Appendix W
Energy Technical Memorandum

RED AHEAD
Moving Ahead to a Better Red

Red Line Extension

Chicago Red Line Extension Project

Energy
Technical Memorandum

July 10, 2013
Updated July 28, 2015

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Abbreviations

API	area of potential impact
BRT	Bus Rapid Transit
BTU	British thermal unit
CMAP	Chicago Metropolitan Agency for Planning
CTA	Chicago Transit Authority
EIS	Environmental Impact Statement
NEPA	National Environmental Policy Act
PJM	PJM Interconnection
RLE	Red Line Extension
ROW	right-of-way
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
UPRR	Union Pacific Railroad
USC	United States Code
VMT	vehicle miles traveled

Section 1
Summary

This technical memorandum presents the potential effects of the Red Line Extension (RLE) Project on transportation-related energy consumption including fossil fuels and electric energy. Energy usage is associated with construction and operation of the proposed project. Net energy demand is associated with changes in travel patterns and mode choice within the regional transportation network related to the project.

Two components of energy consumption were examined: long-term energy consumption and short-term energy consumption. Long-term energy consumption is ongoing energy use that continues year after year. Analysis of long-term energy consumption changes included regional transportation-related energy consumption based on vehicle miles traveled (VMT) and transit operations. Annual VMT is the total number of miles driven by all vehicles within a year in a defined a geographic area. Annual VMT is an output of the Chicago Metropolitan Agency for Planning (CMAP) Travel Demand Model. Transit operations include energy for vehicle propulsion and operation of stations. The second component, short-term energy use, includes construction impacts, which are temporary. Construction impacts include production of materials used in construction and the operation of construction equipment.

Energy impacts are determined by comparing the energy consumption of build alternatives versus the No Build Alternative for the horizon year of 2030. Table 1-1 presents a summary of the energy for long-term energy consumption. As Table 1-1 shows, the difference in projected energy use (regional transportation plus transit operations) between any of the build alternatives and the No Build Alternative would not be greater than the margin of error for regional modeling.

The projected annual transportation-related energy consumption in the region for the No Build Alternative is approximately 368 trillion British thermal units (BTU), based on output from the CMAP Regional Travel Model. The projected regional travel demand for each of the build alternatives is marginally smaller than for the No Build Alternative. The build alternatives would result in 11.4 to 19.6 million fewer annual VMT than with the No Build Alternative.

All of the build alternatives would require energy for operations. The net difference in energy use for any of the build alternatives would be less than +/- 0.02 percent, which is smaller than the margin of error for regional modeling. The difference in energy use between any of the alternatives and the No Build Alternative (368 trillion BTU for regional vehicular travel in 2030) would be negligible and would not have an impact on regional energy consumption.

Table 1-1: Estimated Annual Long-Term Energy Use of Alternatives for Year 2030

Alternative	Estimated Annual Energy Use - Trillion BTU
No Build	368.3
Bus Rapid Transit	368.3
UPRR Rail Options	368.3
Halsted Rail	368.3

Total long-term energy is the sum of energy for regional vehicular travel, transit operations, and station energy.

The total operational energy is rounded to four significant digits, which is appropriate for the confidence level in the regional travel demand modeling. To show differences in estimated operational energy, display of five to six significant digits would be required.

BTU = British thermal unit, UPRR = Union Pacific Railroad

Energy would be required for construction of any of the build alternatives. For the rail alternatives, energy would be used for the production of the guideway and station components (including steel, cement, copper, and glass). Energy would also be used for the operation of construction equipment. Energy use by construction equipment would be localized and temporary. Construction energy use for the rail alternatives would be relatively large, because the rail alternatives would involve construction of elevated structures and substantial elevated stations. Table 1-2 summarizes energy consumption for construction. Construction energy use for the Bus Rapid Transit (BRT) Alternative would be relatively small. The BRT Alternative would use existing at-grade streets; therefore, construction of elevated guideways would not be required. Stops for the BRT Alternative would be at grade and would occupy a smaller footprint than the stations in the rail alternatives.

