprehensive database of publicly and privately owned real property in the city of Chicago maintained by SOM, indicating ownership, acreage, current and past uses and density of development, zoning, and other characteristics. The database also indicates streets and sidewalks, transit, parks and other public infrastructure.

- Other geocoded data, including the Cook County assessor's property assessment database and the historical real estate development database maintained by CoStar, a national real estate research firm.
- MM's proprietary model to calculate Connector running times.

Historical Impact of Rail on Development

A retrospective analysis was conducted in the following manner:

1. A study area was mapped consisting of the core plus likely development sites in surrounding districts (Figure G-1). The map was divided into six zones and showed existing "L" lines and Metra terminals.
2. The white paper team hypothesized that proximity to rail transit was a major driver of downtown development. To test this, "walksheds" were generated around each "L" station and Metra terminal showing the maximum distance riders were willing to walk on average to reach their final destinations. Walksheds were calculated using these assumptions:
    a. Maximum "L" station walking distance was 10 minutes, or 800m.
    b. Since the Metra terminals did not provide convenient transfer to the "L," and CTA bus service to the terminals was slow, Metra commuters had grown accustomed to walking relatively long distances to their workplaces. Given the historical development pattern as evident in Figure E-3, it seemed reasonable to suppose a maximum walking distance of 15 minutes (1,200m) for Metra riders.

    Rail walksheds are shown in yellow in Figure G-1. Walksheds reflect the existing grid of streets and sidewalks as recorded in the GIS, and thus tend to be diamond-shaped.
3. The white paper team further hypothesized that the most desirable locations for large-scale <u>office</u> development in the central area were those convenient to both the "L" and Metra. (Central area workers use the two systems to get to their jobs in roughly equal numbers.[1]) The extent of this "rail hub" was calculated using the following procedure:

Figure G-2. Loop "L" walkshed

a. A collective walkshed for Loop "L" stops was generated, consisting of locations within 800m of any CTA rail stop within the area defined by the Loop elevated – see Figure G-2. The rationale for according special status to Loop stops was that locations within this walkshed were accessible from all downtown "L" lines and thus convenient to all riders.

b. It was observed that, while locations in the traditional Loop were convenient to both suburban trains and the "L," the two West Loop Metra terminals, Ogilvie Transportation Center and Union Station, had exerted outsize influence in recent decades due to their higher traffic volume and the fact that they served the north, northwest, and west suburbs where many corporate decision makers lived. This was evident in the large number of office structures built in the West Loop since 1980. To account for this skew, a collective Metra walkshed was generated consisting of locations within walking distance of <u>any two</u> Metra terminals – see Figure G-3.

c. The "rail hub" was then defined as locations within the Loop "L" walkshed <u>or</u> the Metra walkshed. This was based on the observation that some West Loop office buildings were beyond the Loop "L" walkshed although reachable from non-Loop "L" stops. Defining the rail hub as the <u>union</u> rather than the <u>intersection</u> of the Loop "L" and Metra walksheds seemed the simplest way to capture the importance of the West Loop terminals as a development driver. The resultant rail hub is shown in Figure G-4.

2. The location, type, and square footage of major central area real estate developments constructed between 1995 and 2015 were then plotted – these are the dots shown in Figure G-5, with colors indicating the type and dot size the scale of development.

3. The square footage of different categories of development was tallied with respect to rail access and summarized in Figure G-6. Conclusions:

Figure G-3. Metra walkshed

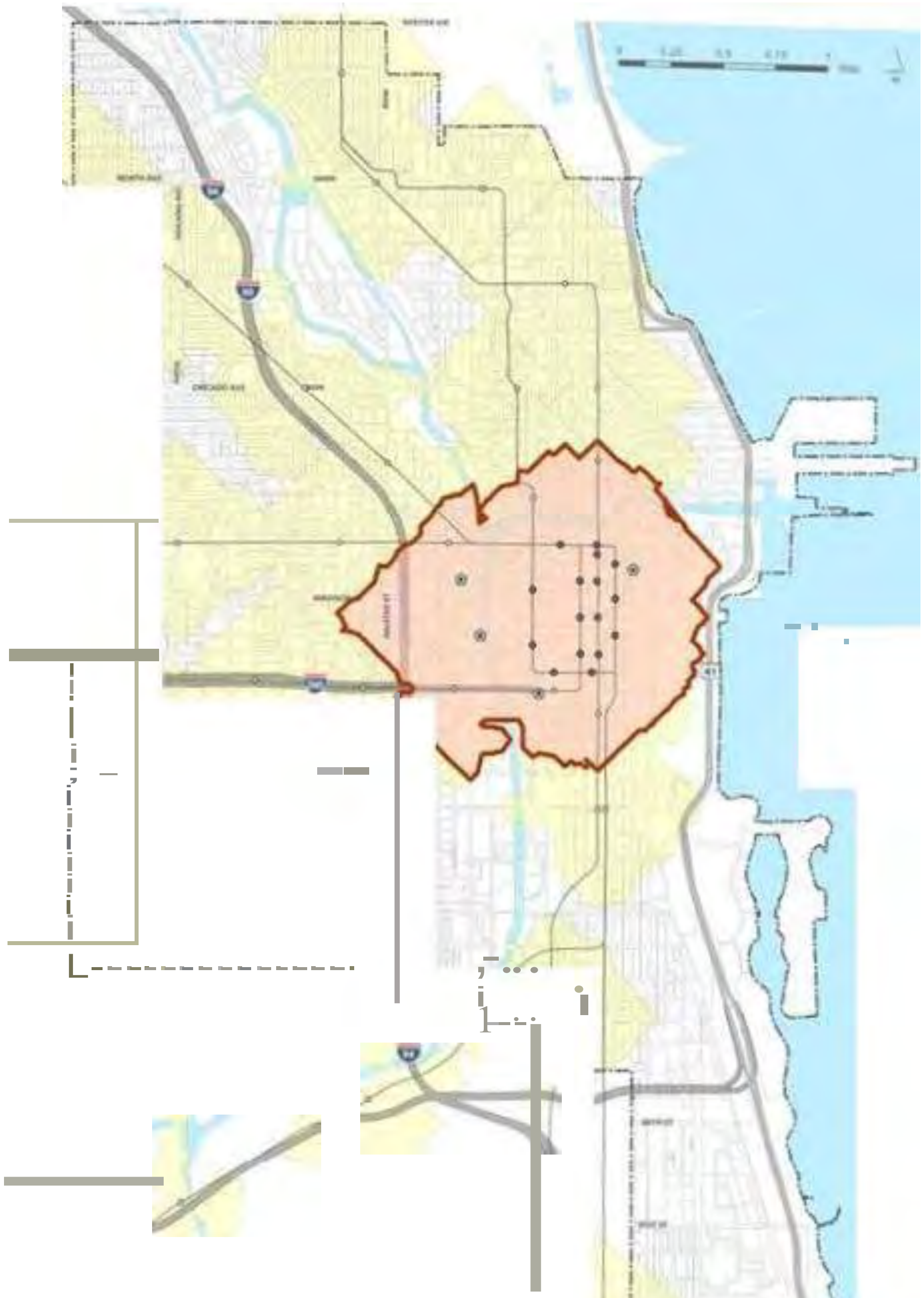


Figure G-4. Rail hub

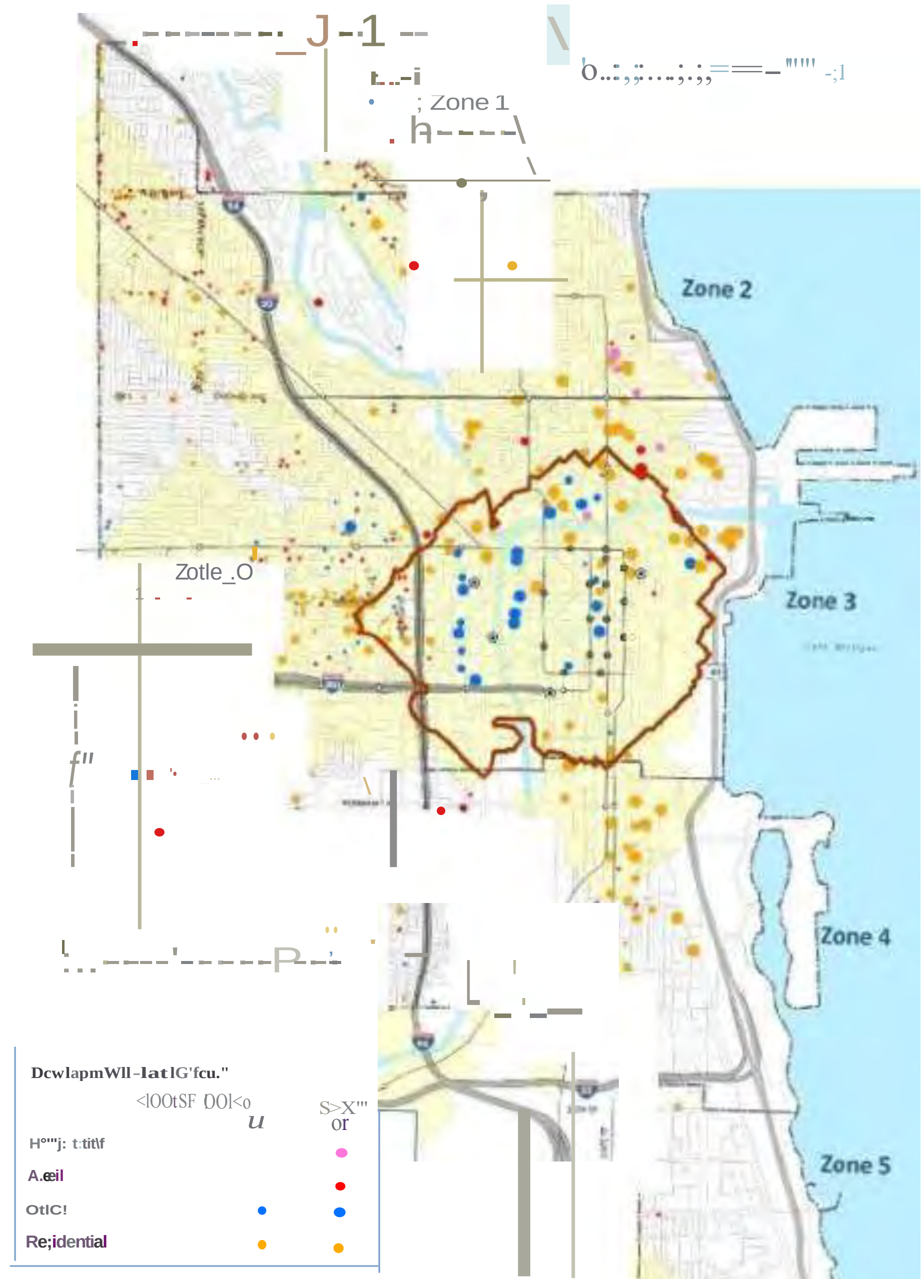


Figure G-5. Development 1995-2015 vs. rail access

a. Most central area development of all types over the past 20 years – 85% – occurred within walking distance of a rail stop.

b. Development in areas without rail service was relatively sparse. Areas without rail accounted for 42% of land but only 15% of development.

c. More than 90% of office development occurred within the rail hub, and 46% of all development, though it accounts for just 12% of central area land.

CENTRAL AREA DEVELOPMENT 1996-2015				
	Rail Hub	Non-Hub Rail	No Rail	Study Area
All Uses (sf)	42.5M	36.4M	13.5M	92.4M
%	46%	39%	15%	100%
Office (sf)	18.9M	1.7M	0.2M	20.7M
%	91%	8%	1%	100%
Residential (sf)	22.6M	28.3M	11.6M	62.4M
%	36%	45%	18%	100%
Retail (sf)	0.4M	4.1M	1.5M	6.0M
%	7%	69%	24%	100%
Hotel (sf)	0.7M	2.2M	0.3M	3.2M
%	21%	70%	9%	100%
Land Area (sf)	32.9M	126.8M	114.2M	274.0M
%	12%	46%	42%	100%

Figure G-6

Based on the foregoing, the white paper team concluded that its hypotheses regarding the importance of rail transit to central area development, and office development in particular, had been confirmed.

Development Capacity of Existing Rail Hub

Given that concentration of development within the rail hub dates back to the nineteenth century and that 42.5M SF had been built there in the past 20 years, it seemed reasonable to inquire how much development capacity remained. To determine this, the white paper team reviewed potential central area development sites and computed the square footage that could be built on those within or partly within the rail hub as defined in this document. Sites were identified using the following sources:

1. Inventory of likely development sites prepared by SOM for the 2003 *Central Area Plan,* defined as (a) vacant property; (b) underutilized land (surface parking, storage); and (c) buildings over 50% vacant and in need of renovation or reuse.[2] Remaining unbuilt sites in this inventory were determined to be capable of supporting ~22M SF gross floor area (GFA) of development.

2. Inventory of additional likely development sites prepared by SBF, consisting of:

   - Vacant sites – ~2.5M SF GFA
   - Underutilized sites (improvement value less than or equal to land value) – ~5.2M SF GFA
   - Remaining unbuilt potential within planned developments – ~5.3M SF GFA.

3. Development sites identified in Amtrak's Union Station redevelopment RFQ – 3M SF GFA.[3]

Based on the above, the team calculated that 38M SF GFA of development potential remained within the rail hub as defined in this document – see Figure G-7.

Next, the team prepared a forecast of development within the study area between 2016 and 2035 based on projections from the Chicago Metropolitan Agency for Planning (CMAP 2040). Anticipated development is expected to fall within the ranges shown in Figure G-8. The high end of the range is based on the observation that, during the past 10 years, a higher percentage of metropolitan Chicago development occurred within the study area than had been true during the previous 10 years.

REMAINING RAIL HUB DEVELOPMENT POTENTIAL

2003 Central Area Plan – Remaining Unbuilt Sites
~22M SF GFA

Vacant Sites
~2.5M SF GFA

Underutilized Sites
~5.2M SF GFA

Planned Developments – Unbuilt Area
~5.3M SF GFA

35M SF shown above + 3M SF in Union Station RFP (not shown) = 38M SF remaining development potential in rail hub

Figure G-7. Remaining rail hub development potential

Land Use	HISTORICAL DEVELOPMENT 1996-2015 SF	PROJECTED DEVELOPMENT 2016-2035 Low – High Range
Residential	62M	65M – 84M
Office	21M	29M – 37M
Hotel	3M	3M – 4M
Retail	6M	4M – 6M
TOTAL	**92M**	**101M – 130M**

Figure G-8 – Past and projected central area development

If the historical pattern were to persist, 46M – 60M SF of projected development (46% of 101M – 130M) would be built within the rail hub – substantially more than it can absorb based on the above calculation. What will happen instead, assuming the rail hub is not enlarged through expanded rail, is that it will be fully built out within the next 13-17 years. Development after that point will be forced to use sites with inferior rail access, increasing project risk. Given rail's pivotal role in shaping Chicago development and the long lead times required to bring new rail infrastructure online, this would suggest expansion is a matter of some urgency.

