APPENDIX A

BENEFIT COST ANALYSIS
TECHNICAL MEMORANDUM

75th Street Corridor Improvement Project and Argo Connections

November 2, 2017
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LIST OF ACRONYMS

75th Street Corridor Improvement Project (75th Street CIP)
Association of American Railroads (AAR)
Average Annual Daily Traffic (AADT)
Benefit-Cost Analysis (BCA)
Benefit/Cost Ratio (B/C Ratio)
Cost Estimate Review (CER)
Chicago Department of Transportation (CDOT)
Chicago Metropolitan Agency for Planning (CMAP)
Chicago Region Environmental and Transportation Efficiency Program (CREATE)
Chicago Transportation Coordination Office (CTCO)
Cook County Department of Transportation and Highways (CCDOTH)
Consumer Price Index (CPI)
Energy Information Administration (EIA)
Federal Highway Administration (FHWA)
Federal Motor Carrier Safety Administration (FMCSA)
Final Environmental Impact Statement (FEIS)
Government Accountability Office (GAO)
Illinois Department of Transportation (IDOT)
National Association of Railroad Passengers (NARP)
National Environmental Policy Act (NEPA)
National Railroad Passenger Corporation (Amtrak)
Net Present Value (NPV)
Nitrogen Oxides (NOx)
Particulate Matter (PM)
Rail Traffic Controller Model (RTC Model)
Metra Southwest Service (SWS)
Texas Transportation Institute (TTI)
United States Department of Transportation (USDOT)
Value of Time (VOT)
Vehicle Miles Travelled (VMT)
Volatile Organic Compounds (VOC)
I. INTRODUCTION

This memorandum provides detailed documentation of the Benefit-Cost Analysis (BCA) performed to evaluate the public benefits generated by the CREATE 75th Street Corridor Improvement Project (75th Street CIP) and Argo Connections Project. The BCA demonstrates the cost effectiveness of each project for which the project sponsors are seeking Federal support, measured in terms of benefit-cost ratios (B/C) ratios and net present value (NPV).

A BCA was prepared for the entire group of project elements when fully complete. In addition, BCAs were prepared for the elements which may be constructed separately or in advance of the full project, to demonstrate that each element with independent utility has benefits in excess of costs.

I.1 Build Scenarios Evaluated

The 75th Street CIP and Argo Connections project consists of the following project elements:

- Argo Connections (CREATE project B9)
- Forest Hill Flyover (CREATE project P3) / 71st Street Grade Separation (CREATE project GS19)
- Belt Junction and 80th Street Junction (CREATE project P2/EW2)

Detailed descriptions of each project element can be found in the main INFRA grant application document.

The project elements were combined into packages of projects, each of which was evaluated in this BCA, representing the potential portions of the overall project that could be constructed independently of others, and which have independent utility. Table 1 describes which projects are included in each of the four BCA scenarios.

Table 1 BCA Scenarios Evaluated

<table>
<thead>
<tr>
<th>Scenario Name</th>
<th>B9</th>
<th>P3/GS19</th>
<th>P2/EW2</th>
</tr>
</thead>
<tbody>
<tr>
<td>B9</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P3/GS19</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>B9 + P3/GS19</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B9 + P3/GS19 + P2/EW2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

P3 and GS19 were evaluated in combination because these two elements cannot be implemented independently. During the alternatives screening process conducted as part of the 75th Street CIP Final Environmental Impact Statement (FEIS), it was determined that the only feasible approach to completing the Forest Hill Junction flyover (P3) was to construct a single flyover structure that would also include 71st Street Grade Separation (GS19). These two components have advanced to final design as a single project element.

The two additional project elements (P2 and EW2) that, in combination with P3/GS19, comprise the full 75th Street CIP, were not evaluated independently of P3/GS19 and B9 because these elements cannot advance without the substantial completion of P3/GS19 and B9. As discussed in the 75th Street CIP FEIS, phasing is necessary due to the complexity of the 75th Street CIP, and the work above the East-West Corridor roadbed (P3/GS19) must be completed prior to track work
below (EW2 and P2). P2 and EW2 are also evaluated in combination with one another because of their environmental and construction phasing linkages.

I.2 BCA Model Development

A spreadsheet-based BCA model was constructed for the purposes of this analysis. The model utilizes available data on freight traffic through the Chicago region, project-specific railroad operations modeling, and global parameters. Many of the global parameters used in this model were provided by the United States Department of Transportation (USDOT) specifically for the purposes of the FY 2018 INFRA grant application.

Using both project-specific inputs and global parameters, the BCA model calculates life-cycle costs, life-cycle benefits, annual benefits, the net present value (NPV) of costs and benefits, and the resulting benefit/cost (B/C) ratio.

I.3 Organization of BCA Memorandum

Section II describes the inputs used in developing the BCA model. These include project-specific inputs such as freight demand forecasts, railroad operating conditions, passenger ridership, project capital and operating costs, and project phasing; and global modeling parameters including inflation, emissions rates, crash rates, unit operating costs, values of time, average trip lengths, fuel efficiency, and monetization factors for all classes of benefits.

Section III describes the detailed methodology for computing project benefits, and the results of the analysis for each of the project elements and combinations thereof that were analyzed.

Section IV summarizes the BCA results and the resulting B/C ratios for the four BCA scenarios that were evaluated.

A presentation developed for the CREATE partners to describe the structure of the BCA is provided as an appendix to assist USDOT reviewers in their understanding of the methodology and results.
II. MODEL INPUTS AND PARAMETERS

II.1 Period of Analysis

Benefits and ongoing maintenance costs were evaluated for a period of 35 years beginning in 2016 and ending in 2050. This time period covers the design and construction periods of the various project elements included in the four BCA scenarios. Because project development activities are ongoing for all of the project elements, the same analysis period was used for each of the four BCA scenarios. This was done in accordance with the most recent Benefit-Cost Analysis Guidance document, which specifies that the analysis period should include “initial development and construction of the project and a subsequent operational period”\(^1\).

II.2 Benefit Classes Evaluated

The following classes of project benefits were evaluated and monetized as part of this analysis. The benefits described in the remainder of this memorandum are grouped according to the segments of traffic affected:

1. Benefits to Existing Rail Capacity -
   Improved Efficiency for Existing and Forecast Rail Traffic accommodated under Existing Terminal Rail Network Capacity

2. Benefits to Expanded Rail Capacity -
   Additional Rail Traffic resulting from Expanded Terminal Rail Network Capacity created by the Proposed Improvements (Avoided Truck-to-Rail Diversion due to Network Saturation)

3. Benefits of the 71st Street Grade Separation

II.2.1 Benefits to Existing Rail Capacity

Rail traffic simulation models of the Chicago region suggest that if one or more of the 75th Street CIP and Argo Connections Project elements are constructed, the existing and forecast traffic accommodated between now and 2029 will benefit from significant delay reduction resulting from the elimination of multiple rail bottlenecks. Reduced delay and idling will result in time savings for freight shippers, Amtrak passengers, and Metra passengers.