Table 1-2: Estimated Short-Term Energy Use of Alternatives

Alternative	Construction Energy Use - Billion BTU
No Build	0
Bus Rapid Transit	91
UPRR Rail - ROW Option	6,130
UPRR Rail - East Option	6,110
UPRR Rail - West Option	6,120
Halsted Rail	6,650

Notes:
Energy use is rounded in this summary table
BTU = British thermal unit, UPRR = Union Pacific Railroad,
ROW = right-of-way

The one-time irreversible commitment of energy resources for construction would amount to less than 1.3 percent of the total annual energy consumption for Cook County, which is 530 trillion BTU (CNT Energy 2009). Construction of any alternative would not have an impact on energy consumption in the area of potential impact (API), Cook County, or the Chicago Metropolitan Area.

Updated July 28, 2015
In August 2014, based on the technical analysis and public input until then, CTA announced the NEPA Preferred Alternative—the UPRR Rail Alternative. CTA is considering two alignment (route) options of this alternative: the East Option and the West Option. At this time, CTA is also considering only the South Station Option of the 130th Street Station. In late 2014 and early 2015, CTA conducted additional engineering on the East and West Options to refine the East and West Option alignments. Appendix A of this technical memorandum summarizes the refined alignments and any additional or different impacts that would result. The information in Appendix A supersedes information presented in other chapters of this technical memorandum.

Section 2
Project Description

The Chicago Transit Authority (CTA) is proposing to extend the Red Line from the existing 95th Street Terminal to the vicinity of 130th Street, subject to the availability of funding. The proposed RLE would include four stations. Each station would include bus transfer and parking facilities. This project is one part of the Red Ahead Program to extend and enhance the entire Red Line. The CTA is also planning 95th Street Terminal improvements that are anticipated to be completed prior to the proposed RLE construction.

The project area is 11 miles south of the Chicago central business district (commonly referred to as the Loop) and encompasses approximately 20 square miles. The boundaries of the project area are 95th Street on the north, Ashland Avenue on the west, Stony Island Avenue on the east, and the Calumet-Sag Channel/Little Calumet River and 134th Street on the south. The I-57 Expressway and I-94 Bishop Ford Freeway cross the western and eastern edges of the project area, respectively. Lake Calumet is in the eastern portion of the project area. The project area encompasses parts of nine community areas in the City of Chicago and the eastern section of the Village of Calumet Park. Chicago community areas include Beverly, Washington Heights, Roseland, Morgan Park, Pullman, West Pullman, Riverdale, Hegewisch, and South Deering. The project area comprises residential (primarily single family), industrial (both existing and vacant), transportation (including freight), and commercial development.

The Draft Environmental Impact Statement (EIS) focuses on the following alternatives (shown in Figure 2-1), which emerged from the Alternatives Analysis and the National Environmental Policy Act (NEPA) scoping process:

- No Build Alternative
- BRT Alternative
- Union Pacific Railroad (UPRR) Rail Alternative
  - Right-of-Way (ROW) Option
  - East Option
  - West Option
- Halsted Rail Alternative