Impact of New Rail on Development

The next task of the white paper team was to estimate the impact of new rail transit. This was done in the following manner:

1. It was assumed the Connector would be constructed as shown in Figure G-9. Ten-minute walksheds around stations are depicted in Figure G-10. Areas made rail-accessible by the Connector (no existing "L" station within walking distance) are shown in dark pink. It was estimated that, on completion of the proposed transitway, the portion of rail-accessible land within the study area would increase from 58% to ~80%.[4]

Figure G-9. Proposed Connector transitway vs. rail hub

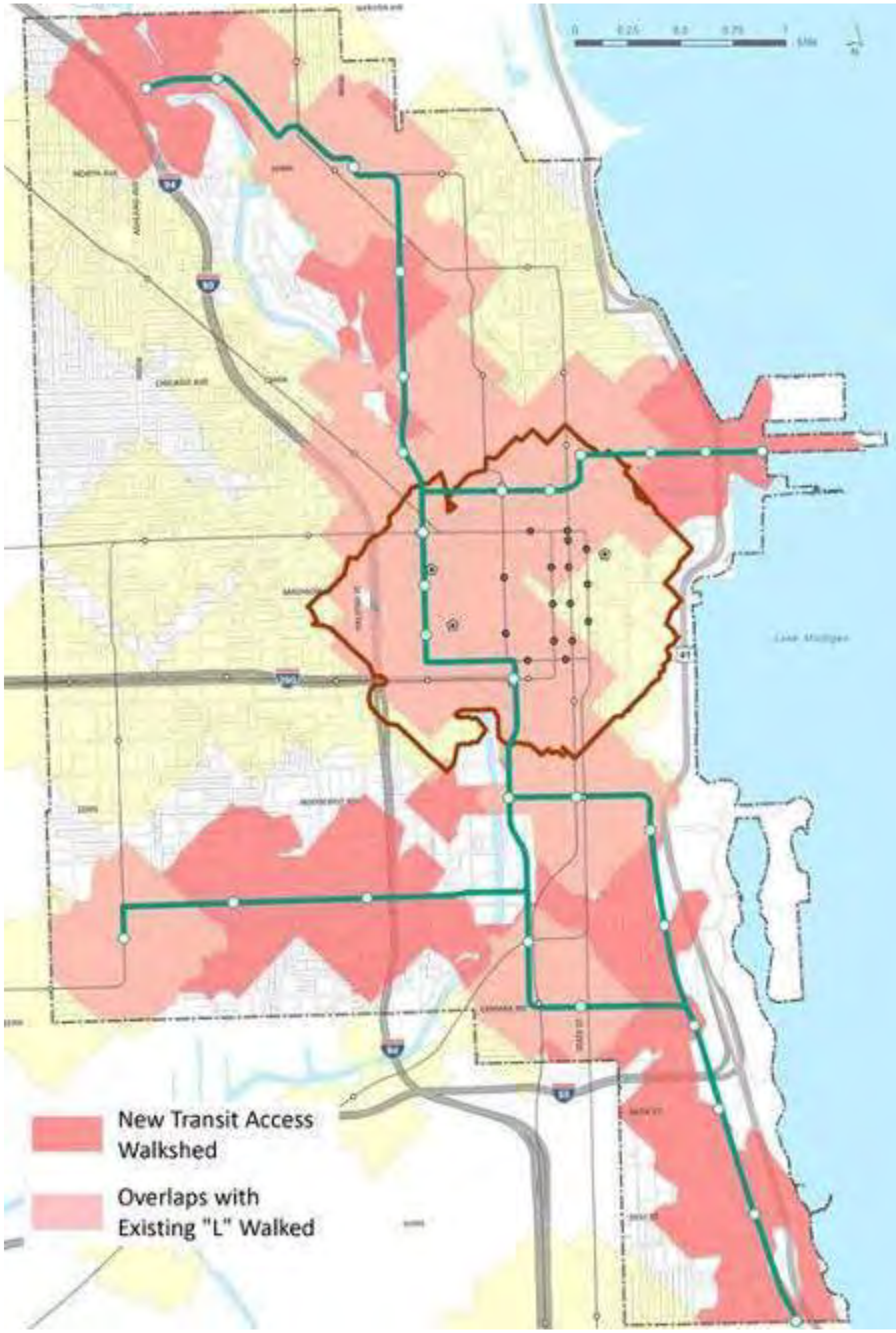


Figure G-10. Land made rail accessible by Connector (dark pink)

2. To gauge the effect on office development, it was necessary to estimate the extent to which the proposed Connector transitway would enlarge the rail hub. The following procedure was used:

   a. Consistent with the assumption that Metra commuters were willing to walk 15 minutes to their workplaces, locations within 15 minutes of Metra via a combination of transit plus walking (the Metra "travelshed") were deemed to be within the rail hub.

   b. For purposes of speed estimation, it was assumed the Connector would be grade-separated except for gated crossings on Carroll Ave. giving priority to transit, with service provided using rail vehicles typical of urban transit service. Clinton and Monroe, midway between Ogilvie Transportation Center and Union Station, was designated as the starting point for travelshed computation.

   c. Running times between stations were estimated using a computer model developed by MM taking account of known vehicle characteristics and typical transit operating practices, including acceleration and braking rates and speed changes due to stations, grades and curves. Average time to reach a Connector platform and board a train was assumed to be three minutes, and dwell (standing) time at each station was assumed to be 20 seconds. Running time calculations are shown in Appendix K.

3. Based on the foregoing, a map of the enlarged rail hub was generated – see areas shaded in red in Figure G-11. It was calculated that the size of the rail hub would be increased 95%. The bulk of the enlarged hub would be north of the river, where growth in offices and all other types of development seems plausible, indeed likely. A significant amount would be south of Congress Parkway, which has seen much other development but no offices. Technology-based industries have shown themselves to be less conservative in choosing office locations than more traditional businesses, and it is possible an office market may

emerge on the near south side. Even if this does not occur, the area has ample vacant land close to other parts of the central area and would surely support dense residential and supporting retail development were rail access improved.

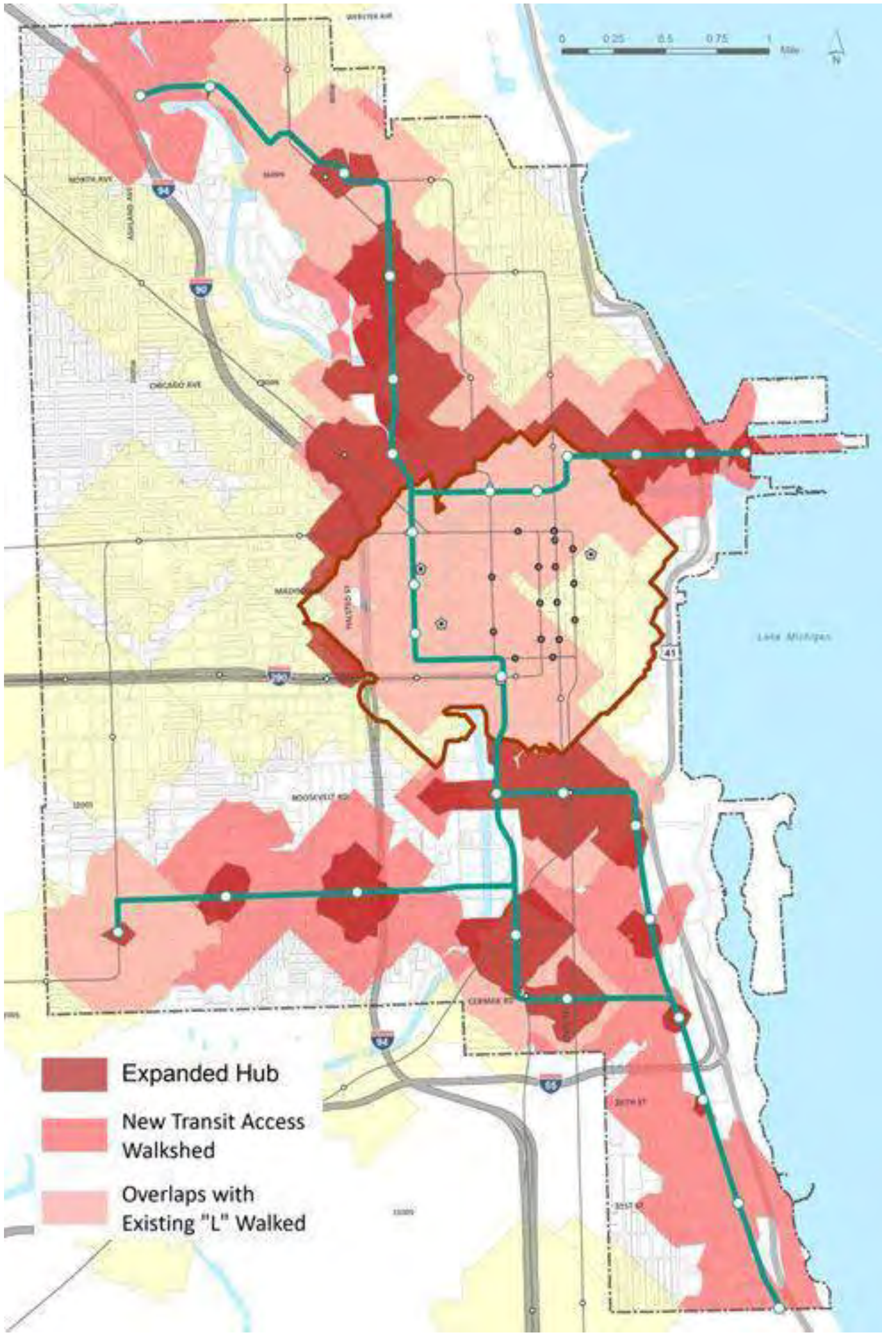


Figure G-11. Enlarged rail hub (red)

Estimate of New Rail's Development Impact 2016-2035

4. With the above in mind, the white paper team attempted to project the extent of development the Connector could be expected to catalyze over the next 20 years. The following considerations were taken into account:

   a. The forecast of central area development based on CMAP 2040 projections (Figure G-8) was taken as the starting point.

   b. The team generated a map of developable central area land within the walksheds of proposed Connector stops based on the parcels identified in Figure G-7. This map is shown in Figure G-12.

   c. The development capacity of the available sites was then quantified based on reasonable assumptions about allowable densities. The results are shown in Figure G-13, indicating total potential development of <u>184M SF</u>.

   d. This in turn was used to generate a 3D representation of potential construction – these are the shapes shown in white in Figure G-14.[5] As can be seen, most sites are north and west of the river or south of Congress St. in areas that would be served by the Connector. Some of these sites are already accessible by CTA rail, but many are not.

   e. To estimate how much prospective development would be attributable to the Connector, the amount of 1996-2015 development in those portions of the proposed Connector walksheds currently beyond walking distance of the "L" was analyzed and determined to be 23M square feet, or 25% of the total – see Figure G-15.