In addition, reduced fuel consumption will result in reduced emissions of Volatile Organic Compounds (VOC), Nitrogen Oxides (NO\(_x\)), and Particulate Matter (PM).

The benefits to existing capacity do not include the substantial benefits associated with increasing the overall capacity of the network to accommodate more rail traffic. This benefit begins to accrue after 2029, as described in the next section.

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II.2.2 Benefits to Expanded Rail Capacity

Rail traffic simulation models also indicate that in the absence of any improvements, the Chicago Terminal\(^2\) rail network will reach saturation in 2029, after which additional traffic can only be accommodated with severe degradation of service. In addition to the benefits to trains accommodated under existing capacity constraints, the 75th Street CIP and Argo Connections Project will also increase overall capacity because of the ripple effect of reducing train delay through the entire Chicago Terminal. This increase in overall network capacity will allow the network to accommodate up to four additional years of projected traffic growth, avoiding the need to eventually increase the portions of intermodal shipping itineraries carried on truck because supply chain managers find it more advantageous to incur somewhat higher shipping costs in order to avoid the travel delays and reliability risks associated with carrying their cargo into or out of the Chicago Terminal on rail. Itinerary changes reflect longer truck shipping distances (and corresponding shorter rail shipping distances) from rail terminals further from the ultimate origins and destinations of intermodal shipments. This results in significant logistics cost savings.

The reduction in truck shipping distances described above can also be expected to result in reduced fatalities and injuries from highway crashes, reduced pavement damage, and reduced emissions of Volatile Organic Compounds (VOC), Nitrogen Oxides (NO\(_x\)), and Particulate Matter (PM).

II.2.3 Benefits of the 71st Street Grade Separation

Finally, the 71st Street grade separation will result in reduced travel times for motorists and trucks traveling on that corridor. This benefit only occurs in scenarios where the P3/GS19 project is constructed.

II.3 Project-Specific Inputs

The project-specific data used to compute benefits and costs are described below.

II.3.1 Project Schedules

The project elements that comprise the 75th Street CIP and Argo Connections Project are in various stages of development. B9 is furthest along: final design is substantially complete and the project is ready for construction. The 75th Street CIP project elements have completed the preliminary engineering and NEPA phase, and are ready to begin final design.

Table 2 summarizes the project implementation schedule for each of the project elements, depicting the start and end dates for Phase I (preliminary engineering / NEPA), Phase II (final design), and Phase III (construction). The dates shown in the table are based on individual project schedules developed and agreed to by the CREATE partners, including the railroads, IDOT, CCDOTH, and CDOT.

All of the dates shown below are contingent upon available funding.

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\(^2\) The Chicago Terminal is generally defined as the railroad network inside the CN Matteson and Leighton subdivisions (formerly the Elgin Joliet & Eastern Railway, or “J”) beltline running around Chicago between Gary, Indiana and Waukegan, Illinois.
Table 2 Implementation Schedule for 75th Street CIP and Argo Connections Project Elements

<table>
<thead>
<tr>
<th>Elements</th>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project B9</td>
<td>Complete</td>
<td>Complete</td>
<td>2018-2020</td>
</tr>
<tr>
<td>Project P3/GS19</td>
<td>Complete</td>
<td>2018-2020</td>
<td>2021-2023</td>
</tr>
<tr>
<td>Project P2/EW2</td>
<td>Complete</td>
<td>2018-2020</td>
<td>2021-2023</td>
</tr>
</tbody>
</table>

Source: Based on updated project schedules provided by Association of American Railroads (AAR), October 2017.

II.3.2 Project Costs

The costs used in calculating the B/C ratio differ from those presented in the INFRA application for several reasons. First, all costs must be adjusted to 2016 dollars, including future expenses that are discounted at a rate of 7% per annum. Second, costs include those expenses already incurred, such as preliminary engineering for all of the project elements, final design for B9. Third, the BCA is based on the full cost of developing a project, including construction costs, even on those project elements for which the INFRA funding request includes only design costs (P2 and EW2). And finally, the BCA must consider not only capital costs, but also ongoing maintenance.

Several sources were used for estimating the capital and maintenance costs of the project.

Table 3 summarizes the Phase I, Phase II, and Phase III capital costs for each of the project elements.

Table 4 describes their estimated maintenance costs. Costs in both tables are presented in 2016 dollars (undiscounted), and the sources are noted below the tables.

Costs for maintenance describe the incremental cost to maintain the system after completion, as compared with maintaining the existing rail network. The estimate is based on unit maintenance costs for specific project components and the estimated quantities of these components. For some individual cost categories such as maintaining rail turnouts and diamonds, this increment is negative, reflecting the removal of complex components as the corridor is untangled and streamlined.

In estimating the actual maintenance costs of the project under the various BCA scenarios, phasing was considered. Actual project maintenance costs will grow incrementally as various project elements enter service.
### Table 3 Project Capital Costs (millions of 2016 dollars)

<table>
<thead>
<tr>
<th></th>
<th>Phase I</th>
<th>Phase II</th>
<th>Construction</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project B9</strong></td>
<td>$0.1</td>
<td>$3.6</td>
<td>$30.8</td>
<td>$34.5</td>
</tr>
<tr>
<td><strong>Project P3/GS19</strong></td>
<td>$4.2</td>
<td>$31.6</td>
<td>$275.9</td>
<td>$311.7</td>
</tr>
<tr>
<td><strong>Project EW2/P2</strong></td>
<td>$6.5</td>
<td>$54.0</td>
<td>$422.6</td>
<td>$483.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$10.8</td>
<td>$89.2</td>
<td>$729.3</td>
<td>$829.3</td>
</tr>
</tbody>
</table>

**Sources:**
A. All costs associated with Project B9 were obtained from the IDOT Form 3.1 prepared as part of the construction cost estimation and completed in December 2016.
B. Project P3/GS19 and EW2/P2 Phase I costs were obtained from the Projects P2, P3, EW2, and GS19 75th Street Corridor Improvement Project (CIP) Phase I Project Report & Design Approval, February 2015, Exhibit I-2: CREATE Design Approval Cost Estimate and Schedule Form 3.1.
C. Project P3/GS19 and EW2/P2 Phase II and construction costs were obtained from AAR, November 2016. The estimate was based on the FHWA Cost Estimate Review Final Report (September 2014), adjusted by AAR to reflect a revised project implementation schedule.