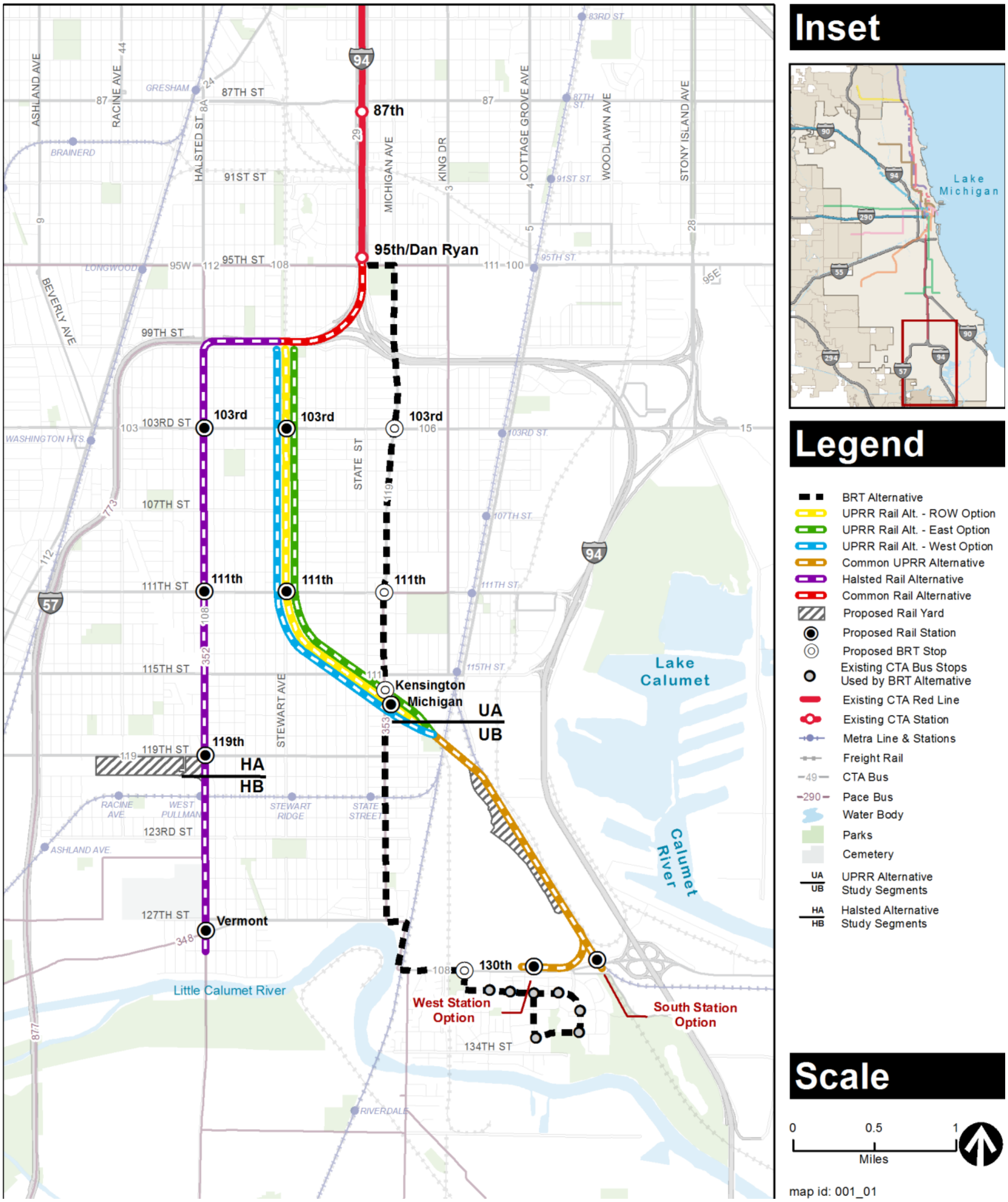

Figure 2-1: Red Line Extension Project Alternatives

The No Build Alternative is a required alternative as part of the NEPA environmental analysis and is used for comparison purposes to assess the relative benefits and impacts of extending the Red Line. The No Build Alternative is carried into the Draft EIS phase of the project development regardless of its performance versus the build alternatives under consideration. No new infrastructure would be constructed as part of the No Build Alternative other than committed transportation improvements that are already in the CMAP Fiscal Year 2010–2015 Transportation Improvement Program and the improvements to 95th Street Terminal. The Transportation Improvement Program projects within the project area consist of four bridge reconstructions, several road improvement projects including resurfacing and coordination of signal timing on 95th Street, work on Metra's facilities, construction of a bicycle/pedestrian multi-use trail, and preservation of historic facilities. The No Build Alternative includes regular maintenance of existing track and structures, and bus transit service would be focused on the preservation of existing services and projects. All elements of the No Build Alternative are included in each of the other alternatives. Under this alternative, travel times would not improve from existing conditions.