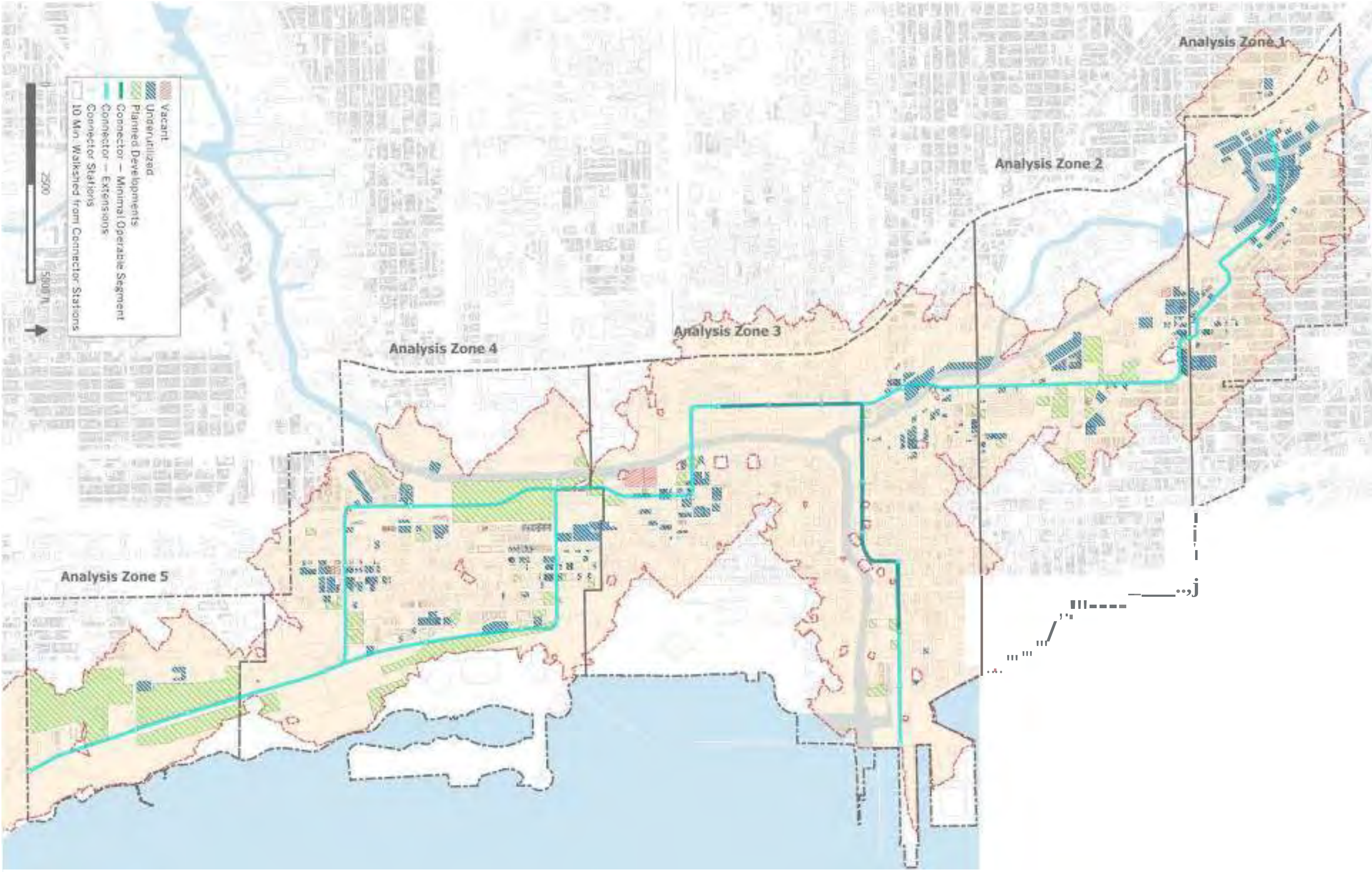


Figure G-12. Vacant and underutilized land near proposed Connector stops

			Planned Development		Vacant		Underutilized			
	Walkshed	FAR	Area (sqft)	Area (acres)	Area (sqft)	Area (acres)	Area (sqft)	Area (acres)	TOTAL	POTENTIAL DEVELOPMENT (SQFT)
Zone 1	1	4.5	30,000	0.7	33,717.94	0.8	978,654	22.5	1,042,372	4,690,674
	2	4.5	-	-	-	-	1,217,158	27.9	1,217,158	5,477,211
	3	5	-	-	17,544.30	0.4	444,556	10.2	462,099	2,310,495
									2,721,629	12,478,381
Zone 2	3	5	26,400	0.6	49,296.00	1.1	546,003	12.5	621,699	3,108,495
	4	4.5	2,754,200	63.2	65,470.60	1.5	697,061	16.0	3,517,232	15,827,542
	5	7	54,200	1.2	2,065.60	0.0	201,503	4.6	257,769	1,804,380
									4,396,699	20,740,417
Zone 3	5	7	67,800	1.6	3,432.00	0.1	520,463	11.9	591,695	4,141,865
	6	8	31700	0.7	-	-	632704	14.5	664,404	5,315,232
	7	12	245200	5.6	-	-	103015	2.4	348,215	4,178,580
	8	12				-				
	9	18	281900	6.5	367393	8.4	1164202	26.7	1,813,495	32,642,910
									3,417,809	46,278,587
Zone 4	10	6	3,045,200	69.9	-	-	44737	1.0	3,089,937	18,539,622
	11	16.5	162800	3.7	10,400	0.2	853000	19.6	1,026,200	16,932,300
	12	12	635140	14.6			237608	5.5	872,748	10,472,976
	13	5	660000	15.2			183932	4.2	843,932	4,219,660
	14	5	179500	4.1	56275	1.3	557145	12.8	792,920	3,964,600
	15	9	1069200	24.5	120526	2.8	650000	14.9	1,839,726	16,557,524
	16	4.5	140800	3.2	-	-	45091	1.0	185,891	836,510
									8,651,354	71,523,202
Zone 5	17	4.5	3427500	78.7	264,000	6.1	74646	1.7	3,766,146	16,947,657
	18	4.5	3568300	81.9	-	-	89712	2.1	3,658,012	16,461,054
									7,424,158	33,408,711
									26,611,649	194,429,298

Figure G-13. Development capacity of land within walking distance of Connector stops (GSF)

Illustrative representation of potential development opportunities. Subject to City approval and zoning requirements

Figure G-14. Likely future development (white) based on site availability

Development Projections in Central Area and Connector Walksheds	Historical 1996-2015	Future 2016-2035 No Connector	Future 2016-2035 With Connector
Central Area	92M	100 M	132 M
Connector Walksheds	23M	25M	66-80M
Capture Rates	25%	25%	50%-60%

Figure G-15

f. If the Connector is not built and the historical trend persists, these areas would be expected to see ~25M SF of development in the next 20 years. If the Connector is built, these areas are likely to capture a larger share of construction activity. How much larger is speculative, but given the scarcity of sites in the traditional core a capture rate of 50%-60% seems plausible. This would mean 50M-80M GSF, for a net gain of 25M-55M GSF over the no-build scenario.

To be clear, this analysis does not presume that a new transit line would generate development that would not occur otherwise. Rather, it would facilitate continued development by providing an essential ingredient, namely access to available land, lacking which development would become more difficult.

To summarize the results of the analysis:

- Rail plays a critical role in Chicago development.
- The amount of prime rail-accessible land in the central area is dwindling and will run out within ~15 years.
- The Connector rail line proposed in this paper will almost double the amount of prime land (that is, accessible to both the "L" and commuter rail) and will support many decades of additional development.

NOTES

[1] The chart below is based on data from Regional Transportation Authority Mapping and Statistics, CTPP Data and Demographics – Work Trip Mode Share by Area – 2010, www.rtams.org/rtams/ctppModeShareByArea.jsp, accessed 2/28/2016:

Metra has the highest transit mode share of any suburban commuter rail system among Chicago's peer cities – see chart below, drawn from American Public Transportation Association, *Transit Ridership Report, Third Quarter 2015,* www.apta.com/resources/statistics/Documents/Ridership/2014-q3-ridership-APTA.pdf, accessed 2/28/2016:

City	Comm Rail	Heavy Rail	Light Rail	Bus	Total Transit	Comm Rail %
New York	333,600	8,721,300		2,348,700	11,403,600	3%
Chicago	301,300	795,600		966,700	2,063,600	15%
Los Angeles	40,800	142,900	189,300	1,182,700	1,555,700	3%
Washington	55,500	899,200		444,400	1,399,100	4%
Boston	121,600	578,500	232,000	381,100	1,313,200	9%
Philadelphia	126,300	293,800	66,400	492,400	978,900	13%
San Francisco	62,700	455,600	180,500	488,000	1,186,800	5%

[2] City of Chicago, *Chicago Central Area Plan – Draft Final Report to the Chicago Plan Commission – May 2003,* Chapter 2 – Physical & Economic Assessment, p. 30, www.cityofchicago.org/content/dam/city/depts/zlup/Planning_and_Policy/Publications/Central_Area_Plan_DRAFT/04_Central_Area_Plan_Chapter2b.pdf, accessed 8/7/2016.

[3] Amtrak, *Request for Qualification ("RFQ") Related to a Master Development Agreement for the Chicago Union Station Development Project* (May 20, 2016),

"Project Details," p. 16, http://f.datasrvr.com/fr1/316/87087/CUS_RFQ_05-20-2016_Final.pdf, accessed 8/7/2016.

[4] Land within walking distance of a rail station following construction of the Connector was initially determined to be 78% of the total, but this figure was judged to be low. Walksheds were calculated based on existing sidewalks – thus vacant tracts without sidewalks, such as the former rail property along the South Branch, were depicted as beyond the reach of rail even if new stops were built nearby. In reality, pedestrian access would undoubtedly be provided when these sites were developed. If this were factored into the analysis, the project team thought it likely the percentage of rail-accessible land would be 80% or more.

[5] Illustrative representation of potential development opportunities along proposed alignment. Subject to City approval and zoning requirements.

Appendix H – Funding Sources

The following funding sources are described in this appendix:

- Special service area (SSA)
- Federal Transit Administration (FTA) capital investment grants
- U.S. Department of Transportation (USDOT) TIFIA program.

Special Service Area (SSA)

A special service area (SSA) is a defined geographic area in which some or all property owners pay an annual surcharge on their property taxes to fund a specified public service. The process for formation of an SSA requires notice to affected property owners and electors as well as a public hearing. The following is a summary of that process.

Qualification of the SSA. Formation of an SSA, as well as the levying of a tax thereunder, is governed by the Illinois Special Service Area Tax Act (35 ILCS 200/27-5, et seq. – the "SSA Act"). The SSA Act allows an SSA to be established over any area provided that: (a) the area is contiguous; (b) the special services to be provided are in addition to those services provided generally throughout the municipality, and (c) the special services are paid for through taxes levied on property located within the SSA. The proposed Connector SSA would meet all of these requirements.

Proposing the SSA. The first step in establishing an SSA involves proposing the SSA. This can be done by application by an owner or owners of record within the proposed SSA or directly by the corporate authorities.

Hearing Notice/Public Hearing. After the proposing of an SSA the municipality is required to set a public hearing which must be prior to or within 60 days of the adoption of an ordinance proposing the SSA. The SSA Act requires that notice of the public hearing be published in a paper of general circulation not less than 15 days prior to the hearing date and be mailed not less than 10 days prior to the hearing date to all persons in whose name the general taxes for the last preceding year were paid on each property within the proposed SSA.

The public notice must contain: (a) the time and place of hearing; (b) the boundaries of the SSA by legal description and street location; (c); the permanent tax index number (PIN) of each parcel within the SSA; (d) the nature of the proposed special services and whether the special services are for new construction, maintenance, or other purposes; (e) notification that all interested persons will be given an opportunity to be heard and an opportunity to file objections to the amount of the tax levy if the tax is a tax upon property; and (f) the maximum rate of taxes to be extended within the SSA in any year and the maximum number of years taxes will be levied. In addition, if bonds will be involved, the notice should include (x) a notification that all interested persons will be given an opportunity to be heard and an opportunity to file objections to the issuance of the bonds; (y) a statement as to who will maintain the special services after the life of the bonds (if other than the municipality); and (z) the maximum amount of bonds proposed to be issued, the maximum period of time over which the bonds will be retired and the maximum interest rate the bonds will bear.

Objection Petition. Within 60 days following the final adjournment of the public hearing, the formation of the proposed SSA can be rejected if the County Clerk receives objection petitions signed by (a) 51% of the electors within the SSA and (b) 51% of the owners of record within the SSA. If both are filed with the clerk of the municipality or county, the proposed SSA fails and cannot be proposed again for 2 years. By focusing the SSA only on non-residential properties and obtaining buy-in from the primary owners involved, the chance of an effective objection petition should be minimized.

FTA Capital Investment Grants

For the federal share, the Connector may qualify for funding under the Federal Transit Authority's ("FTA") Capital Investment Grant ("CIG") program. The CIG program offers three types of funding based on the size and scale of the project:

- "New Starts" funds support transportation infrastructure projects with total project costs in excess of $250M and which seek funding from the CIG program in excess of $75M.

- Projects are eligible for "Small Starts" funds only when total project costs are less than $250M and the CIG program funding sought is less than $75M.

- "Core Capacity" projects address improving corridors at or near capacity. Under any of these programs the applicant must be state or local governmental authorities.

Funding for the CIG program is dependent on annual appropriations by Congress. The FTA submits an annual report with a funding recommendation to Congress. In fiscal year 2014, FTA sought $2.13B in total CIG funding. Congress ultimately appropriated $2.125B for the program, including $1.9B for New Starts projects. For fiscal year 2015, FTA recommended a $2.5B appropriation for the CIG program, but Congress ultimately appropriated $2.148B.

New Starts

Grant Process. New Starts projects require successful completion of two phases, Project Development and Engineering, before the FTA will enter into a construction grant agreement with the project sponsor.

To enter the Project Development phase, and more broadly the New Starts program, the project sponsor is directed to send a letter to FTA. The letter, which FTA asks be limited to 2-5 pages, must contain certain specific information, including:

- Project sponsor and identification of the project manager
- Description of the project with a clear map of the corridor
- A cost estimate for the project and for project development
- An anticipated timeline for completing the required activities
- A demonstration that funding is available and committed for the Project Development work.

A project may not spend more than two years in the Project Development phase. Accordingly, FTA encourages project sponsors to conduct sufficient work and analysis prior to applying for entry to that phase, so that the project will be able to meet the two-year deadline. This may include, for example, initiating the required environmental review.

During the Project Development phase the project sponsor must complete a number of activities, including:

- Selecting a locally preferred alternative and adopting it into the fiscally constrained metropolitan transportation plan
- Completing the NEPA environmental review process
- Obtaining commitment of at least 30% of non-CIG funding
- Completing at least 30% of design and engineering
- Providing sufficient information for FTA to develop its required project rating.

Specific New Starts templates, for which FTA provides detailed instructions, must be completed and submitted in order for the project to advance. All CIG programs are rated by FTA in light of the list above – the information required in the templates is used to determine that rating. In order to advance between phases, be eligible for a grant, and ultimately receive and continue to receive funds, a project must be graded as at least "Medium."

To complete the Engineering phase, the project sponsor must establish a firm and reliable cost, scope, and schedule for the project, obtain all non-CIG funding commitments, and complete third party agreements. FTA retains discretion on whether to include a project in its annual Congressional recommendation report. An Early System Work Agreement may be used to firmly commit FTA funds for a project before a Full Funding

Grant Agreement is awarded. To request a construction grant agreement, the project sponsor is required to submit assorted information for FTA review and approval.

Similar New Starts Projects. The following is a list of similar projects which have received New Starts funding:

- Eagle Commuter Rail – Denver. Total project costs $2.043B, New Starts funding $1.03M
- LA Westside Purple Line Extension. Total project cost $2.8B, New Starts funding $1.25M
- Cambridge-Medford Green Line Extension – Boston. Total project cost $2.3B, New Starts funding $996M.

Judging from the examples above, a New Starts funding level of 40-50% of project costs appears to be achievable. This funding, when coupled with SSA and/or TIF bond proceeds, would provide sufficient funding for the Connector.

Small Starts

Much of the application process for Small Smarts is the same as or similar to New Starts, including project rating and FTA provision of templates. However, Small Starts projects require only one phase – Project Development. FTA suggests that a project sponsor consider beginning planning work and environmental review prior to entering that phase. As with New Starts, commencing the Project Development phase requires submitting a letter to FTA.

Unlike New Starts, there is no two-year cap on completing the Project Development phase. Nonetheless, FTA requires project sponsors to obtain commitments of at least 50% of all non-CIG funding within 3 years of entering the phase. A project sponsor must, among other things, complete sufficient engineering and design, obtain funding commitments for all non-CIG funding, and meet FTA readiness requirements in order to complete the phase and be eligible for a construction grant agreement.

Core Capacity

Proposed projects seeking core capacity funding must be "substantial corridor-based capital investment in an existing fixed guideway system." That corridor must be at or over capacity, and the project must increase capacity by at least 10%. The method for demonstrating the corridor is at capacity is provided by FTA.

In addition to demonstrating eligibility, project sponsors seeking a core capacity grant must move through the two-stage process familiar from the New Starts program. The same two-year limit on the Project Development phase applies. The CTA plans to apply for Core Capacity funding to pay for its Red-Purple Modernization program.