### Table 4 Project Ongoing Annual Maintenance Costs (2016 dollars)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit Costs</th>
<th>Change in Quantities</th>
<th>B9 A</th>
<th>P3/GS19 E</th>
<th>EW2/P2 E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New Track (mi)</strong></td>
<td>$50,660</td>
<td>2.00</td>
<td></td>
<td>0.29</td>
<td>16.19</td>
</tr>
<tr>
<td><strong>Centralized Traffic Control (mi)</strong></td>
<td>$20,264</td>
<td>4.00</td>
<td></td>
<td></td>
<td>0.29</td>
</tr>
<tr>
<td><strong>Turnouts</strong></td>
<td>$7,599</td>
<td>24</td>
<td></td>
<td>-6</td>
<td>12</td>
</tr>
<tr>
<td><strong>Crossovers</strong></td>
<td>$15,198</td>
<td>0</td>
<td></td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td><strong>Diamonds</strong></td>
<td>$0</td>
<td>0</td>
<td></td>
<td>-8</td>
<td>-1</td>
</tr>
<tr>
<td><strong>Noise Walls (sf)</strong></td>
<td>$1.25</td>
<td>0</td>
<td></td>
<td>0</td>
<td>163,812</td>
</tr>
<tr>
<td><strong>Flyover</strong></td>
<td>$15,000</td>
<td>0</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Annual Maintenance Cost Estimate</strong></td>
<td><strong>$364,752</strong></td>
<td></td>
<td><strong>$50,871</strong></td>
<td><strong>$1,790,333</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Sources:**
A. B9 quantities and associated unit costs prepared as part of TIGER VII grant application, June 2015. Unit costs adjusted to 2016 dollars.
B. Number of diamonds remains constant or negative for all project elements and would constitute a maintenance cost saving. To promote a conservative cost estimate, this cost savings was excluded.
C. Noise walls based on estimated cost of $50/square foot to remove graffiti, 5% of total area maintained per year, divided by two because the railroads will only perform aesthetic maintenance on the outward-facing side.
D. Assumed $15,000 per year for routine inspections.
E. Quantities for Projects P3/GS19 and EW2/P2 were obtained from FHWA Cost Estimate Review source spreadsheets prepared as part of the Projects P2, P3, EW2, and GS19 75th Street Corridor Improvement Project (CIP) Phase I Project Report & Design Approval, February 2015.

#### II.3.3 Regional Freight Demand Forecast

The Chicago Metropolitan Agency for Planning (CMAP) has published data on overall existing and forecasted rail freight volumes through the seven-county area of Northeast Illinois. The forecast includes base year 2007 and future year 2040 volumes. Traffic is categorized by origin/destination category (inbound to the region, outbound from the region, local, and through traffic), and is further broken out by shipment type (carload or intermodal). This forecast is used to estimate the additional traffic that would utilize the rail network if capacity is expanded, and associated benefits resulting from fewer truck miles and a corresponding increase in rail miles.

Table 5 summarizes the freight rail forecast for Northeast Illinois.
Table 5 Existing and Projected Rail Volumes

<table>
<thead>
<tr>
<th></th>
<th>Carload Tons (thousands)</th>
<th>Intermodal Tons (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007</td>
<td>2040</td>
</tr>
<tr>
<td>Inbound</td>
<td>135,762</td>
<td>192,114</td>
</tr>
<tr>
<td>Outbound</td>
<td>79,293</td>
<td>93,787</td>
</tr>
<tr>
<td>Local</td>
<td>11,457</td>
<td>14,665</td>
</tr>
<tr>
<td>Through</td>
<td>294,995</td>
<td>399,077</td>
</tr>
<tr>
<td>Total</td>
<td>521,507</td>
<td>699,643</td>
</tr>
</tbody>
</table>


II.3.4 Railroad Operations Simulation

The Chicago Transportation Coordination Office (CTCO), a consortium of the major freight and passenger railroads operating in the Chicago Terminal, maintains the Rail Traffic Controller (RTC) rail simulation model, which simulates the full scale of railroad operations through the Chicago Terminal.

In this BCA, the RTC model was used to determine the year at which the Chicago Terminal rail network will no longer be able to accommodate further traffic growth. Based on this saturation year, the model was also used to estimate how the 75th Street CIP and Argo Connections Project will impact existing and future traffic growth between the current year and the no-build saturation year.

Each of the project build scenarios was simulated using the RTC model to determine impacts to railroad delay and total fuel consumption over time. The simulation covers a five-day period (Wednesday through Sunday). The first and last 12 hours of the simulation are excluded from the results in order to allow for “warm up” and “cool down” periods in modeling railroad operations, resulting in aggregate total operations data for a four-day period. These totals are then annualized in the BCA analysis. The RTC model was run for current (base year 2016) conditions as well as 5, 10, and 15 years in the future.

In addition to identifying the delay and fuel consumption impacts of the project, the RTC model results were used to estimate the project’s impact on postponing the eventual saturation of the railroad network. To estimate the number of additional years of network capacity enabled by the project, a benchmark for network saturation was identified for base case conditions. Saturation was defined to occur in the year at which delay per 100 train miles reached 100 minutes for freight traffic. Under no-build conditions, network saturation occurs in 2029. Under the build scenarios, network saturation occurs in the following years:

- **B9**: 2030 (1-year postponement)
- **P3/GS19**: 2031 (2-year postponement)
- **B9 + P3/GS19**: 2032 (3-year postponement)
- **B9 + P3/GS19 + P2/EW2**: 2033 (4-year postponement)

II.3.5 Passenger Rail Ridership Data

In addition to freight traffic, the project will impact both Amtrak and Metra passenger trains.

Amtrak daily passenger train ridership was derived from National Association of Railroad Passengers (NARP). Two Amtrak routes, the Hoosier State and the Cardinal, combine to provide
daily service to and from Union Station, passing through the 75th Street corridor. Estimated annual ridership through the corridor was based on the most recent four-year average of total boardings at Chicago Union Station for the two routes combined. Annual ridership was estimated at 78,859 passengers, or 108 passengers per train per direction of travel. Based on observed flat demand over the past eight years, no growth in ridership was assumed for future years.

Metra’s SouthWest Service commuter rail line also passes through the 75th Street corridor. According to Metra’s 2016 Annual Ridership Report, the line experienced 2,538,773 boardings in 2016, or an average of 312 passengers per train. Based on a detailed rider survey conducted in 2014, approximately 98% of all trips on the line either originated or terminated at Union Station, and thus passed through the 75th Street corridor.

A review of historical ridership growth on the SouthWest Service found an average annual growth rate of 0.99% between 2007 and 2015, reflecting a period of relatively constant service levels on the line. This growth rate was applied to project future growth in ridership. Assuming a constant number of trains, this ridership growth is reflected in a corresponding increase in passengers per train.

II.3.6 71st Street Grade Crossing Traffic Volumes

Traffic volumes on 71st Street were analyzed to estimate the travel delay impacts of eliminating the 71st Street grade crossing, part of the P3/GS19 project.

CSX Transportation conducted a study of 71st Street traffic conditions and impacts of the grade crossing. The study included current and projected daily traffic volumes, current and projected total daily gate-down time, and current and projected average down time per gate closure. These results are summarized in Table 6. The values shown were interpolated for intermediate years and beyond 2029.