The BRT Alternative (formerly referred to as the Transportation Systems Management Alternative) is a 5.0-mile, limited-stop, enhanced BRT route, which is assumed to operate 24 hours per day between the existing 95th Street Terminal and the intersection of 130th Street and Eberhart Avenue. No dedicated bus lanes would be provided for the BRT Alternative; however, parking lanes would be removed for some portions of the alignment and four stops with improved bus shelters and park & ride facilities would be created at 103rd Street and Michigan Avenue, 111th Street and Michigan Avenue, Kensington Avenue and Michigan Avenue, and 130th Street and Eberhart Avenue. Although BRT service elements would not continue south of the 130th Street stop, the bus route would continue through Altgeld Gardens along the existing route with six stops. The BRT Alternative would be consistent with bus routing changes that may occur as part of improvements to the 95th Street Terminal. Under this alternative, travel times between 130th Street and the Loop would improve over existing conditions.

The UPRR Rail Alternative is a 5.3-mile extension of the heavy rail transit Red Line from its existing 95th Street Terminal to 130th Street, just west of I-94. The Chicago Transit Board designated the UPRR Rail Alternative as the Locally Preferred Alternative at its August 12, 2009 board meeting. This alternative includes construction and operation of new heavy rail transit tracks, mostly in existing transportation corridors. The UPRR Rail Alternative has three options for alignment (ROW, East, and West), all of which would include operation on elevated structure from 95th Street to just past the Canadian National/Metra Electric District tracks near 119th Street. The alignment would then transition to at-grade through an industrial area with no public through streets, terminating at 130th Street in the vicinity of Altgeld Gardens. Four new stations would be constructed at 103rd Street, 111th Street, Michigan Avenue, and 130th Street. The 130th Street station would be the terminal station, with two options under evaluation: the South Station Option and the West Station Option. A new yard and shop facility would be sited near 120th Street and Cottage Grove Avenue. The bus routes in the vicinity of the UPRR Rail Alternative would be modified to enhance connectivity between the Red Line and the bus network. The hours of operation and service frequency for the UPRR Rail Alternative are assumed to be the same as for the current Red Line. Under this alternative, travel times between 130th Street and the Loop would improve substantially over existing conditions.

The Halsted Rail Alternative is a 5.0-mile heavy rail transit extension of the existing Red Line. In this alternative, the Red Line would operate on an elevated structure running south from 95th Street along I-57 until Halsted Street. The alignment would then turn south and continue along Halsted Street to the intersection of Halsted Street and Vermont Avenue near 127th Street. This alternative would include four new stations at 103rd Street, 111th Street, 119th Street, and Vermont Avenue. The Vermont Avenue station would be the terminal station. A new yard and shop would be sited west of Halsted Street and between the 119th Street and Vermont Avenue stations. The bus routes in the vicinity of the Halsted Rail Alternative would be modified to enhance connectivity to the Red Line. The hours of operation and service frequency for the Halsted Rail Alternative are assumed to be the same as for the current Red Line. Under this alternative, travel times between 127th Street and the Loop would improve substantially over existing conditions. This alternative would not extend rail to Altgeld Gardens, which would be served by bus connecting to the Vermont terminal station.

Section 3
Methods for Impact Evaluation

3.1 Regulatory Framework

3.1.1 Federal

The National Environmental Policy Act of 1969 (NEPA) requires that federal agencies consider environmental impacts before taking actions that could affect the human environment. As interpreted by the Council on Environmental Quality, NEPA requires that "reasonably foreseeable" impacts of a proposed action be considered in the decision making process. As defined by NEPA, the term "impacts" includes "aesthetic, historic, cultural, economic, social, or health" impacts. Energy use is one of the environmental elements typically assessed in NEPA documentation. Applicable federal regulation for the analysis of transit projects also includes the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Public Law 109-59, August 10, 2005. SAFETEA-LU focuses on reducing traffic congestion, increasing intermodal connectivity, and protecting the environment. SAFETEA-LU gives state and local transportation decision makers more flexibility over previous legislation for solving transportation problems in their communities (Federal Highway Administration 2005). The Federal Public Transportation Act of 2012, effective October 1, 2012, continues reference to NEPA and does not alter the regulatory framework regarding evaluation of alternatives with regard to energy.