Work on the Connector to date has already gone a significant way toward completing many of the tasks prescribed by the FTA funding application process. During the detailed engineering analysis proposed as the next phase of the project, the following FTA-required tasks would be completed:

- Definition of the project
- Detailed cost estimates
- Timeline for completion of project.
- Demonstration of availability of local matching funds.

As such, with the City of Chicago or CTA as project sponsor, we believe this project could readily qualify for funding under the New Starts program.

USDOT TIFIA Program

The Transportation Infrastructure Finance and Innovation Act ("TIFIA") provides federal credit assistance for qualified projects. The program is administered by the U.S. Dept. of Transportation. The credit assistance may be in one of three forms: (1) secured, direct loans; (2) loan guarantees; and (3) standby lines of credit. To be eligible, a project must be included in the state transportation improvement program and the metropolitan transportation plan, and must have a project cost of at least $50 million. In addition, a direct revenue source, such as tolls or user fees, must be available to repay the credit obligation. TIFIA credit assistance is limited to 33% of total eligible project costs. The award of credit assistance is subject to evaluation against statutory criteria, including environmental impact, significance of the project to the national transportation system, economic benefits, leveraging of private capital, and promotion of innovative technologies.

Project sponsors interested in TIFIA financing may electronically submit a letter of interest on a rolling basis using the form provided by USDOT. If DOT deems the project worthy of consideration, it will request additional information regarding creditworthiness, including a credit rating opinion letter. It will also request a $100,000 fee and invite the sponsor to submit a completed application and make an oral presentation to DOT.

Appendix I – Projected Ridership

The research team at the Urban Transportation Center (UTC) of the University of Illinois – Chicago was tasked with developing ridership projections for the Connector transitway. The tool selected for this purpose was the Federal Transit Administration's Simplified Trips-on-Project Software (STOPS), which generates ridership forecasts for fixed-guideway transit systems based on census work-trip data, population and employment growth projections, current transit schedules, and other inputs.

STOPS is the logical first choice for any fixed-guideway transit project because the FTA makes it available at no charge and will accept the results in support of an application for federal New Starts funding (see Appendix H). Nonetheless it was recognized that STOPS was designed for greenfield projects in areas having no existing rail or similar service and as such was not well suited to infill projects such as the Connector.

UTC obtained the STOPS model from the FTA and decided that due to the difficulty in setting up the Chicago network from scratch, it was best to use the already coded network created by the Regional Transportation Authority (RTA). The RTA was approached and asked for the coded Chicago transit network. The RTA complied with this request, providing the network and meeting with the UTC team to explain the network coding process. The RTA was also supportive in helping to navigate the software and resolving the many errors and bugs encountered during the process.

STOPS is a memory-intensive tool that has dependencies with ArcGIS software. The computing power and memory needed for each run of the software made it difficult to achieve any convergence in the beginning stages. Once an appropriate hardware configuration was arrived at, the UIC team first ran the network as developed by the RTA to ensure accuracy. This resulted in a couple of additional issues that were fixed over a week's time.

The next step was to geocode the stations that had been identified for inclusion in the Connector's minimum operable segment (MOS). After this was done, the stations were grouped into a separate category to ensure the software recognized them as newly added.

A schedule was developed for the service to be provided to the new stations. In developing this schedule, care was taken to ensure that the connections between the previous and subsequent stations to the new Connector stations were preserved. This was done to make sure that the transfer (if it was BRT or any other surface mode) from the existing service was protected.

The STOPS model was run with the new stations for the base year (2015) as well a future year (2025). This was done to see how ridership would be allocated to the new stations in the current scenario for which we have ridership numbers (both aggregate and at the station level). The horizon year then becomes the starting date for any planned new service. The belief is that if the model can be calibrated for the 2015 scenario with new stations added, then any projections that are made for a future year will reflect the ridership accurately.

Despite the UTC team's best efforts, the model did not allocate any ridership to the new stations for either 2015 or 2025. The team sought the help of both the RTA and the FTA but despite assistance was not able to achieve the desired results.

Possible reasons for this are many, but in all probability stem from the limited ability of the STOPS software to apportion trips or ridership to stations in an area where existing transit service is relatively abundant. We were warned about this possibility when we first spoke to the RTA. We are not certain if this is the case and intend to continue working with the FTA and adjusting the model, but as of now the results are not encouraging.

We emphasize that the problem was STOPS, not the proposed service. The next round should budget for a tool capable of more fine-grained analysis.

Appendix J – Comparable Transit Operations

Characteristics of high-capacity transit lines similar to the proposed Connector in other U.S., world cities

System: Atlanta Streetcar		
Type: Light rail	**Weekday Ridership:** 2,500	
Opened: 2014	**Lines:** 1	**Length:** 2.7 mi
Max Riders/Train: 195	**Vehicle Width, Max Length:** 8’8”, 82’	
	Riders/Mile: 926	
ROW: Surface, mixed traffic	**Min/Max Headway (Mins):** 15/15	**Max Riders/Hr:** 780
Cost: $69.2M	**Major Funding Sources:** $47M, U.S. Transportation Investment Generating Economic Recovery (TIGER) II program	

Description: Operates in a primarily one-way loop in downtown Atlanta, connecting major destinations to MARTA heavy rail. Uses Siemens S70 light rail vehicles. A total of four S70 cars were purchased.

History: Not-for-profit Atlanta Streetcar (ASC) formed in 2003 to promote streetcars; major local institutions served on its board. Peachtree Corridor Partnership formed in 2007 to promote Peachtree St. redevelopment; ASC backers shifted to partnership. Atlanta city council approved feasibility study in 2009. Downtown Loop is first phase of envisioned 50-mile system serving entire city. Joint project of City of Atlanta, Atlanta Downtown Improvement District, Metropolitan Atlanta Rapid Transit Authority (MARTA)

Pros: Connects MARTA heavy rail to downtown destinations.

Cons: Infrequent service, mixed-traffic operation, low ridership.

System: Boston (MBTA) Green Line		
Type: Light rail	**Weekday Ridership:** 191,300	
Opened: 1897	**Lines/Stops:** 4/67	**Length:** 23 mi
Max Riders/Train: 200+standing	**Vehicle Width, Max Length:** 8'8", 3x74'=222'	
	Riders/Mile: 8,317	
ROW: Subway downtown; outlying a mix of grade separated, dedicated surface w/crossings, mixed traffic	**Min/Max Headway (Mins):** 1.5/10	**Max Riders/Hr:** 20,000
Cost: Legacy system	**Major Funding Sources:** Various	

Description: Busiest light rail line in U.S. on per mile, overall basis; 2nd in North America after Calgary

History: Green Line is an evolution of Boston streetcar system, most of which was replaced by buses following WW2. Surviving lines operate in subway downtown, on grade-separated or dedicated surface ROW (e.g., landscaped median) in outlying areas. Some remaining mixed-traffic operation but this has been cut back and replaced by buses over time.

Pros: Frequent service, well patronized, convenient access to many major destinations. Well integrated with MBTA heavy rail, commuter rail. Subway speeds downtown operation. Much of outlying ROW attractively landscaped.

Cons: Crush loading during peak periods; closely spaced stops on some branches slow operation. Small vehicles limit capacity even in multi-car consists. Three-unit trains introduced on some branches relatively recently; this likely is practical maximum. Future of mixed-traffic operation uncertain. Long history of equipment problems. Much of system shut down for extended period by heavy snow during winter of 2014-15.

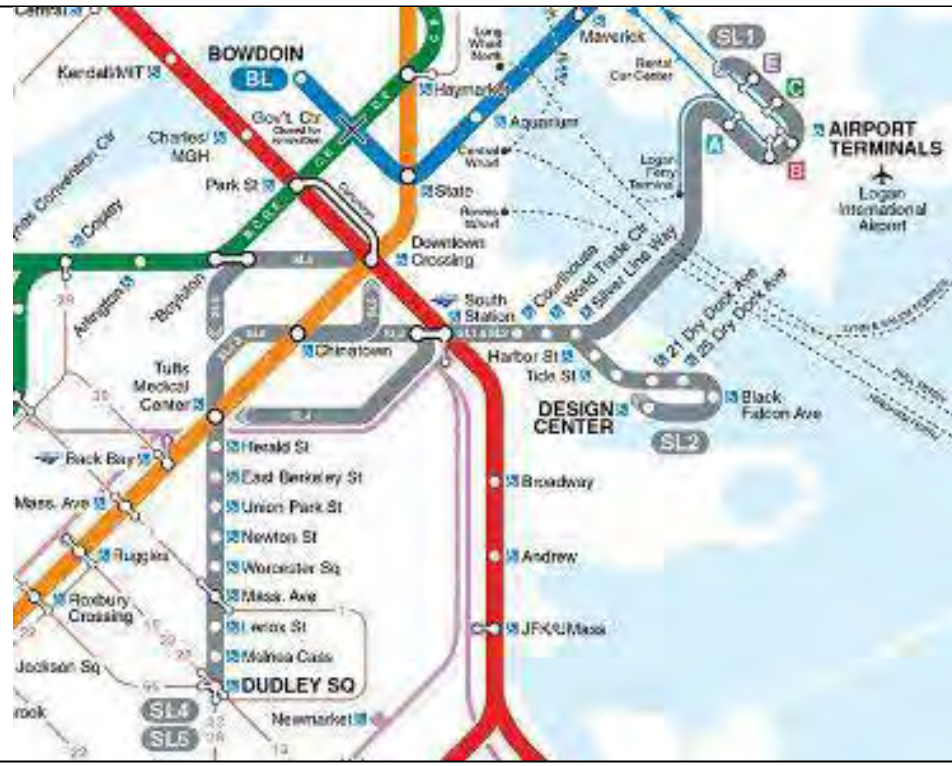
System: Boston (MBTA) Silver Line		
Type: Bus rapid transit	**Weekday Ridership:** 33,386	
Opened: 2002-2004	**Lines/Stops:** 4/22	**Length:** 13 mi
Max Riders/Bus: 100?	**Vehicle Length:** 60' articulated	
	Riders/Mile: 2,568	
ROW: Tunnel connects to South Station Red Line stop; mixed traffic via Ted Williams Tunnel to Logan Airport; bus lanes in airport. Reserved lanes for SL4/5 (South Boston)	**Min/Max Headway (Mins):** Not determined	**Max Riders/Hr:** Not determined
Cost: $33.35M	**Major Funding Sources:** Various	

Description: Boston's version of BRT; connects downtown Boston to Logan Airport, waterfront, South Boston

History: Routes SL1/2, opened in 2004/5, serve airport, Design Center; SL4/5, opened in 2002, serve South Boston. SL5 replaced demolished Washington St. Elevated branch of Orange Line. Dual-mode (electric/diesel) buses use trolley poles in tunnels to avoid exhaust fumes, diesel in airport.

Pros: Frequent service, convenient connections to MBTA rail, Logan Airport terminals. Inexpensive to implement. Robust ridership, in part due to free boarding at Logan. Luggage racks on buses. SL5 is MBTA's busiest bus route.

Cons: Circuitous routing, slow mixed-traffic operation in some sections, although faster access to Logan than MBTA Blue Line. Not considered true BRT by some due to lack of dedicated lanes, etc.



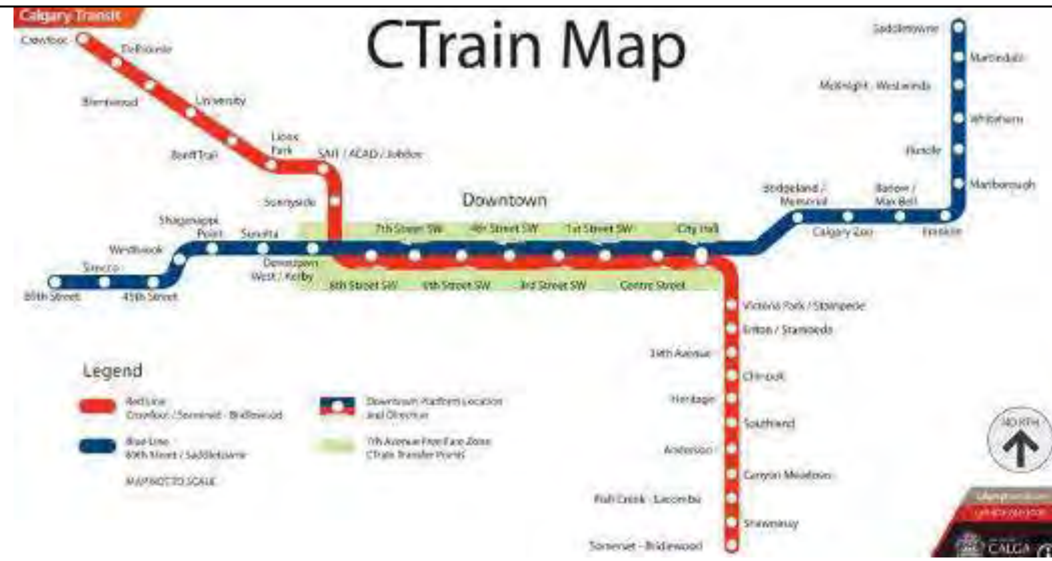
City/System: Calgary CTrain		
Type: Light rail	**Weekday Ridership:** 333,800	
Opened: 1981-2012	**Lines/Stops:** 2/45	**Length:** 37.2 mi
Max Riders/Train: 792	**Vehicle Width, Max Length:** 8'8", 3x79.8"=239'	
	Riders/Mile: 8,973	
ROW: Dedicated corridor downtown, mostly grade separated private ROW w/some gated crossings outlying	**Min/Max Headway (Mins):** 3/15	**Max Riders/Hr:**
Cost: US$24.5M/mi as of 2000	**Major Funding Sources:**	

Description: Most heavily traveled light rail system in North America. Rides solely within downtown are free. Downtown operation via dedicated grade-level 7th Av transit mall used by LRT, buses, and emergency vehicles only – no autos. Due to coordination of transit with traffic signals, trains attain 25 mph speeds in transit mall, 50 mph in outlying areas. City making provision for some future LRT operation via downtown 8th Av subway.

History: City reserved corridors for transit use in 1960s, although active rail planning did not begin till 1970s. Voters opposed freeway construction to downtown. Due to rigorous cost-control efforts, including spartan stations and off-the-shelf rolling stock, capital cost per passenger lowest of 14 North American cities studied. Low operating cost due to honor system fare payment.