<table>
<thead>
<tr>
<th>Table 6 Existing and Projected Conditions at the 71st Street Grade Crossing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average Annual Daily Traffic (AADT)</strong></td>
</tr>
<tr>
<td><strong>Average Total Daily Gate Down Time (minutes)</strong></td>
</tr>
<tr>
<td><strong>Average Gate Down Time per Closure (minutes)</strong></td>
</tr>
</tbody>
</table>

Source: CSX Transportation, November 2016.

Using the values shown in the table, the impact of eliminating the grade crossing was estimated. The total daily gate down time was computed as a percentage of the total day, resulting in the estimated share of traffic impacted by a closure. For these vehicles, it was assumed that each vehicle would experience an amount of delay equal to half the average duration per closure. Multiplying this by an annualization factor of 365 resulted in a potential delay savings from the grade separation of 8,022 hours based on 2009 traffic volumes, increasing to 17,351 hours in 2029.

II.4 Global Parameters

Various global parameters, primarily pertaining to economic values, emissions rates, and safety factors, are used in the BCA model.
II.4.1 Economic Factors

The BCA model was prepared in 2016 dollars. To adjust past year values and expenditures to 2016, the Gross Domestic Product (GDP) deflator factors published by the federal Bureau of Economic Analysis were used (see Table 7). These deflator factors were applied to all pre-2016 expenditures as well as any monetization factors generated in prior year dollars, to bring all calculations to consistent 2016 dollars.

Future year inflation was based on the Congressional Budget Office’s 10-year Economic Projections of the GDP (see Table 8). The 2026-2027 growth rate was applied to estimate GDP in the 2028-2050 period.

<table>
<thead>
<tr>
<th>Table 7 Historical GDP Deflator Factors (Relative to 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>2001</td>
</tr>
<tr>
<td>2009</td>
</tr>
</tbody>
</table>

Source: Bureau of Economic Analysis, National Income and Product Accounts, Table 1.1.9, "implicit price deflators for gross domestic product" (March 2016).

<table>
<thead>
<tr>
<th>Table 8 Forecast GDP (billions of dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>------</td>
</tr>
<tr>
<td>2015</td>
</tr>
<tr>
<td>2023</td>
</tr>
</tbody>
</table>


II.4.2 Parameters Provided by USDOT

Many of the parameters used in this BCA are provided by USDOT specifically for the purposes of BCA preparation.

Table 9 summarizes the global BCA monetization factors provided by USDOT and utilized in the BCA model. Monetization factors are all presented in 2016 dollars and have been adjusted from the source data accordingly.

Because the crash data used in this BCA does not specify crash severity, it was necessary to apply factors to combine and average the injury crash monetization factors presented in Table 9.
Table 9 BCA Monetization Factors (2016 dollars)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Value of Time (VOT)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local travel, all purposes</td>
<td>$14.10</td>
<td>/ hour</td>
</tr>
<tr>
<td>Intercity travel, personal</td>
<td>$20.40</td>
<td>/ hour</td>
</tr>
<tr>
<td><strong>Vehicle Occupancy A</strong></td>
<td>1.39</td>
<td>/ vehicle</td>
</tr>
<tr>
<td><strong>Value of Emissions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatile Organic Compounds (VOCs)</td>
<td>$1,844</td>
<td>/ short ton</td>
</tr>
<tr>
<td>Nitrogen Oxides (NOx)</td>
<td>$7,266</td>
<td>/ short ton</td>
</tr>
<tr>
<td>Particulate Matter (PM)</td>
<td>$332,405</td>
<td>/ short ton</td>
</tr>
<tr>
<td><strong>Value of Safety Benefits (Injuries and Fatality Crashes)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury B</td>
<td>$174,000</td>
<td>/ person</td>
</tr>
<tr>
<td>Fatality</td>
<td>$9,600,000</td>
<td>/ person</td>
</tr>
</tbody>
</table>

Sources and Notes:

A The vehicle occupancy rate was used in the estimation of motorist travel time benefits for the 71st Street grade separation project. The rate of 1.39 is for passenger vehicles. Because 71st Street traffic counts do not include any truck data, and because through trucks are not permitted on 71st Street, the analysis assumed 100% passenger vehicles to ensure a conservative analysis.

B The “injured (severity unknown)” monetization factor for injuries was used because specific crash severities are generalized and therefore unknown.

II.4.3 Additional Parameters Developed for the 75th Street CIP and B9 Analysis

Freight Train Operating Cost

To estimate the value of freight train delay savings, a freight train operating cost factor was provided to IDOT by the AAR. This value was $365.92 per train-hour in 2016 dollars. This value includes crew costs, fuel, maintenance, and depreciation.

Unit Shipping Costs by Mode

The USDOT’s Bureau of Transportation Statistics (BTS) maintains data on the unit costs to shippers for various modes of freight transportation. This was used to estimate the logistics cost savings associated with shipping by rail as compared to shipping by truck.

Table 10 summarizes the shipping unit costs per ton-mile used in the BCA. Truck shipping rates were based directly on the USDOT data for that mode, estimated at $0.1894 per ton-mile. Rail shipping cost was $0.0415 per ton-mile. It should be noted that these figures include all commodity types. Actual per-ton-mile shipping costs for different commodities vary substantially, and in the case of rail also vary based on the type of shipment (carload versus intermodal). However, the analysis included in this BCA focuses primarily on increasing the lengths of projected rail shipments and reducing the lengths of projected truck shipments, rather than creating entirely new rail shipments or entirely eliminating truck shipments (this is discussed in greater detail in Section
III.2.1). For this type of incremental shipping distance analysis, the composite per-ton-mile shipping costs were deemed reasonable after consultation with the Class I railroads.

Due to the volatility and uncertainty of future growth in unit costs, costs were assumed to grow at the rate of inflation.

**Table 10 Shipping Cost by Mode (2016 dollars)**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most recent year of data available</td>
<td>2007</td>
<td>2014</td>
</tr>
<tr>
<td>Unit cost per ton-mile</td>
<td>$0.1894</td>
<td>$0.0415</td>
</tr>
</tbody>
</table>

**Source:**

**Fuel Efficiency**

Rail is a more fuel-efficient mode of freight transportation than trucking on a per-ton-mile basis. According to a 2017 Texas Transportation Institute (TTI) study, trucks can transport freight at an efficiency of approximately 145 ton-miles per gallon of diesel fuel, whereas freight trains offer more than triple the productivity at the same level of consumption, with efficiency of approximately 477 ton-miles per gallon of diesel fuel.³

**Emissions Rates**

There are two sources of emission reductions assumed in this analysis.

The first source is reduction in delay and associated fuel consumption for trains accommodated within existing rail capacity. This reduction in emissions was estimated on the basis of fuel consumption, using the fuel consumption totals from the RTC model simulation results. The emissions factors used for these calculations are summarized in Table 11. These factors decline over time as a result of improving engine design and idle-stop technologies; sample values for the years 2016 and 2040 are shown in the table.