Title 42 of the United States Code (USC) concerns public health and welfare and has 159 chapters. The following sections of Title 42 of the USC focus on energy conservation, reduced reliance on foreign energy sources (mainly petroleum), use of alternative fuels, and increased efficiency in energy use:

- Providing for improved energy efficiency in motor vehicles (42 USC 6201)
- Increasing economic efficiency by meeting future needs for energy services at the lowest cost, considering technologies that improve the efficiency of energy end use, while conserving energy supplies such as oil (42 USC 13401)
- Reducing air, water, and other environmental impacts (including emissions of greenhouse gases) related to energy production, distribution, transportation, and use by development of an environmentally sustainable energy system (42 USC 13401)
- Reducing demand for oil in the transportation sector for all motor vehicles (42 USC 13431)

The Energy Policy Act of 2005 was amended and now supersedes several previous energy policy acts, including the National Energy Act of 1978 (PL 95-619), the Energy Policy and Conservation Act Amendments of 1985 (PL 99-58), and the Energy Policy Act of 1992 (PL 102-486). The Energy

Policy Act of 2005 includes transportation-related provisions that reduce reliance on foreign energy sources (mainly petroleum) and increase use of recovered mineral content in federally funded projects involving procurement of cement or concrete.

3.1.2 State

The Illinois Sustainable Energy Plan (State of Illinois 2005) includes both a Renewable Energy Portfolio Standard and an Energy Efficiency Portfolio Standard for energy production and consumption in Illinois. This plan recommends an increase in percent of renewable energy in the portfolio of electric energy suppliers. There is no guidance in the plan for energy impact assessment.

3.1.3 Local

The City of Chicago's Energy Conservation Code was adopted by the City Council on November 5, 2008. The code is underpinned by the American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America 90.1-2004. The code is related to residential and commercial buildings. While the code does not provide guidance for energy assessment of transportation systems, the code's discussion of heat island effects may be applicable during design.

The Village of Calumet Park's Code of Ordinances (§152.08) adopts the International Energy Conservation Code. The International Energy Conservation Code establishes minimum requirements for energy efficiency of commercial and residential buildings, but does not provide guidance for energy assessment of transportation systems.

3.2 Impact Analysis Thresholds

NEPA does not set specific thresholds of significance for energy impacts. Title 40 Code of Federal Regulations § 1502.16(e) directs that EISs include a discussion of the "energy requirements and conservation potential of various alternatives…natural or depletable resource requirements, and conservation potential of various alternatives," and potential mitigation measures. For the purpose of this EIS, an impact would be adverse if it would result in a permanent increase in annual energy or fuel usage that could not be accommodated by the regional (Cook County) supply.

3.3 Area of Potential Impact

The project area is 11 miles south of the City of Chicago's central business district (commonly referred to as the Loop) and encompasses approximately 20 square miles. The boundaries of the project area are 95th Street on the north, Ashland Avenue on the west, Stony Island Avenue on the east, and the Calumet-Sag Channel/Little Calumet River and 134th Street on the south. The I-57 Expressway (I-57) and I-94 Bishop Ford Freeway (I-94) cross the western and eastern edges of the project area, respectively. Lake Calumet is in the eastern portion of the project area. The

South Red Line currently terminates at the 95th Street Terminal. The API (Figure 3-1) for the operational energy analysis was defined as follows:

- On the north by 91st Street (four blocks north of the existing 95th Street Terminal)
- On the south by a varying boundary that includes Jackson Street/134th Street (four blocks south of both the UPRR Rail Alternative and Halsted Rail Alternative terminal) station locations
- On the east by a varying boundary that includes Martin Luther King Drive, Michigan Avenue, and I-94 (from the north to south)
- On the west by a varying boundary that includes Halsted Avenue, Vincennes Avenue, and I-57 (from north to south)

While the project would occur within the API, both long-term (vehicular and transit operations) and short-term (construction) energy use associated with the project would extend well outside the API. Changes in vehicular energy use would be regional because a portion of travelers would change modes from automobile to transit for trips between the project area and downtown Chicago. Because changes in vehicular energy use would be regional, the regional CMAP travel demand model was used to assess changes in VMT. This regional model includes the six-county metropolitan area.