Pros: Due to strong support by public and officials, public policy has consistently favored transit over autos. Nearest limited-access highway almost 2 miles from downtown. Coordinated signaling through 7th Av transit mall permits end-to-end average speed of ~24 mph, 2 mph faster than Edmonton, which has downtown tunnel.

Cons: Train length currently limited to 3-unit consists, although 4-unit trains to start soon on Red Line. Downtown block size a constraint.



City/System: Cleveland (GCRTA) Green, Blue Lines

Type: Light rail	**Weekday Ridership:** 8,900	
Opened: 1913	**Lines/Stops:** 2/34	**Length:** 15.3 mi
Max Riders/Train: 84 seats+standing	**Vehicle Width, Max Length:** 9'4", 77'1"'	
	Riders/Mile: 582	
ROW: Subway downtown; grade separated in outlying city; dedicated surface w/grade crossings in suburbs	**Min/Max Headway (Mins):** 5/30	**Max Riders/Hr:** 210
Cost: Legacy system	**Major Funding Sources:** Various	

Description: Evolution of old streetcar system.

History: As with Boston Green Line, the two Cleveland lines are what remains of an extensive streetcar system mostly replaced with buses after WW2. Surviving lines operate in tunnel downtown, grade-separated or dedicated surface ROW in outlying areas. Both lines built pre-WW1 to serve new suburban development. Waterfront extension to Browns football stadium, Amtrak station opened in 1996.

Pros: Frequent peak service in city; convenient access to downtown Cleveland; attractive rolling stock. Well integrated with GCRTA heavy rail. Much of system grade separated; subway speeds downtown operation. Suburban ROW attractively landscaped.

Cons: Ridership on per-mile basis among lowest of any U.S. light rail system – Health Line BRT has higher ridership. Transit corridors not densely populated. Waterfront extension to serve Browns stadium has seen low ridership due to lack of transit-oriented development, resulting in reduction of service.

City/System: Cleveland (GCRTA) HealthLine		
Type: Bus rapid transit	**Weekday Ridership:** 14,367	
Opened: 2008	**Lines/Stops:** 1/36	**Length:** 7.1 mi
Max Riders/Bus: 47 seats+53=100	**Vehicle Length:** 63’	
	Riders/Mile: 2,113	
ROW: Reserved lanes in median of wide street with grade crossings	**Min/Max Headway (Mins):** 5/30	**Max Riders/Hr:** 2,000 (max loaded vehicles at 3 min headways)
Cost: $200M	**Major Funding Sources:** U.S., state, with contributions from Cleveland Clinic and University Hospitals	

Description: BRT line operates on Euclid Avenue between downtown Cleveland and airport; serves many local institutions, including Cleveland Clinic and University Hospitals of Cleveland, who pay for naming rights.

History: Intended to stimulate redevelopment of Euclid Avenue, a once prestigious thoroughfare. Street substantially rebuilt as part of BRT project.

Pros: 24-hour service; 5-min intervals during peak. Closer to true BRT than most U.S. implementations: off-board fare payment to permit boarding at all doors, sheltered stops, dedicated lanes, level boarding (no steps), traffic signal prioritization. Attractive vehicles, landscaped ROW, next-bus-arrival signs at stops. End-to-end travel time reduced from 40 mins to 28. Low cost; ridership 3x higher than Cleveland light rail per mile. According to Institute for Transportation and Development Policy, a BRT advocate, stimulated $5.8B in investment, $114 for each $1 invested. Increased ridership 47% over local bus service it replaced.

Cons: Service initially slower than planned due to poor traffic light timing, since resolved.

System: Dallas (DART) light rail		
Type: Light rail	**Weekday Ridership:** 92,500	
Opened: 1996-2015	**Lines/Stops:** 4/62	**Length:** 90 mi
Max Riders/Train: 784	**Vehicle Width, Max Length:** 8'10", 4x123.5'=494'	
	Riders/Mile: 1,028	
ROW: Dedicated surface ROW with grade crossings downtown; one tunnel segment; outlying portions on old rail ROW with grade crossings	**Min/Max Headway (Mins):** 10/30	**Max Riders/Hr:** 4,700
Cost: $2.3B	**Major Funding Sources:** Local sales tax, federal	

Description: Large hub-and-spoke system, with all four lines running on same two-track downtown Dallas Corridor. Lines outside CBD mostly use former freight railroad right of way.

History: In 1983 voters in Dallas and 13 suburbs approved creation of the Dallas Area Transit Authority, to be funded by 1¢ sales tax and promise of upgrading bus system. High costs to expand bus service coupled with wrangling over cost and type of rail service delayed opening of 20-mile starter rail system until 1996, with additions through 2014. Traffic signal priority downtown permits more frequent service. According to DART, development within 0.25 miles of a DART station totaled >$1.5B from 1993 to 2013, compared to $600M in markets without rail access. Existing, under construction, and planned developments near DART stations totaled $5.4B.

Pros: Connects to commuter rail, Amtrak, airport; convenient CBD service.

Cons: Use of 2-track surface ROW by all four lines slows service, limits service frequency, capacity. Low ridership on a per-mile basis. Transit usage not supported by local policy, which favors cheap downtown parking, additional highway construction.

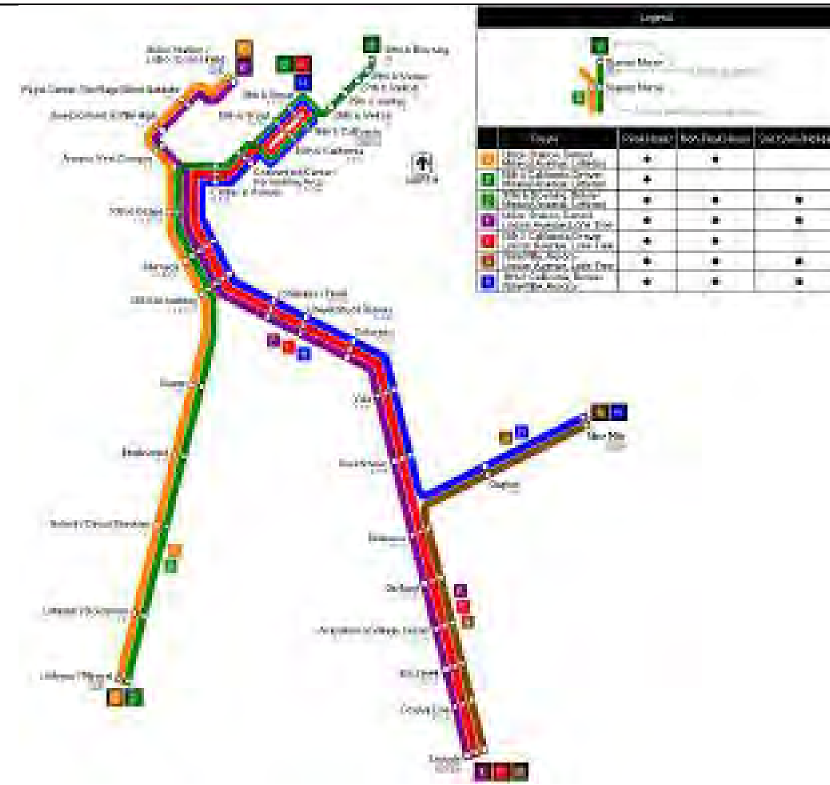
System: Denver RTD light rail		
Type: Light rail	**Weekday Ridership:** 85,900	
Opened: 1994	**Lines/Stops:** 6/46	**Length:** 47 mi
Max Riders/Train: 182 seated + 242 standing = 370	**Vehicle Width, Max Length:** 8'8", 2x81.5"=162'10"' **Riders/Mile:** 1,828	
ROW: Dedicated surface ROW w/grade crossings downtown; parallel to highways, rail ROWs in outlying areas	**Min/Max Headway (Mins):** 10/30	**Max Riders/Hr:** 4,440
Cost: ?	**Major Funding Sources:** Local use tax, FTA	

Description: Typical modern LRV system with all lines converging on single 2-track corridor through CBD, in this case a one-way pair.

History: Denver Regional Transportation District initially built a 5.3-mile Central Corridor line for $115 million, paid for by local business use tax plus revenue bonds – no federal money was used. Central Corridor, running from 30th Avenue and Downing in the Five Points district through downtown Denver via Welton, California/Stout Streets and W. Colfax, then along the BNSF Colorado Joint Line right-of-way south to I-25/Broadway, opened in 1994. By 1999, over 16,000 riders were being carried each weekday. Several lines have been since been added.

Pros: Convenient to CBD, many downtown destinations, including Union Station. High ridership considering late system start.

Cons: Service relatively infrequent. All lines converge on one 2-track corridor through CBD with dedicated ROW but grade crossings at every street, limiting speed and throughput. Much of outlying service area thinly populated. Many outlying stations difficult to reach on foot; many riders arrive by car and use park-and-ride facilities.



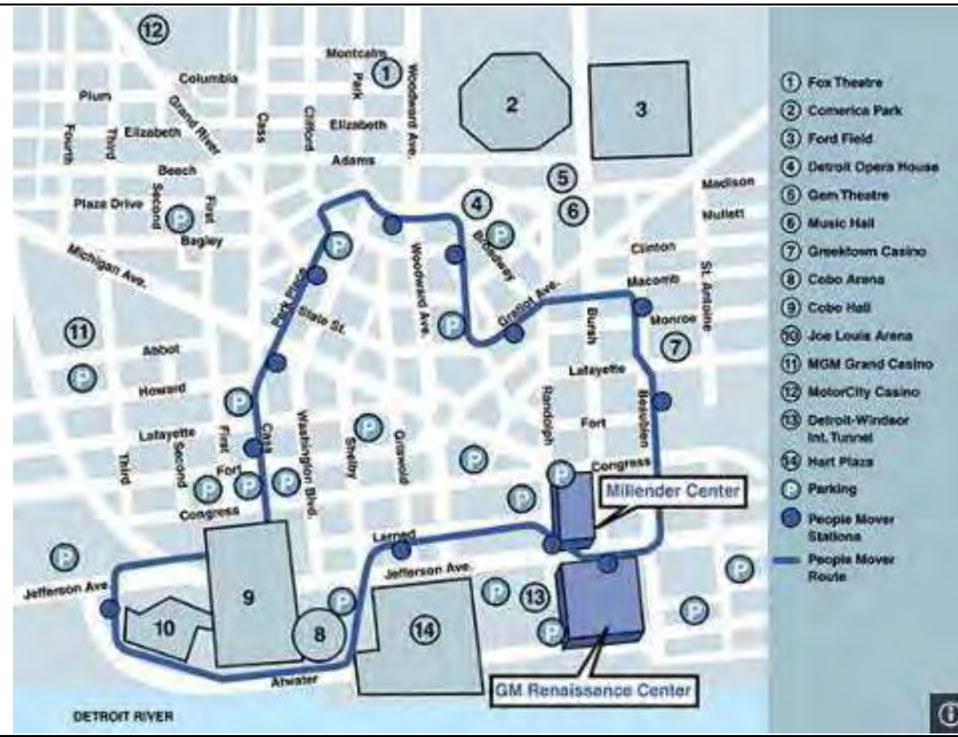
System: Detroit People Mover		
Type: Automated people mover	**Weekday Ridership:** 6,000	
Opened: 1987	**Lines/Stops:** 1/13	**Length**: 2.9 mi
Max Riders/Train: 68 seats + 132=200	**Vehicle Width, Max Length:** 8'2", 2x41'8"=83.6"	
	Riders/Mile: 2,069	
ROW: Grade-separated (elevated) single-track ROW	**Min/Max Headway (Mins):** 2.5/4	**Max Riders/Hr:** 4,700
Cost: $446M	**Major Funding Sources:** Federal	

Description: Automated people mover circling downtown Detroit

History: Intended as downtown distributor for a proposed citywide light rail system that was scrapped when squabbling among local leaders led to withdrawal of $600M in promised federal funds. People Mover built nonetheless but projected daily ridership of 67,700 never materialized.

Pros: Frequent service due to automated operation; convenient to many downtown destinations.

Cons: Limited usefulness given absence of citywide rail system – an LRV system is being planned. Single track operation inconvenient.



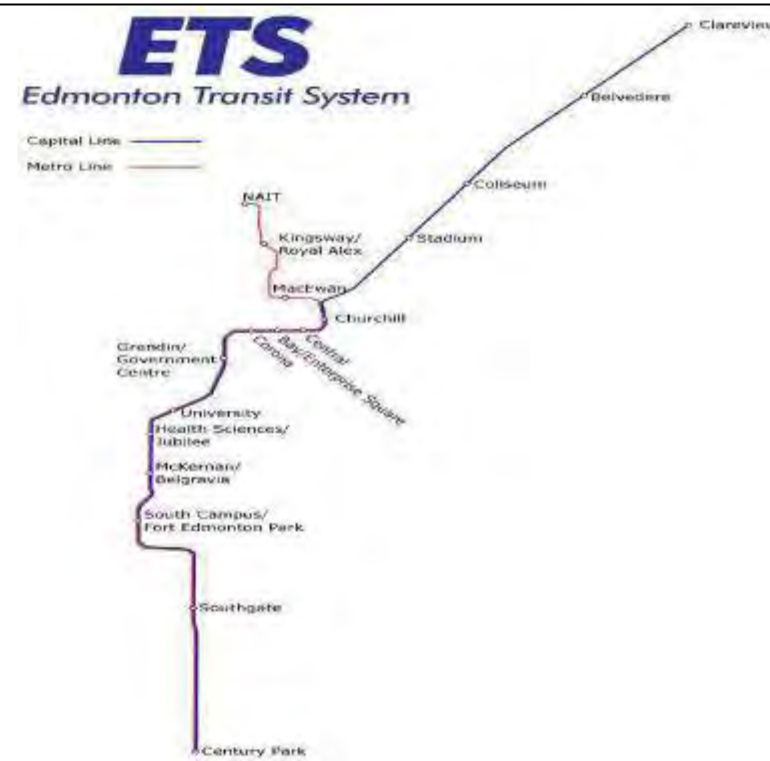
City/System: Edmonton Light Rail Transit		
Type: Light rail	**Weekday Ridership:** 100,760	
Opened: 1978-2015	**Lines/Stops:** 2/18	**Length:** 15.1 mi
Max Riders/Train: Not determined	**Vehicle Width, Max Length:** 8’8”, 79’8”x5=398’4”	
	Riders/Mile: 6,673	
ROW: Tunnel downtown; private ROW in tunnel, elevated structure, at-grade w/gated crossings outlying	**Min/Max Headway (Mins):** 5/15	**Max Riders/Hr:** Not determined
Cost: First phase $65M	**Major Funding Sources:** Federal, provincial, city governments	

Description: First modern light rail system in North America – i.e., not a former streetcar or interurban operation

History: Original line followed CN rail ROW to downtown tunnel; several later extensions, most recently 2.1 mi branch opened in Sept. 2015. Pioneered proof-of-payment (honor system) fare collection, now common in North American light rail systems.