Table 11 Emissions Rates for Locomotives (grams per gallon)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>2016</th>
<th>2040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile Organic Compounds (VOCs)</td>
<td>5.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Nitrogen Oxides (NO(_x))</td>
<td>121</td>
<td>28</td>
</tr>
<tr>
<td>Particulate Matter (PM)</td>
<td>3.1</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Sources and Notes:
C. U.S. Environmental Protection Agency. Emission Factors for Locomotives, Table 6. Accessed at https://www3.epa.gov/nonroad/locomotv/420f09025.pdf. Adjusted from PM\(_{2.5}\) to PM\(_{10}\) using a factor of 0.97 (also provided by EPA).

The second source of emission reductions pertains to reduced truck miles and a corresponding increase in train-miles resulting from increased rail capacity in the Chicago Terminal. Increased rail emissions and reduced truck emissions were estimated on the basis of emissions per ton-mile to make use of consistently developed emissions data available for each mode. Emissions rates are summarized in Table 12.

Table 12 Emissions Rates for Truck and Rail Transportation (grams per ton-mile)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Truck</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile Organic Compounds (VOCs)</td>
<td>0.08</td>
<td>0.0128</td>
</tr>
<tr>
<td>Nitrogen Oxides (NO(_x))</td>
<td>0.94</td>
<td>0.2830</td>
</tr>
<tr>
<td>Particulate Matter (PM)</td>
<td>0.05</td>
<td>0.0075</td>
</tr>
</tbody>
</table>

Source:

**Truck and Rail Crash Fatality and Injury Rates**

To determine the number of fatal and injury crashes avoided by reducing the distance that intermodal shipments must travel by truck, it was necessary to first establish the rate at which such crashes occur. Data from the Federal Motor Carrier Safety Administration (FMCSA) and the Federal Highway Administration (FHWA) was used to determine the rate of fatalities and injuries in crashes involving large trucks, per vehicle miles traveled (VMT). The rates are summarized in Table 13.
Table 13 Truck Fatality and Injury Rates per VMT (2015)

<table>
<thead>
<tr>
<th></th>
<th>Fatalities</th>
<th>Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total injuries/fatalities involving large trucks (^{A,B})</td>
<td>4,067</td>
<td>116,000</td>
</tr>
<tr>
<td>Total large truck VMT (millions) (^{C})</td>
<td>279,844</td>
<td>279,844</td>
</tr>
<tr>
<td>Rate per million VMT</td>
<td>0.0145</td>
<td>0.4145</td>
</tr>
</tbody>
</table>

Sources:

The safety benefits resulting from a decrease in truck miles will be partly offset by a corresponding increase in rail-related fatalities and injuries resulting from an increase in train-miles. The rates are summarized in Table 14.

Table 14 Rail Fatality and Injury Rates per Train-mile (2016)

<table>
<thead>
<tr>
<th></th>
<th>Fatalities</th>
<th>Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total injuries/fatalities from rail crashes (^{A,B})</td>
<td>813</td>
<td>7,961</td>
</tr>
<tr>
<td>Total train miles (millions) (^{C})</td>
<td>689</td>
<td>689</td>
</tr>
<tr>
<td>Fatality/injury rate per million train-miles</td>
<td>1.18</td>
<td>11.55</td>
</tr>
<tr>
<td>Tons per train (^{D})</td>
<td>3,548</td>
<td>3,548</td>
</tr>
</tbody>
</table>

Sources:

Pavement Maintenance Cost

To estimate the benefit of reducing truck volumes on the highway system, an estimated unit value of avoided pavement maintenance was used. The U.S. Government Accountability Office (GAO) estimated the value of avoided pavement maintenance at $7,000 per million ton-miles (2010...
dollars).\textsuperscript{4} Adjusting this to 2016 dollars and using an assumed truck payload factor of 24.5 tons per truck,\textsuperscript{5} this equates to $0.1887 per truck-mile.

To establish the net benefit of reduced pavement damage, the estimated loss of diesel fuel taxes as a result of fewer truck-miles was deducted from the $0.1887 per mile pavement maintenance cost savings. The federal diesel fuel tax is currently $0.2440 per gallon. The average state diesel taxes of Illinois and surrounding states, weighted by the respective volumes of freight carried between each state and Illinois (including freight transported within Illinois itself)\textsuperscript{6}, was $0.2985 per gallon, for a total federal plus state diesel tax of $0.5425. Adjusting this to dollars per ton-mile based on the assumed fuel efficiency and truck payload factors, results in a fuel tax cost of $0.0916 per truck mile.

The net benefit to pavement maintenance costs resulting from reduced truck mile is $0.0971 per truck mile.

\textsuperscript{4} U.S. Government Accountability Office, \textit{A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments that are Not Passed on to Consumers}. January 2011. Table 3.


III. MODEL RESULTS

III.1 Benefits to Existing Capacity

The benefits of the project that accrue to traffic accommodated within the no-build network capacity through the year 2050 are summarized in Table 15. Detailed methodologies for computing each benefit class are described in the sections that follow.

Table 15 Benefits to Existing Capacity (2016-2050)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Freight Train Delay</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train-hours saved</td>
<td>130,000</td>
<td>440,000</td>
<td>575,000</td>
<td>748,000</td>
</tr>
<tr>
<td>Value (millions)</td>
<td>$47.5</td>
<td>$161.0</td>
<td>$210.5</td>
<td>$273.9</td>
</tr>
<tr>
<td><strong>Passenger Train</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delay Reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger-Hours</td>
<td>133,342,000</td>
<td>254,353,000</td>
<td>277,726,000</td>
<td>216,404,000</td>
</tr>
<tr>
<td>Value (millions)</td>
<td>$1,863.3</td>
<td>$3,575.5</td>
<td>$3,926.7</td>
<td>$3,063.8</td>
</tr>
<tr>
<td><strong>Emission Reductions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction in VOCs</td>
<td>8</td>
<td>10</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>(metric tons)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction in NOx</td>
<td>204</td>
<td>281</td>
<td>336</td>
<td>392</td>
</tr>
<tr>
<td>(metric tons)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction in PM</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>(metric tons)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value (millions)</td>
<td>$2.5</td>
<td>$3.3</td>
<td>$4.0</td>
<td>$4.6</td>
</tr>
</tbody>
</table>

Notes:
All monetary values are in 2016 dollars (undiscounted).

III.1.1 Railroad Delay Savings

The RTC model simulation for the Chicago Terminal railroad network generates aggregate totals for delay by train type. The totals for 2015, 2020, 2025, and 2030 were interpolated for intermediate years, and extended beyond 2030 using the same average growth rate of the 2025 to 2030 period.