Energy for transit operations and for construction was determined for the API; however, energy use would be distributed well beyond the API. Only energy use caused by the project is assessed in this document. For transit operations, energy generation can be dispersed over a wide region. For instance, electric power generation for rail transit can take place anywhere within a 13-state region. Manufacture of materials (such as rail, reinforcement steel, and cement) for the project would also be distributed well beyond the API. Construction energy includes manufacture of components, transportation to the project site, and the localized construction activities.

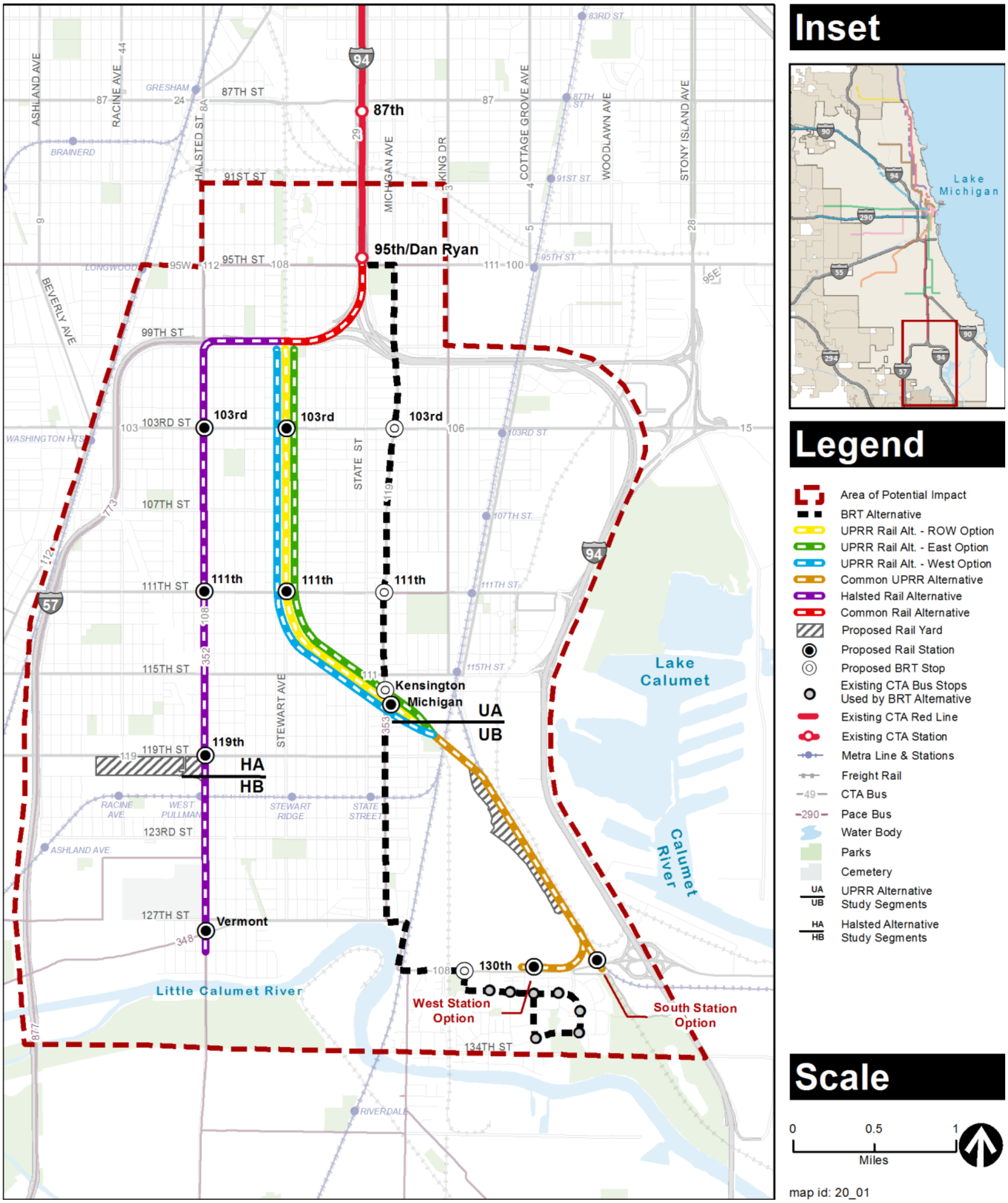

Figure 3-1: Energy Area of Potential Impact

3.4 Methods

The following methods were used to determine impacts for energy consumption under the No Build Alternative and the build alternatives.