Pros: High ridership, frequent service given size of city (878K city, 1.3M metro, density 5K/sq.mi.). Downtown subway portions link to Edmonton pedway. High average speed (22 mph end-to-end for Capital Line) due to widely spaced stations, dedicated right of way. No street operation downtown; grade crossings in outlying areas are mostly gated, giving transit priority. Public policy favors transit – nearest limited-access highway is two miles from downtown.

Cons: Limited service area – single line with short branch, although additional routes planned. Environment of some outlying stations not pedestrian friendly.



System: Houston METRORail		
Type: Light rail	**Weekday Ridership:** 55,000	
Opened: 2004	**Lines/Stops:** 3/37	**Length**: 22.7 mi
Max Riders/Train: 144 seats + 338 standing = 482	**Vehicle Width, Max Length:** 8'8", 2x96.5"=192'10"'	
	Riders/Mile: 2,423	
ROW: Dedicated surface ROW w/grade crossings downtown; parallel to roads, rail ROWs in outlying areas. Some elevated structure.	**Min/Max Headway (Mins):** Not determined	**Max Riders/Hr:** 4,820
Cost: $2.3B	**Major Funding Sources:** Local use tax, FTA	

Description: Radial light rail system with all lines converging on downtown.

History: Voter referendum approved 20-mile light rail plan in 1988 but implementation delayed due to local opposition. 7.5-mile first phase started construction in 2001, opened in 2004; several extensions since.

Pros: Relatively high ridership considering brief operating history. Attractive trains and stations.

Cons: Highest collision rate of any U.S. light rail system at one point due mainly to illegal left turns by motorists; improved traffic signals (e.g., 4-way red lights) cut this 75%. Some mixed-traffic operation in Texas Medical Center. Many ungated grade crossings. Reserved transit lanes have minimal separation from parallel vehicular traffic.

System: Hudson-Bergen Light Rail (NJ Transit)			
Type: Light rail	**Weekday Ridership:** 54,434		
Opened: 2000	**Lines/Stops:** 3/24	**Length:** 17 mi	
Max Riders/Train: 190 (old), 300 (new)	**Vehicle Width, Max Length:** 8'10", 90' (old), 127' (new); 2 car consists		
	Riders/Mile: 3,202		
ROW: Dedicated surface ROW with grade crossings, short mixed traffic segment in Jersey City; old rail ROW with grade crossings, some grade separated segments in outlying areas	**Min/Max Headway (Mins):** 5/10	**Max Riders/Hr:** 4,700	
Cost: $2.2B	**Major Funding Sources:** State, federal		

Description: Connects NJ waterfront to PATH trains to Manhattan, Hoboken ferry terminal.

History: NJ Transit awarded design/build/operate/maintain contract to private firm (now part of URS), which provided vehicles and will operate and maintain system for 20 years for a fixed price.

Pros: Connects with commuter services to Manhattan, although transfer in some cases inconvenient. Has stimulated some waterfront redevelopment. Fare collection integrated with NJ Transit services. Relatively little street operation.

Cons: Some stations inconveniently located. Much of corridor formerly industrial, not pedestrian-friendly. Some mixed-traffic operation in Jersey City.

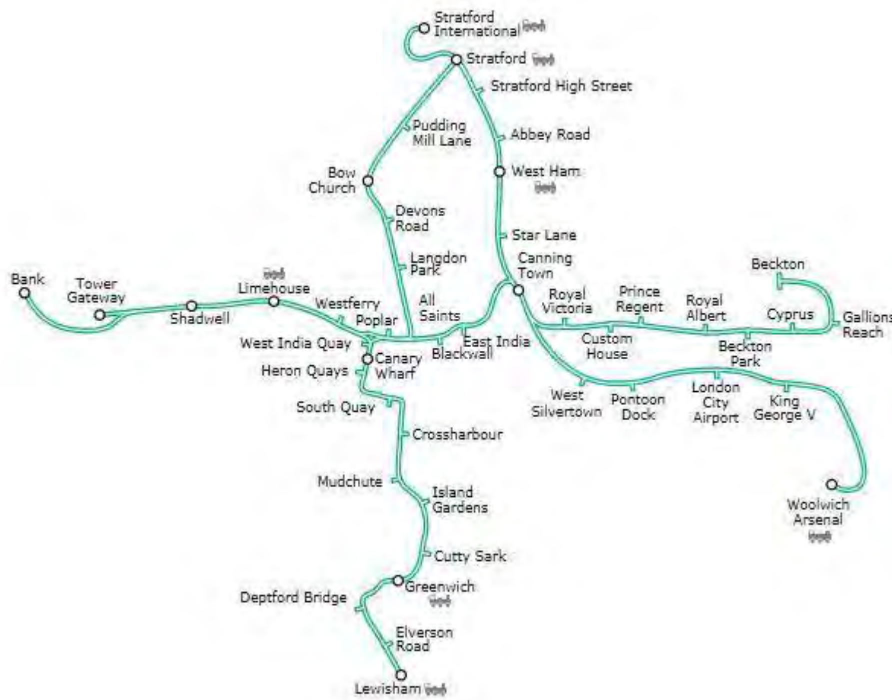
City/System: London/Docklands Light Railway		
Type: Automated light metro	**Weekday Ridership:** 278,100	
Opened: 1987-2011	**Lines/Stops:** 7/45	**Length:** 21 mi
Max Riders/Train: 852	**Vehicle Width, Max Length:** 8'8", 3x91.10"=275'6"	
	Riders/Mile: 13,243	
ROW: Almost entirely grade separated – in subway in central London, on old RR ROW outlying; some purpose-built structure.	**Min/Max Headway (Mins):** 7/14	**Max Riders/Hr:** 7,300
Cost: £751M as of 1996	**Major Funding Sources:** UK Dept. of Transport through urban development corporation, a quasi-public entity; later privatized. £95M contribution by private developer	

Description: Light metro system built to support redevelopment of disused East London dockyards as extension of financial district.

History: Dock district declined in 1960s, acquired by government in 1980. London Docklands Development Corp. created in 1981. Initial 12km system opened 1987; multiple extensions constructed since through public-private partnerships. Built primarily on or adjacent to existing RR ROW. In 1998, LDDC claimed £2.5B ($4B) in public investment had stimulated £10B ($16B) in private development, creating 25M s.f. of commercial space, 24,000 dwellings.

Pros: Convenient transfer to London Underground, suburban rail. Heavily patronized; significant development stimulus. Attractive trains and stations. Automated operation; one attendant per train, stations unstaffed. No street operation although some at-grade segments. First phase built at modest cost by comparison to U.S. systems – £90M. Total cost up to 1996 £751M.

Cons: As initially designed**, l**ow capacity, poor Tube connections. With increase in traffic, transfer facilities improved; 1-unit consists expanded to 3, requiring platform extensions. At short stations where extension not practical, end doors on 3-unit trains do not open.



City/System: Los Angeles/Metro Rail (Blue, Green, Gold, Expo light rail lines)		
Type: Light rail	**Weekday Ridership:** 193,600	
Opened: 1990	**Lines/Stops:** 4/58	**Length:** 64.8 mi
Max Riders/Train: 352	**Vehicle Width, Max Length:** 8'8.5", 2x89'6"=179'	
	Riders/Mile: 2,988	
ROW: Tunnel, elevated, dedicated at-grade w/crossings. Extensive use of ex-RR ROW	**Min/Max Headway (Mins):** 12/20	**Max Riders/Hr:** 1,760
Cost: Not determined – multiple projects over many years	**Major Funding Sources:** Voter-approved sales tax	

Description: Part of comprehensive urban rail/BRT system; second highest light rail ridership in U.S. after Boston Green Line.

History: Planning began in 1970s. Blue Line opened in 1990; many subsequent system expansions. Five extensions or new lines currently under construction.

Pros: Comprehensive system, well integrated with heavy rail, commuter rail, BRT. High ridership on per-mile basis considering historical auto dominance. Green Line fully elevated. Dependable funding stream from sales tax has permitted steady expansion.

Cons: Extensive at-grade operation, resulting in many problems. Frequent collisions at Blue Line grade crossings (28 gated, 62 ungated) in early 90s, mostly due to illegal left hand turns by motorists; accidents substantially reduced at gated crossings due to increased enforcement, public education, but remain a concern at ungated crossings. Blue Line train length limited by downtown Long Beach block length to 3-unit consists. Tight street clearances on portion of Gold Line limit train speed to 20 m.p.h. Proof of purchase fare collection enables unstaffed stations but has led to high fare evasion; faregates now installed at some light rail, all heavy rail and all future stations.

City/System: Los Angeles Metro – Orange Line		
Type: Bus rapid transit	**Weekday Ridership:** 25,369	
Opened: 2005	**Lines/Stops:** 18	**Length:** 18 mi
Max Riders/Bus: 57 seated plus standees=~90	**Vehicle Length:** 60’ **Riders/Mile:** 1,409	
ROW: Dedicated former at-grade rail ROW with grade crossings, except several blocks of street running near Warner Center	**Min/Max Headway (Mins):** 4/18	**Max Riders/Hr:** 1,350 under current schedule
Cost: $324M/$18M mi	**Major Funding Sources:** Voter-approved sales tax	

Description: Busway links San Fernando Valley to Red Line subway to downtown LA. Not referred to as BRT by agency but has many BRT features such as dedicated ROW, widely spaced stops, sheltered stations, off-board fare payment, boarding at all three doors.

History: Ex-rail corridor initially envisioned as extension of Red Line subway, but high rail construction cost, local opposition necessitated buses instead.

Pros: Busiest bus line in San Fernando Valley.

Cons: Line said to be approaching design capacity. Conversion to light rail would cost >$1.2B.

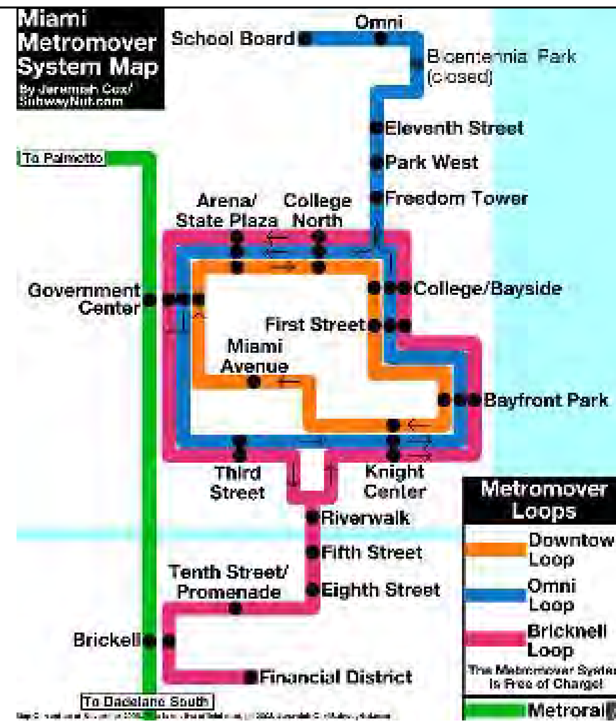
City/System: Miami Metromover		
Type: Automated people mover (APM)	**Weekday Ridership:** 35,300	
Opened: 1986-1994	**Lines/Stops:** 3/21	**Length:** 4.4 mi
Max Riders/Train: 22 seats+83=105x2=210	**Vehicle Width, Max Length:** 9’2.4”, 2x42’=84’	
	Riders/Mile: 8,023	
ROW: Fully grade separated, mostly on elevated structure	**Min/Max Headway (Mins):** 2.5/6	**Max Riders/Hr:** 2,520
Cost: $660M in 2011 dollars – $165M/mi	**Major Funding Sources:** Half penny transit tax approved 2002	

Description: One of three demonstration people mover projects built in U.S. as part of federal initiative – others in Detroit, Jacksonville. Automated rubber-tired vehicles distribute heavy-rail riders to downtown destinations. Stations approximately every quarter mile. Two-car trains operate on downtown loop; one-car trains on branches.

History: Originally a 1.9 mi downtown loop with branches added later. Ridership lower than expected until fare waived in 2002; subsequently doubled. People mover program long considered a failure but Metromover ridership per mile exceeds all U.S. light rail systems except Boston Green Line.

Pros: Frequent service convenient to major downtown destinations. Low cost of operation (~$1/trip as of 2008). 25c fare discontinued because cost of collection ~same as revenue received.

Cons: Slow operation due to closely space stations; average speed 12 m.p.h.; 30 m.p.h. max. High construction cost. Ridership has yet to achieve original projection of 43,000/day.



City/System: New York/1st-2nd Av (M15 SBS), 34th St (M34 SBS) Select Bus Service		
Type: Bus rapid transit	**Weekday Ridership:** M15 49,597; M34 15,945	
Opened: M15 2010, M34 2011	**Stops:** M15 20,	**Length**: M15 8. 5 mi; M34 2.5 mi
Max Riders/Vehicle: 100	**Vehicle Length:** 60’ **Riders/Mile:** M15 5,835; M34 6,378	
ROW: Dedicated lanes M34, M15 north of Houston St.; Mi15 mixed traffic south of Houston	**Min/Max Headway (Mins):** Not determined	**Max Riders/Hr:** Not determined
Cost: M15 $18M, M34 $5M	**Major Funding Sources:** Internal	

Description: Select Bus Service is New York’s version of BRT; currently seven routes total. M15 ridership figure reflects mix of SBS, local service; M34 ridership 100% SBS

History: SBS implemented in response to slow local bus operating speeds, poor access to and crowding on subways. M15 corridor (1st and 2nd Av one-way pair) parallel to but distant from crush-loaded Lexington Av subway. SBS lines typically but not always feature off-board fare payment, articulated buses, dedicated lanes, widely spaced stops. Some segments of some lines have traffic signal priority.

Pros: Inexpensive to implement; MTA claims 16%-22% faster operation than previous local bus service. On overall and per-mile basis, probably highest ridership of any U.S. BRT system, although comprehensive data lacking.

Cons: No net increase in riders. SBS ridership, like all NYC bus ridership, in decline; 10% drop in M15 ridership between 2013 and 2014. Ridership on all SBS lines now lower than local bus service it replaced; subway ridership increased during same period. Traffic congestion a factor on M15; dedicated lanes sometimes blocked by delivery vehicles; 2nd Av subway construction causes delays.