For build scenarios in which multiple phases are constructed, the model results for multiple build scenarios were blended to account for the interim benefits of earlier project phases while later project phases are still under construction.

To estimate and monetize the delay reduction benefits, the BCA model calculates the following:

- Annual hours of freight train delay are multiplied by the freight train operating cost per hour as provided by the AAR.
- Annual hours of Amtrak train delay are multiplied by the average riders per train times the VOT for intercity travel, as shown in Table 9.
- Annual hours of Metra train delay are multiplied by the average riders per SouthWest Service train through the corridor, and by the average VOT for local travel, as shown in Table 9.

To ensure that these benefits do not double-count the benefits to expanded capacity (as described in Section III.2), the benefit calculations described here stop growing after the no-build saturation year of 2029. No additional delay savings to trains accommodated by existing capacity can occur after the existing capacity is reached.
III.1.2 Emissions Reductions

The RTC model also generates total fuel consumption by rail mode for each build scenario. The rail emissions reductions attributable to reduced delay were estimated by multiplying the total change in fuel consumption from the RTC model by the locomotive emissions rates shown in Table 11.

The net total changes in emissions rates are monetized using the factors presented in Table 9.

III.2 Benefits to Expanded Capacity

The benefits of the project that accrue to additional traffic accommodated under the Build scenario are summarized in Table 16. Detailed methodologies for computing each benefit class are described in the sections that follow.

Table 16 Benefits to Expanded Capacity (2016-2050)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics Cost Savings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck Ton-miles Avoided</td>
<td>32,227,535,000</td>
<td>63,986,682,000</td>
<td>95,206,007,000</td>
<td>125,809,676,000</td>
</tr>
<tr>
<td>Rail Ton-miles Created</td>
<td>43,469,698,000</td>
<td>86,307,618</td>
<td>128,417,404,000</td>
<td>169,696,772,000</td>
</tr>
<tr>
<td>Value (millions)</td>
<td>$4,300.0</td>
<td>$8,537.6</td>
<td>$12,703.1</td>
<td>$16,786.5</td>
</tr>
<tr>
<td>Emissions Reductions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction in VOCs (metric tons)</td>
<td>2,022</td>
<td>4,014</td>
<td>5,973</td>
<td>7,893</td>
</tr>
<tr>
<td>Reduction in NOx (metric tons)</td>
<td>17,992</td>
<td>35,722</td>
<td>53,152</td>
<td>70,237</td>
</tr>
<tr>
<td>Reduction in PM (metric tons)</td>
<td>1,285</td>
<td>2,552</td>
<td>3,797</td>
<td>5,018</td>
</tr>
<tr>
<td>Value (millions)</td>
<td>$510.0</td>
<td>$1,012.5</td>
<td>$1,506.5</td>
<td>$1,990.8</td>
</tr>
<tr>
<td>Injury and Fatal Crashes Avoided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatalities Avoided</td>
<td>5</td>
<td>9</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Injuries Avoided</td>
<td>404</td>
<td>802</td>
<td>1,194</td>
<td>1,577</td>
</tr>
<tr>
<td>Value (millions)</td>
<td>$115.2</td>
<td>$228.6</td>
<td>$340.2</td>
<td>$449.5</td>
</tr>
<tr>
<td>Pavement Maintenance Cost Savings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value (millions)</td>
<td>$127.8</td>
<td>$253.8</td>
<td>$377.6</td>
<td>$498.9</td>
</tr>
</tbody>
</table>

Notes:
All monetary values are in 2016 dollars (undiscounted).

III.2.1 Logistics Cost Savings

As discussed in Section II.3.3, the RTC model also provides a basis for estimating the year in which the railroad network reaches capacity under baseline (no build) conditions, and the benefits of the various project components associated with postponing this eventual saturation.

The benefit of postponed network saturation is computed in terms of trips on the rail network that, but for the capacity improvements, could not otherwise be accommodated. The approach to quantifying this benefit is described below. This analysis was structured to ensure the forecast was as conservative as possible.

- The analysis assumes that under baseline conditions, the network would reach saturation in 2029. Under the baseline condition, all growth in intermodal freight traffic that has an origin or destination in Chicago beyond 2029 would be carried in and out of the city by truck. To avoid the delay and travel time reliability risk to these higher value shipments of
traveling into the saturated Chicago Terminal by rail, supply chain managers would switch from rail to truck at an intermodal terminal further from the city instead of transferring at an intermodal terminal within Chicago.

- Under build conditions, this saturation would be postponed by up to four years, depending on the project elements included in the scenario. Thus, the projected growth in rail freight demand (described in Section II.3.3) between the baseline saturation year and the build saturation year could be accommodated on the rail network. For example, CMAP forecasts demand for intermodal tonnage to/from Chicago to increase by 14.6 percent from 205.5 million tons in 2029 to 235.6 million tons in 2033. Further growth beyond the build saturation year would not be accommodated.

- The analysis assumes that once the network reaches capacity, shippers and their logistics partners will adjust their intermodal shipping itineraries to minimize the impact of Chicago rail congestion on supply chain reliability. Specifically, intermodal shipments to and from Chicago will connect to and from the rail network further from Chicago than if the rail network had remaining capacity for more trains. This would result in increased truck miles and reduced train miles for intermodal shipments to and from Chicago. The average additional truck shipping distance for shipments was estimated at 250 miles. This value is based on the distance from Chicago to the nearest major intermodal terminals outside the region, which are located in Toledo, Ohio and St. Louis, Missouri. This distance represents a half-day trip by truck, which can be accommodated within typical driver assignments. It is likely that in actuality many of these shipments might travel significantly further by truck, perhaps as far as ports on the east coast, which is a distance of 800 miles or greater. Using the average distance of 250 miles ensures that the BCA is conservative. Actual benefits are likely to be higher.

- The analysis disregards both non-intermodal (i.e. carload) shipments and intermodal through shipments not destined for or originating in Chicago. These types of shipments were judged more likely to be rerouted to other parts of the national network rather than offloaded to truck, and the costs of this rerouting are difficult to estimate. No benefits from avoiding longer train trips that bypass Chicago are included in the BCA.

- The average value of intermodal commodities shipped to and from Chicago is about $14,000 per ton. Relative to this overall value, the increased shipping cost of the longer truck distance reflects about 0.2% of value of the final delivered goods. Therefore the increased shipping cost is assumed to have a negligible impact on the overall demand, and thus total goods shipped are not assumed to be reduced as a result of the increase in shipping cost should the rail network become saturated.

- The analysis assumes that truck shipping distances are generally shorter than rail shipping distances. The model assumes that for every mile of trucking avoided, 1.16 miles of rail travel is added.

- The analysis assumes that the increased trucking distances avoided under the build scenarios would be partially offset by an increase in drayage of rail shipments within and through Chicago. It was assumed that locally-bound shipments that transfer between rail and truck in the Chicago region will be trucked an average of 35 miles between the intermodal terminal and their final origin or destination.