The construction and operation (bus operations and stops, or rail operations and stations) energy usage was calculated for each of the build alternatives. The alternatives considered for the RLE were measured against the baseline conditions (No Build Alternative). The methods for calculating long-term (regional vehicular travel and transit operations) and short-term (construction) energy usage are described below.

Long-Term Energy Analysis

The baseline energy consumption was determined from the total regional VMT for the No Build Alternative in 2030, as estimated by the CMAP regional travel demand model. The entire CMAP region was used in assessing vehicular travel, because the project would affect travel outside of the API. The VMT was then converted to BTU using 3,650 BTU per vehicle mile traveled, a value derived from an estimated achieved fuel economy of 34.5 miles per gallon for cars and light trucks in 2025 from Corporate Average Fuel Economy standards (National Highway Traffic Safety Administration 2012).[1] (Miles traveled by transit vehicles, other than those associated with the project, would not differ among the alternatives; therefore, separating out transit vehicles and applying different energy consumption factors is not necessary to calculate the difference in energy use between the build alternatives and the No Build Alternative.) Any of the build alternatives would result in lower regional VMT than with the No Build Alternative, and would thus result in less vehicular energy consumption than the No Build Alternative. Energy consumption by vehicles is primarily in the form of gasoline and diesel fuel.

For the BRT Alternative, operational energy consumption was calculated from additional annual bus miles and the national average BTU per bus mile from the United States Department of Energy's Energy Data Book (Edition 31). The BRT stop energy was calculated from total platform area and estimated energy use per square foot (primarily for lighting) from *Transit Cooperative Research Board Project J-11/Task 9* (Center for Neighborhood Technology 2010).[2]

[1] A gallon of gasoline supplies 125,000 BTU. A gallon of diesel fuel supplies 139,000 BTU. For future years, the estimated 2025 achievable fleet-wide fuel economy of 34.5 miles per gallon is used (forecast under the Corporate Average Fuel Economy "No Action" Alternative). Diesel was estimated to make up a higher percentage of fleets (compared to only 2.9 percent in 2012) because diesel automobiles get better mileage per gallon than gasoline automobiles. For the energy calculations, 6.6 percent was used for the percentage of diesel vehicles in future analysis years.

[2] Average building energy use for the buildings in the research is 89,900 BTU per square foot per year, with 52 percent used for heating, ventilation, and air conditioning, and 20 percent used for lighting. For BRT platforms, where the primary energy use is lighting, 20 percent (or 18,000 BTU per square foot) was applied.

For the rail alternatives, operational energy consumption was calculated from the total additional annual railcar miles and the average kilowatt-hour per revenue car mile provided by CTA.[3] Kilowatt-hours were then converted to BTU. Station energy was calculated based on similar CTA Red Line elevated stations (based on 2010 data provided by CTA). Table 3-1 lists the energy use factors for operations.

Table 3-1: Energy Use Factors for Operations

Operational Element	Operational Energy Use (BTU)	Primary Source of Energy
Transit Bus	36,000 BTU/vehicle mile	Diesel Fuel
CTA Railcar	26,785 BTU/revenue car mile	Electricity
Platform Lighting	18,000 Annual BTU/square foot	Electricity
ADA Accessible Elevated Station	1,700 Million BTU Annually/station	Electricity
Elevators	25,000,000 Annual BTU (each)	Electricity
Escalators	70,000,000 Annual BTU (each)	Electricity

BTU = British thermal unit, CTA = Chicago Transit Authority, ADA = Americans with Disabilities Act

Construction Energy Analysis

The construction energy consumption was evaluated for each of the build alternatives to determine the short-term impacts of the project on the regional energy use. Capital cost estimates were used to determine the construction energy consumption by applying an energy cost factor from *Energy and Transportation Systems* (California Department of Transportation 1983). Energy was expressed using BTU. The reference document states energy use per construction dollar (shown in Table 3-2) should be viewed as "informed estimates." Energy use includes both manufacture of components and construction activities to install the components.