City/System: Philadelphia (SEPTA) subway-surface trolley lines		
Type: LRV/streetcar hybrid	**Weekday Ridership:** 84,829 (total trolley ridership inc. surface only 111,900)	
Opened: 1906	**Lines:** 5	**Length:** 19.8 mi
Max Riders/Train: 101	**Vehicle Width, Max Length:** 8’6”, 50’	
	Riders/Mile: 4,284	
ROW: Tunnel downtown, mostly mixed traffic elsewhere	**Min/Max Headway (Mins):** 5/35	**Max Riders/Hr:**
Cost: Legacy system	**Major Funding Sources:** Various	

Description: Subway-surface trolleys operate through Philadelphia Center City in tunnel shared with Market–Frankford heavy rail line; in mixed traffic elsewhere. One other streetcar line (#15 Girard) operates entirely on surface; two suburban trolley lines originate at Market-Frankford terminal.

History: Subway-surface trolleys plus Girard Av line are what remains of originally much larger Philadelphia streetcar system, most of which was replaced by buses after WW2.

Pros: Tunnel speeds operation through Center City, serves major destinations, provides convenient connections to heavy rail, commuter rail, Amtrak. Outlying sections run on commercial streets well served by retail. Relatively high ridership despite single-car operation, in contrast to Boston, San Francisco, and most modern light rail lines, which operate multi-unit trains during peak times.

Cons: Outside downtown, mixed traffic operation (ROW shared with other vehicles) slows service.

City/System: Portland – TriMet MAX Light Rail		
Type: Light rail	**Weekday Ridership:** 113,900	
Opened: 1986-2015	**Lines/Stops:** 5/97	**Length:** 59.7 mi
Max Riders/Train: 72 seats+156=228	**Vehicle Width, Max Length:** 8’8.4”, 2x95’5”=190’10”	
	Riders/Mile: 2,190	
ROW: Dedicated lanes w/grade crossings in city, mostly grade separated private ROW outlying, inc. highway shoulders, medians; tunnel; elevated structure	**Min/Max Headway (Mins):** 15 (10 Blue Line at peak)/15; more frequently in corridors with multiple lines	**Max Riders/Hr:** 1,908
Cost: $3B as of 2004	**Major Funding Sources:** Initial line built using federal funds for cancelled freeway.	
Description: Modern regional light rail system.		
History: Tri-County Metropolitan Transit District (Tri-Met) used funds for cancelled Mt. Hood freeway to build Blue Line on intended freeway alignment. Service began 1986, extended to undeveloped west side in 1998 for 33 mi total length. Red Line to airport opened 2001, Yellow Line to Expo Center in 2004, Green Line to Portland State U. 2009, Orange Line to Milwaukie 2015		
Pros: In combination with Portland Streetcar, provides access to most major destinations in downtown. Has stimulated development in many corridors. Well integrated into downtown environment. Transit strongly supported by local officials; Portland a pioneer in transit-oriented development. Service infrequent in outlying areas by big-city standards, but nonetheless much shorter off-peak headways (15 mins) than typical suburban commuter rail elsewhere (1 hr).		
Cons: Despite Portland’s transit-friendly reputation, MAX has much lower ridership per mile than Canadian systems built in same era in smaller cities (Calgary metro 1.2M, Edmonton 1.2M vs. Portland 2.3M), possibly due to close proximity of two interstate highways to Portland downtown.		

City/System: Portland Streetcar

Type: Streetcar	**Weekday Ridership:** 20,000	
Opened: 2001-2012	**Lines/Stops:** 2/76	**Length:** 7.2 mi
Max Riders/Vehicle: 127 (mostly standing; few seats)	**Vehicle Width, Max Length:** 8’1”, 66’1” **Riders/Mile:** 2,083	
ROW: Mixed traffic	**Min/Max Headway (Mins):** 12/14	**Max Riders/Hr:** 635
Cost: $223.4M	**Major Funding Sources:** FTA, TriMet, fares, city parking revenue, and "local improvement district" (special tax levied on properties near line)	

Description: Distributor streetcar system for downtown Portland. Consists of two routes, one running north-south through the CBD and nearby neighborhoods, the other a loop linking downtown to a former industrial district on west side of Willamette River. Owned by city of Portland, operated by TriMet transit agency, managed by public benefit corporation. Free fare zone discontinued in 2012; fares now paid on honor system with occasional inspections. Tickets sold at vending machines at stops and aboard vehicles; operator does not collect.

History: Launched in 2001 to stimulate central area development, connect to major attractions, reduce downtown auto use. Mixed-traffic streetcar service chosen to reduce cost. Agency claims $3.5B in investment within 2 blocks of alignment as of 2008; development near tracks is higher density than projects more distant. Strong mixed-use growth in neighborhoods near downtown served by streetcar.

Pros: Attractive, pedestrian-friendly vehicles and facilities well integrated into urban environment. Convenient access to MAX light rail system, central area destinations. Free transfer between streetcar and TriMet service. Ridership has grown steadily. Riders can board at all doors due to proof of payment fare system. Low-floor boarding.

Cons: Slow due to mixed traffic operation, numerous turns, infrequent service. Vehicles do not have traffic signal priority. Limited capacity; single-car operation only.

City/System: San Diego Trolley		
Type: Streetcar	**Weekday Ridership:** 119,800	
Opened: 1981-2005	**Lines/Stops:** 3/53	**Length**: 53.5 mi
Max Riders/Train: 204 seats+486=690	**Vehicle Width, Max Length:** 8’8”, 3x93’6”=280’10”	
	Riders/Mile: 2,239	
ROW: Dedicated lanes w/grade crossings in city, ex-rail ROW in outlying areas; much of Green Line elevated or in subway	**Min/Max Headway (Mins):** 7.5/30	**Max Riders/Hr:** 5,520
Cost: $2.869B	**Major Funding Sources:** State, U.S., local sales tax, fares	

Description: First modern U.S. light rail system, 2nd in North America (after Edmonton) – i.e., not a former streetcar or interurban operation

History: Metropolitan Transit Development Board, established in 1976, decided light rail in dedicated at-grade ROW offered best mix of speed, reach and affordability. South (now Blue) Line to San Ysidro/Tijuana built on old freight rail ROW, opened 1981; East (Orange) Line, also on ex-freight ROW, started operation 1987, later extended; Green Line opened 2005. Silver Line operates as downtown circulator service using vintage trolleys.

Pros: Convenient downtown service, well integrated with buses, commuter rail, Amtrak; well patronized considering historical auto dominance. Attractive stations and trains.

Cons: Much lower ridership than systems built in smaller Canadian cities during same era (Calgary, Edmonton), perhaps due to close proximity of downtown San Diego to multiple interstate highways. Service relatively infrequent – Blue headway 7.5 mins at peak, 15 min baseline; Green and Orange 15 mins during day.

City/System: San Francisco – Muni Metro		
Type: Light rail/streetcar hybrid	**Weekday Ridership:** 150,300 (reported numbers vary widely)	
Opened: 1917-2007	**Lines/Stops:** 7/120 (inc. peak-hr shuttle)	**Length:** 36.8 mi
Max Riders/Train: 60 seats+100 standing = 160/car x 2=320/train	**Vehicle Width, Max Length:** 9', 75'x2=150' **Riders/Mile:** 4,084	
ROW: Tunnel downtown; outlying mostly mixed traffic, some dedicated ROW inc. all of T-Third line, additional tunnel	**Min/Max Headway (Mins):** 9/20	**Max Riders/Hr:** 2,133
Cost: Legacy system	**Major Funding Sources:** $1.6B Central Subway funded primarily through FTA New Starts program plus state, county, city.	

Description: Upgraded streetcar system with light rail elements on downtown backbone section and T-Third line. Central Subway now under construction will re-route T-Third line from Caltrain commuter rail terminal to Chinatown.

History: Most San Francisco streetcars converted to bus after WW2; those remaining operated on surface routes until construction of Market St. subway for BART heavy rail system, following which they were re-routed into tunnel's upper level. In outlying areas, older lines still operate in mixed traffic. T-Third line to southeast part of city, which opened in 2007, runs in reserved lanes with grade crossings.

Pros: Convenient access to downtown destinations, BART, Caltrain. Growing ridership. Reserved lanes recently established for J-Church line.

Cons: Slow service, poor on-time record due to mixed traffic operation, too many trains in Market St. tunnel; upgraded signaling has resolved latter issue for now. History of equipment problems. Numerous lines using Market St. tunnel limits service frequency, capacity; Central Subway will partly relieve this problem.

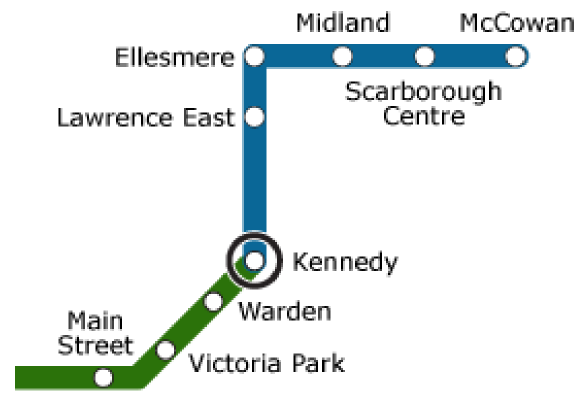
City/System: Toronto – Line 3 Scarborough		
Type: Automated light metro	**Weekday Ridership:** 32,000	
Opened: 1985	**Lines/Stops:** 1/6	**Length:** 4 mi
Max Riders/Train: 34 seats+66=100/car x 4=400	**Vehicle Width, Max Length:** 8’2”, 4x41’8”=166’8”	
	Riders/Mile: 8,000	
ROW: Dedicated private ROW with no crossings – variously elevated, at grade, or in tunnel	**Min/Max Headway (Mins):** 4/6	**Max Riders/Hr:** 6,000
Cost:	**Major Funding Sources:** Ontario provincial government	

Description: Suburban branch line connecting to Toronto heavy rail system. Automated but single operator kept on each train due to resistance from unions, public.

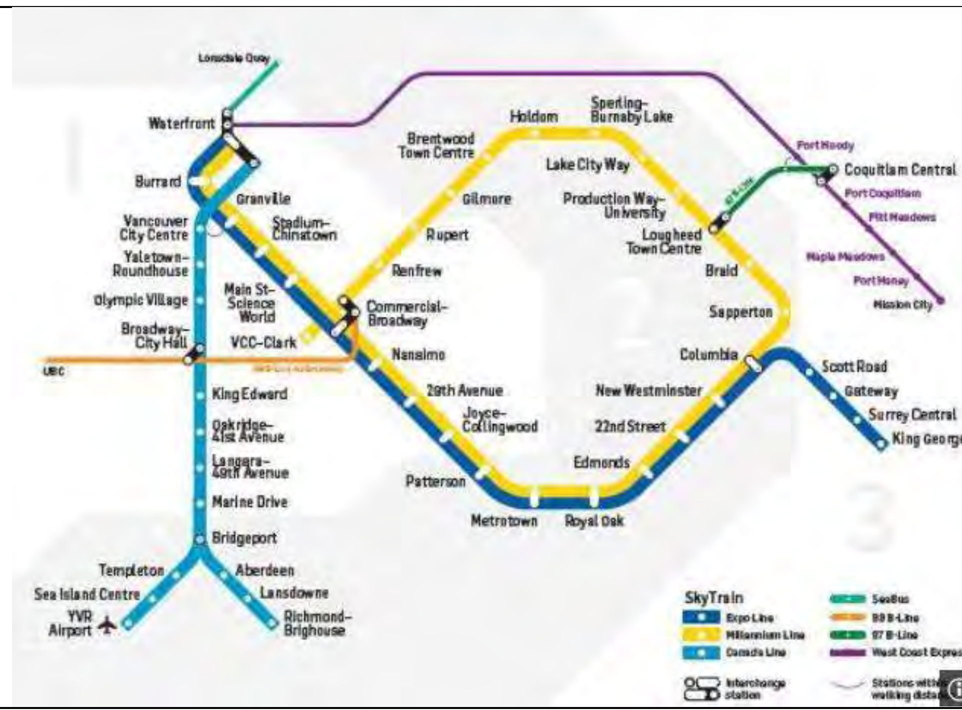
History: Originally planned as a suburban streetcar line, converted to automated light metro using rolling stock manufactured by Ontario firm (now a division of Bombardier) when provincial government agreed to pay most of the cost. Propelled by linear induction rather than conventional motors; vehicles identical to those initially used for Vancouver SkyTrain, Detroit People Mover. Now considered obsolete, the line will be replaced by an extension of the Bloor-Danforth subway.

Pros: High ridership considering it serves a thinly populated suburban area. Frequent service, low operating cost.

Cons: Rolling stock incompatible with other Toronto rail lines



<table>
<tr><td colspan="3">City/System: Vancouver SkyTrain</td></tr>
<tr><td>Type: Light metro</td><td colspan="2">Weekday Ridership: 390,600</td></tr>
<tr><td>Opened: 1985</td><td>Lines/Stops: 3/47</td><td>Length: 42.7 mi</td></tr>
<tr><td rowspan="2">Max Riders/Train: 480 to 580; Canada Line 800 (4 cars @ 200 crush load)</td><td colspan="2">Vehicle Width, Max Length: Various; maximum train length ~20’. Canada Line trains 9’10” wide x 65’7”, max ~263’</td></tr>
<tr><td colspan="2">Riders/Mile: 9,148</td></tr>
<tr><td>ROW: Grade separated, mostly on elevated structure, some subway</td><td>Min/Max Headway (Mins): 1.8/10 on core segments, 2.7/20 on outlying</td><td>Max Riders/Hr: 8,622; Canada Line upgradeable to 15,000</td></tr>
<tr><td>Cost: $3.333B ($78M/mile)</td><td colspan="2">Major Funding Sources: Federal, provincial governments, TransLink (regional public transit authority), airport authority, city of Vancouver – mix varies with line. Operating expenses subsidized through fuel, property tax. Canada Line built through public/private partnership.</td></tr>
<tr><td colspan="3">Description: Automated light metro</td></tr>
<tr><td colspan="3">History: Initial Expo Line built for Expo 86, multiple extensions and new lines since. 6.8 mi Evergreen Line set to open in 2016. Vancouver public policy historically has discouraged freeway construction. The city has only one major freeway, which is two miles from downtown at the closest point.</td></tr>
<tr><td colspan="3">Pros: Fast, frequent service due to grade separation. 96% on-time performance claimed. High ridership. Low construction cost – $78M/mi. Low operating cost due to automation; in 2007 agency claimed fares covered all costs of operation. System said to have stimulated $5B in development.</td></tr>
<tr><td colspan="3">Cons: 5% fare evasion due to proof-of-payment fare system (tickets sold at vending machines in stations but no turnstiles). Faregates subsequently installed but not yet operational due to technical issues.</td></tr>
</table>



Appendix K – Estimation of Connector Running Times

Connector running times, which were needed to gauge project development impact, were estimated using a Mott MacDonald model. Assumptions:

- Route: as depicted in Figure E-16. Grade-separated except for gated crossings in Carroll Ave.; priority given to transit.
- Vehicle operating characteristics: similar to those of CTA rail cars. Vehicles capable of reaching speeds of 50 MPH.
- Average walking time from Metra to Connector: three minutes.
- Average dwell (standing) time in stations: 20 seconds.