To monetize the shipping cost savings, the BCA model calculates the following:
• Truck shipping costs avoided are equal to truck ton-miles avoided times average truck shipping costs per ton-mile.
• Rail shipping costs created are equal to rail ton-miles created times average rail shipping costs per ton-mile.
• The cost savings is the truck shipping costs avoided minus the rail shipping costs created.

III.2.2 Emissions Reductions

For each build scenario, rail and truck emissions rates described in Table 12 were multiplied by the increase in rail ton-miles and the decrease in truck ton-miles, based on the methodology described in Section III.2.1. The change in rail emissions was subtracted from the change in truck emissions to produce a net change in emissions due to reduced truck miles and increased rail miles.

The net total changes in emissions rates are monetized using the monetization factors presented in Table 9.

III.2.3 Injury and Fatal Crashes Avoided

The reduced truck mileage calculations described in Section III.2.1 were also utilized to estimate the potential reduction in highway crashes associated with fewer trucks on the highway. Global rates of injuries and fatalities per truck-mile, as summarized in Table 13, were multiplied by the total estimated truck-miles avoided, to estimate the total number of injuries and fatalities avoided. These were monetized according to the monetization factors included in Table 9.

It should be noted that there are also potential safety benefits associated with rail-highway and rail-rail grade crossing eliminations. To promote a conservative BCA result, this benefit has been excluded from the analysis.

III.2.4 Pavement Maintenance Cost Savings

The truck mileage reduction calculations described in Section III.2.1 were also utilized to estimate the avoided pavement maintenance costs associated with fewer trucks on the highway. To monetize this benefit, the total estimated truck-miles avoided were multiplied by the estimated net cost savings from reduced pavement damage ($0.0971 per truck-mile, described in Section II.4.3).

III.3 71st Street Motorist Delay Savings

When completed, the 71st Street grade separation project will eliminate a very active rail-highway grade crossing that is currently subjected to nearly two hours of gate closures on an average day. The methodology for estimating existing motorist delay due to crossing closures is described in Section II.3.6. Under the build condition, this delay would be eliminated. To monetize the delay, the total hours of estimated no-build grade crossing delay were multiplied by the VOT for local travel, as shown in Table 9. The result is summarized in Table 17.
Table 17 71st Street Motorist Delay Savings (2016-2050)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Value (millions)</td>
<td>$0</td>
<td>$13.1</td>
<td>$13.1</td>
<td>$13.1</td>
</tr>
</tbody>
</table>

Notes:
All monetary values are in 2016 dollars (undiscounted).

III.4 Residual Value

Residual value is the remaining capital value of an asset at the end of the analysis period. The residual value of the 75th Street CIP and B9 project investments was determined using a simple straight-line depreciation assuming a 50-year useful life. As many project components, such as rail bridges are expected to last longer, the assumption contributes to a conservative BCA result. The results are summarized in Table 18. Residual value is added to the project benefit in the benefit-cost ratio calculation.

Table 18 Year 2051 Residual Value (2016-2050)

|----------------------------|----|---------|-------------|----------------------|

Notes:
All monetary values are in 2016 dollars (undiscounted).
IV. BENEFIT-COST ANALYSIS SUMMARY

A favorable B/C ratio is one that exceeds 1.0, indicating that the 35-year life-cycle benefits of a project exceed the ongoing maintenance costs over the same period, plus the project’s capital costs. As shown in Table 19, the results for the 75th CIP and Argo Connections Project demonstrate that each project element generates public benefits well in excess of its costs under conservative assumptions. The table presents the net present value (NPV) of all benefits and costs, in 2016 dollars, using a 7% discount rate.

Table 19 BCA Summary Results, 7% Discount Rate, 2016-2050)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benefits to Existing Capacity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freight Train Delay Reduction</td>
<td>$13.1</td>
<td>$38.5</td>
<td>$51.3</td>
<td>$66.2</td>
</tr>
<tr>
<td>Passenger Train Delay Reduction</td>
<td>$226.4</td>
<td>$439.3</td>
<td>$486.4</td>
<td>$384.6</td>
</tr>
<tr>
<td>Emissions Reductions</td>
<td>$0.9</td>
<td>$1.0</td>
<td>$1.2</td>
<td>$1.4</td>
</tr>
<tr>
<td><strong>Benefits to Expanded Capacity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistics Cost Savings</td>
<td>$920.7</td>
<td>$1,791.2</td>
<td>$2,612.5</td>
<td>$3,385.5</td>
</tr>
<tr>
<td>Emissions Reductions</td>
<td>$109.2</td>
<td>$212.4</td>
<td>$309.8</td>
<td>$401.5</td>
</tr>
<tr>
<td>Injury and Fatal Crashes Avoided</td>
<td>$24.7</td>
<td>$48.0</td>
<td>$70.0</td>
<td>$90.7</td>
</tr>
<tr>
<td>Pavement Maintenance Cost Savings</td>
<td>$27.4</td>
<td>$53.2</td>
<td>$77.6</td>
<td>$100.6</td>
</tr>
<tr>
<td><strong>71st Street Grade Separation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71st Street Motorist Delay Savings</td>
<td>$0.0</td>
<td>$3.1</td>
<td>$3.1</td>
<td>$3.1</td>
</tr>
<tr>
<td><strong>Total Benefits</strong></td>
<td><strong>$1,322.3</strong></td>
<td><strong>$2,586.7</strong></td>
<td><strong>$3,611.9</strong></td>
<td><strong>$4,433.5</strong></td>
</tr>
<tr>
<td>less Maintenance Costs</td>
<td>-$3.5</td>
<td>-$0.4</td>
<td>-$3.8</td>
<td>-$17.2</td>
</tr>
<tr>
<td>plus Residual Value</td>
<td>$1.5</td>
<td>$14.0</td>
<td>$15.5</td>
<td>$36.9</td>
</tr>
<tr>
<td><strong>TOTAL NET BENEFITS</strong></td>
<td><strong>$1,320.4</strong></td>
<td><strong>$2,600.3</strong></td>
<td><strong>$3,623.6</strong></td>
<td><strong>$4,453.2</strong></td>
</tr>
<tr>
<td><strong>Total Capital Costs</strong></td>
<td>$28.9</td>
<td>$216.1</td>
<td>$245.0</td>
<td>$577.9</td>
</tr>
<tr>
<td><strong>BENEFIT-COST RATIO</strong></td>
<td><strong>45.67</strong></td>
<td><strong>12.03</strong></td>
<td><strong>14.79</strong></td>
<td><strong>7.71</strong></td>
</tr>
<tr>
<td><strong>NET PRESENT VALUE</strong></td>
<td><strong>$1,291.5</strong></td>
<td><strong>$2,384.2</strong></td>
<td><strong>$3,378.6</strong></td>
<td><strong>$3,875.6</strong></td>
</tr>
</tbody>
</table>

Notes:
Benefit-cost ratio = (Benefits + Residual Value – Maintenance Costs) / Capital Costs
All monetary values are in discounted 2016 dollars.

Figure 1 illustrates the benefits that are derived from each traffic segment.
Figure 1 Discounted Benefits by Traffic Segment
APPENDIX: BCA OVERVIEW PRESENTATION
Benefit Cost Analysis for FY2018 INFRA Grant
Overview Presentation
• BCA Principles
• Project Costs
• Classes of Benefits
• Results
BCA Principles
• General Principles
  – Project versus No Project
  – Analyze entire project, including sunk costs
  – Exclude “transfers”

• 2017 USDOT BCA Guidance
  – Monetization factors provided
  – All benefits and costs in 2016 Dollars
  – 7% discount rate on future costs/benefits
Project Costs
• Converted from year of expenditure to 2016$ (based on Form 3.1 phasing/timing)
• Includes sunk costs
• Includes construction costs for P2/EW2 for full build scenario
Project Costs

• Sources:
  – Form 3.1s for previous expenditures
  – CER with Dec 2016 growth factor for estimated future capital costs
  – B9 FASTLANE BCA for maintenance unit costs
  – Phasing from updated schedules per AAR
## Costs in 2016 Dollars

(Including *previously incurred* and *estimated* costs)

<table>
<thead>
<tr>
<th>Build Scenario</th>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>B9</td>
<td>$95,505</td>
<td>$3,610,871</td>
<td>$31,562,360</td>
<td>$35,268,735</td>
</tr>
<tr>
<td>P3/GS19</td>
<td>$4,197,042</td>
<td>$32,562,360</td>
<td>$281,321,965</td>
<td>$318,081,367</td>
</tr>
<tr>
<td>P2/EW2</td>
<td>$6,476,422</td>
<td>$55,024,349</td>
<td>$421,226,266</td>
<td>$482,727,039</td>
</tr>
</tbody>
</table>

Note: P2/EW2 Phase III is not included as part of the INFRA grant, but is included in the BCA.
Project Benefits
• 75th Street CIP will improve efficiency for existing traffic
  – Delay reduction and fuel savings from RTC Model

• 75th Street CIP will increase network capacity
  – Growth forecast from CMAP
  – RTC Model: without improvements the network will reach “saturation” in 2029
Project Benefits

- Three benefit “groups”:
  1. Benefits to Existing Rail Capacity
  2. Benefits to Expanded Rail Capacity
  3. Benefits of the 71st Street Grade Separation
Project Benefits

Benefits to Existing Capacity

- Benefits to Existing and Forecast Traffic Accommodated under Existing Terminal Network Capacity

Benefits to Expanded Capacity

- Benefits to Additional Traffic Accommodated under Expanded Terminal Network Capacity
  - Through Intermodal and Carload Traffic Excluded from Analysis
  - Intermodal Traffic to/from Chicago Included in Analysis

Capacity - Unconstrained Growth Forecast (CMAP)

Build Network Saturation (2033)

No Build Network Saturation (2029)
Project Benefits

Benefits to Existing Capacity

Benefits to Expanded Capacity

Discounted Benefits

Benefit Group 1
Improved Efficiency for Existing Traffic
- 1a - Amtrak Delay
- 1b - Emissions
- 1a - Metro Delay
- 1a - Freight Delay

Benefit Group 2
Additional Traffic from Expanded Rail Capacity
- 2a - Shipper Cost
- 2b - Emissions
- 2c - Fatalities
- 2c - Injuries
- 2d - Pavement

Benefit Group 3
71st Street Grade Separation
- 3a - Travel Time

Residual Value
Benefit Group 1: Benefits to Existing Capacity - Improved Efficiency for Existing and Forecast Rail Traffic accommodated under Existing Terminal Rail Network Capacity

- Delay and fuel consumption from CTCO model (Benefit = Build – No-Build)
- Network saturation year from CTCO model
- Benefits stop growing beyond network saturation year
Benefit Group 1
Benefit 1a: Railroad Delay Savings

- Amtrak: (delay savings) X (passengers/train) X (passenger value of time/hour)
- Metra (delay savings) X (passengers/train) X (passenger value of time/hour)
- Freight (delay savings) X (freight rail value of time/hour)
Benefit Group 1:
Benefit 1b: Emissions Reductions

- Benefit = (Reduced fuel) X (Emissions/gallon) X ($/emissions)
- Pollutants: NOx, VOCs, PM ($/emissions per USDOT)
Benefit Group 2: Benefits to Expanded Capacity - Additional Rail Traffic resulting from Expanded Terminal Rail Network Capacity created by the Proposed Improvements

- Tonnage growth forecast from CMAP
- After network saturation, rail shipments to/from Chicago transfer to truck outside Chicago terminal

- **Applied to intermodal to/from Chicago only (CMAP)**
  - (Through intermodal and carload shipments continue on rail – no benefits claimed)
Benefit Group 2:
Benefit 2a: Logistics Cost Savings

- \((\text{Rail }$/\text{ton-mile} - \text{Truck }$/\text{ton-mile}) \times \text{Ton-miles diverted}\)
- Ton-miles diverted stop growing after Build saturation year
Benefit Group 2:
Benefit 2b: Emissions Reductions

– Truck emissions avoided on a per-ton-mile basis
– Rail emissions created on a per-ton-mile basis
– Pollutants: NOx, VOCs, PM
  ($/emissions per USDOT)
Benefit Group 2: Benefit 2c: Injury and Fatal Crashes Avoided

- Avoided fatalities, injuries per truck-mile from FMCSA
- $/fatality, $/injury from USDOT
Benefit Group 2:

Benefit 2d: Pavement Maintenance Cost Savings

– Marginal savings in pavement damage per truck-mile from GAO report
– For net benefit, subtract lost diesel fuel taxes
– Benefit = (Truck miles avoided) X (Per-mile pavement cost savings – Lost diesel tax revenue)
Benefit Group 3:
71st Street Motorist Delay Savings

- Only travel time savings included (no crash data for this crossing)
- AAR provided AADT and gate down time forecast
- Assume all passenger vehicles (no truck counts)
- Benefit = (Total delay eliminated) X (Value of time/hour) X (Average vehicle occupancy)
Results
## Results

### Benefits and Costs

<table>
<thead>
<tr>
<th></th>
<th>B9</th>
<th>P3/GS19</th>
<th>B9 + P3/GS19</th>
<th>75th CIP + B9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Discounted</strong></td>
<td><strong>Benefits</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1,320.4</td>
<td>$2,600.3</td>
<td>$3,623.6</td>
<td>$4,453.2</td>
</tr>
<tr>
<td><strong>Total Discounted</strong></td>
<td><strong>Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$28.9</td>
<td>$216.1</td>
<td>$245.0</td>
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</tr>
<tr>
<td><strong>B/C Ratio</strong></td>
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