The following procedure was used:

- The proposed route was mapped and GPS coordinates were determined for key locations. A typical route map is shown in Figure K-1.

Figure K-1. Typical route map

- GPS coordinates and other necessary data were entered into the model and station-to-station running times were estimated between each pair of Connector end points, taking account of curves, grades and vehicle characteristics such as acceleration and braking rates.
- Results were generated in two forms – first, a spreadsheet showing running times between stations, and second, a plot of estimated train speed vs. distance. Figure K-2 shows the spreadsheet of running times for the run from Navy Pier to the 18th St. Pink Line station.

Run Times - Estimated Curve Speeds				
Northbound				
Course	Station	Arr. Actual [HH:MM:SS]	Dep. Actual [HH:MM:SS]	Station to Station Times No Dwell
NB100	18th Street		8:00:00	
NB100	Blue Island	8:01:16	8:01:36	0:01:16
NB100	Halsted	8:02:56	8:03:16	0:01:20
NB100	Roosevelt/Wells	8:05:55	8:06:15	0:02:39
NB100	Lasalle	8:07:24	8:07:44	0:01:09
NB100	Union	8:09:33	8:09:53	0:01:49
NB100	Ogilvie	8:11:01	8:11:21	0:01:08
NB100	Clinton/Lake Street	8:12:00	8:12:20	0:00:39
NB100	Merchandise Mart	8:14:05	8:14:25	0:01:45
NB100	State Street	8:15:31	8:15:51	0:01:06
NB100	Wabash/Michigan	8:16:47	8:17:07	0:00:56
NB100	Columbus/Illinois	8:18:00	8:18:20	0:00:53
NB100	Peshtigo	8:19:17	8:19:37	0:00:57
NB100	Navy Pier	8:20:27		0:00:50
			Total Run Time	**0:16:27**
Southbound				
Course	Station	Arr. Actual [HH:MM:SS]	Dep. Actual [HH:MM:SS]	Station to Station Times No Dwell
SB100	Navy Pier		8:00:00	
SB100	Peshtigo	8:00:53	8:01:13	0:00:53
SB100	Columbus/Illinois	8:02:02	8:02:22	0:00:49
SB100	Wabash/Michigan	8:03:16	8:03:36	0:00:54
SB100	State Street	8:04:30	8:04:50	0:00:54
SB100	Merchandise Mart	8:05:55	8:06:15	0:01:05
SB100	Clinton/Lake Street	8:07:49	8:08:09	0:01:34
SB100	Ogilvie	8:08:48	8:09:08	0:00:39
SB100	Union	8:10:19	8:10:39	0:01:11
SB100	Lasalle	8:12:27	8:12:47	0:01:48
SB100	Roosevelt/Wells	8:14:00	8:14:20	0:01:13
SB100	Halsted	8:16:49	8:17:09	0:02:29
SB100	Blue Island	8:18:23	8:18:43	0:01:14
SB100	18th Street	8:19:59		0:01:16
			Total Run Time	**0:15:59**

Figure K-2. Spreadsheet showing typical Connector running times

Speed-Distance Plot - Estimated Speeds

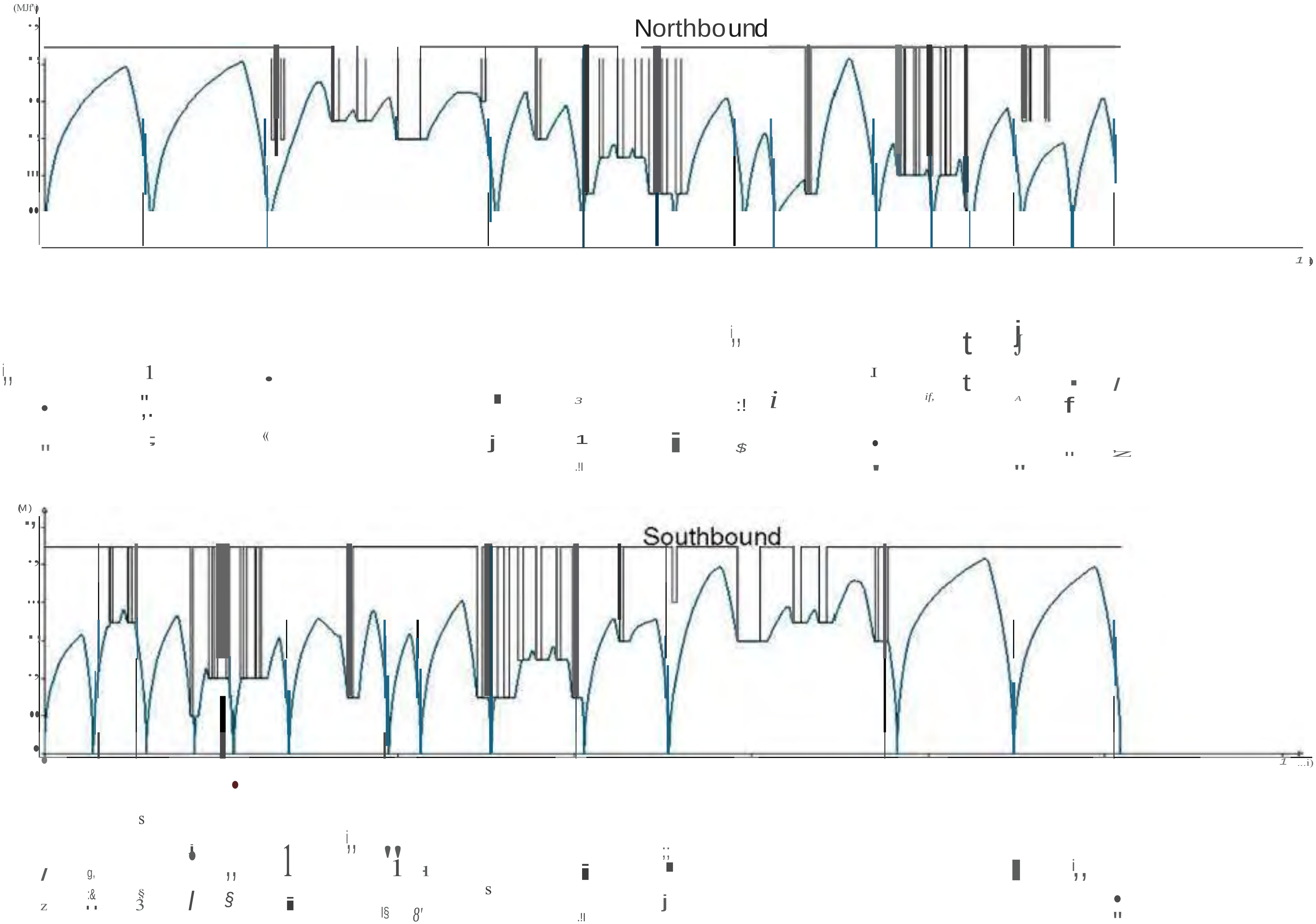


Figure K-3. Typical speed-distance plot, Navy Pier to is•h St./Pink Line

- Figure K-3 shows the speed/distance plot for the Navy Pier/18th St. run. Note that two lines are shown. The sawtooth gray line indicates speed restrictions due to curves, etc. The blue line is estimated vehicle speed.

As explained in Appendix G, Connector running times were needed to gauge the project's potential impact on office development. Viability of office sites was shown to be mainly a function of "last mile" travel time for Metra riders, with 15 minutes the maximum time such riders were willing to spend traveling from Metra to their workplaces (travel time = transit + walking). Locations easily reachable via both Metra and the "L" collectively constitute the "rail hub," which historically has attracted almost all large-scale office development. To calculate the extent to which the Connector would enlarge the rail hub by bringing additional development sites within the 15-minute travel-time horizon, the following procedure was used:

- The West Loop Metra terminals, Union Station and Ogilvie Transportation Center, were observed to be the dominant factor in office location decisions. Therefore, the starting place for travel time calculation was designated as Clinton and Monroe, the point on the Connector route midway between these two terminals.

- The spreadsheet shown in Figure K-4 on the next page was created. Assumptions:

    - Maximum travel time = 15 mins × 60 secs/min = 900 secs
    - Average time to walk from Metra to Connector = 180 secs (3 mins)
    - Travel time from starting point to Union Station or Ogilvie Transportation Center = 68 secs/2 = 34 secs
    - Station-to-station running times taken from Mott MacDonald spreadsheets
    - Dwell time per station = 20 seconds.

- Elapsed time on arrival at each Connector station (in seconds) was subtracted from 900 to produce the remaining time to reach the workplace on foot within the 15-minute window.

- Seconds of remaining time × 1.333 m/sec walking speed = radii of walksheds around destination stations (in meters via existing sidewalks). Stations beyond the 15-minute travel time horizon are grayed out in Figure K-4. As can be seen, only a few outlying Connector stations were beyond the 15-minute horizon.

- The walkshed radii were then plugged into the GIS model used in Appendix G to generate the map of the expanded rail hub shown in Figure G-9.

- End-to-end speed on the 2-mile minimum operable segment (MOS) – that is, from Union Station to Columbus/Illinois – would be 7:47, for an average speed of ~15.5 MPH, compared to 9 MPH for BRT or at-grade light rail or 3-5 MPH for conventional bus. Overall speed between terminals, e.g., Navy Pier to 18th St./Pink, would be 20.3 minutes for the 6.09 mile run or 18 MPH.

Distance from Metra is not the only factor in determining viability of office development sites. However, the foregoing analysis suggests that:

- If built on grade-separated right of way as proposed, the Connector would largely eliminate the current requirement that new office buildings be located within walking distance of the West Loop Metra terminals. Historically most new office development in central Chicago has been contiguous to existing offices. If the Connector were built it would be possible to establish multiple geographically distinct office nodes within the central area, as has already begun to occur.

- Significant enlargement of the rail hub is a function of transit speed, which is made possible by grade separation. As seen in Figure K-3, Connector trains would reach speeds of 30-40 MPH on portions of the MOS and 50 MPH on the extensions. Although a close analysis of travel speeds via the Connector vs. surface solutions was not conducted, it is evident that BRT or at-grade light rail would enlarge the rail hub to a much lesser degree than grade-separated light metro.

Station	ArrivH	Adj (secs)	Secs Elapsed	Remain Secs	Remain Dist (m}	Dwell	Departs	Run Time	Till Next
TO CLYBOURN STN									
Ogilvie	0:00:34	180	214	686	915	0:00:20	0:00:54	0:00:39	
Clinton/Lake	0:01:33	180	273	627	836	0:00:20	0:01:53	0:01:41	
Grand	0:03:34	180	394	506	675	0:00:20	0:03:54	0:01:12	
Chicago	0:05:06	180	486	414	552	0:00:20	0:05:26	0:01:08	
Division	0:06:34	180	574	326	435	0:00:20	0:06:54	0:01:44	
North/Clybourn	0:08:38	180	698	202	269	0:00:20	0:08:58	0:02:38	
Finkl Steel	0:11:36	180	876	24	32	0:00:20	0:11:56	0:01:01	
Metra-Clybourn Stn	0:12:57	180	957	-57	-76	0:00:20			
TO NAVY PIER								0:01:45	from Clinton/Lake
Merch Mart	0:03:38	180	398	502	669	0:00:20	0:03:58	0:01:06	
Marina City	0:05:04	180	484	416	555	0:00:20	0:05:24	0:00:56	
Illinois/Wabash	0:06:20	180	560	340	453	0:00:20	0:06:40	0:00:53	
Illinois/Columbus	0:07:33	180	633	267	356	0:00:20	0:07:53	0:00:57	
Peshtigo	0:08:50	180	710	190	253	0:00:20	0:09:10	0:00:50	
Navy Pier	0:10:00	180	780	120	160	0:00:20			
TO 35th/LSD									
Union Station	0:00:34	180	214	686	915	0:00:20	0:00:54	0:01:48	
LaSalle St Station	0:02:42	180	342	558	744	0:00:20	0:03:02	0:01:13	
Roosevelt/Wells	0:04:15	180	435	465	620	0:00:20	0:04:35	0:00:51	
Roosevelt/State	0:05:26	180	506	394	525	0:00:20	0:05:46	0:01:22	
Museum Campus	0:07:08	180	608	292	389	0:00:20	0:07:28	0:01:09	
18th/LSD	0:08:37	180	697	203	271	0:00:20	0:08:57	0:01:00	
McCormick Place/Cermak	0:09:57	180	777	123	164	0:00:20	0:10:17	0:01:03	
26th/LSD	0:11:20	180	860	40	53	0:00:20	0:11:40	0:01:10	
31st/LSD	0:12:50	180	950	-50	-67	0:00:20	0:13:10	0:01:11	
35th/LSD	0:14:21	180	1041	-141	-188	0:00:20			
TO Mee PL VIA S. BRANCH								0:01:09	from Roosevelt/Wells
16th/Wells	0:05:44	180	524	376	501	0:00:20	0:06:04	0:01:41	
Cermak/State	0:07:45	180	645	255	340	0:00:20	0:08:05	0:00:58	
McCormick Pl/Cermak	0:09:03	180	723	177	236	0:00:20	0:09:23		
TO 18th/PINK								0:02:29	from Roosevelt/Wells
Halsted/16th	0:07:04	180	604	296	395	0:00:20	0:07:24	0:01:14	
Blue Island/16th	0:08:38	180	698	202	269	0:00:20	0:08:58	0:01:16	
18th/Pink	0:10:14	180	794	106	141	0:00:20			

Figure K-4. Estimated Connector running timesf rom West Loop M etra stations