3 A revenue car mile is one CTA rail car traveling 1 mile while in revenue service. Energy use per revenue car mile was provided by CTA. The figure is for 2010 and is based on the system-wide average. The energy use may decrease with future vehicles and use of regenerative braking.

Table 3-2: Energy Factors for Construction

Construction Element	Construction Energy Cost Factor (BTU/$)[1]	Typical Elements
Track and Guideway	5,940	Structures, Track, Steel, Concrete
Stations	5,940	Platform, Canopy, Stairs, Escalator, Elevator, Station House
Facilities	7,310	Maintenance Building and Yard
Site Work	5,940	Utilities, Excavation, Removal, Hauling
Systems	9,130	Communications, Signals, Fare Collection, Traction Power, Substations

BTU = British thermal unit

1. Construction energy per dollar figures are for 2012, derived from *Energy and Transportation Systems* (California Department of Transportation 1983).

Section 4
Affected Environment

According to the City of *Chicago Climate Action Plan*, prepared in 2008, 21 percent of the city's greenhouse gas emissions are produced by cars, trucks, buses, and trains. Regional daily VMT are projected by the CMAP 2030 regional travel model to be 276,438,000. On an average weekday, over 1.6 million trips are made on CTA trains and buses (as of January 2013). If these trips were made in passenger vehicles rather than on CTA trains and buses, several hundred thousand vehicles would potentially be added to the regional roads each weekday.

To reduce its emission of greenhouse gases and energy use, the CTA is implementing the use of diesel-electric hybrid buses and exploring green technologies such as all-electric buses. The CTA has upgraded its support vehicle fleet to include hybrid-electric vehicles, vehicles that can use E-85 fuel, and vehicles that run on compressed natural gas. The E-85 fuel and compressed natural gas have a lower equivalent BTU amount than gasoline. The CTA is working to decrease the environmental impact of rail stations, offices, and maintenance facilities by implementing sustainable features in new buildings and retrofitting existing buildings to increase energy efficiency. The CTA currently uses approximately 9.8 trillion BTU annually for rail operations. (As Section 5 describes, any of the rail alternatives would result in 1.3 percent more energy use than the No Build Alternative.)

The CTA receives its power from Commonwealth Edison Company (purchased primarily from alternative retail electricity suppliers). Commonwealth Edison is part of the PJM Interconnection (PJM, a regional transmission organization) territory, which includes all or part of 13 states and the District of Columbia. The PJM region has 214,000 square miles, a population of about 60 million and a peak demand of 158,448 megawatts (in 2011). Renewable energy sources account for 5.3 percent of the total generating capacity for the region, which is 185,600 megawatts. The difference between the peak demand and the existing generating capacity is called the surplus generating capacity and is equal to 27,000 megawatts. (As Section 5 describes, the additional demand from the project would be less than 0.02 percent of the surplus generating capacity in the regional transmission territory.) As of June 27, 2011 there were 88,674 megawatts of planned generating station projects (in addition to existing generating capacity) for the PJM, and renewable energy sources account for 48.3 percent of the proposed projects. (PJM 2012)

Section 5
Impacts and Mitigations

This section describes the energy impacts for each of the four alternatives under consideration for the RLE Project, including the No Build Alternative. Impacts are discussed in three categories for each alternative: long-term operational impacts, short-term construction impacts, and cumulative impacts. Long-term operational impacts would occur after the project is fully constructed and operational. Long-term impacts include both regional vehicular travel and transit operations. Construction impacts would occur during the construction phase of the project and would be temporary in nature. Cumulative impacts would result from the incremental impact of the alternative combined with other past, present, and reasonably foreseeable future actions.

While other technical memoranda analyze alternatives by segment, the affected environment for energy is regional and widespread. (Compare the affected environment for energy with that of noise, for example. Noise generation occurs along the corridor and affects receptors adjacent to the corridor, and analysis within any discrete geographic area can be performed. Energy use, in contrast, is regional. Energy sources—whether for electricity, gasoline, or manufacture of construction components—extend far beyond the corridor.) See further discussion on page 3-3 of this technical memorandum.

A summary of impacts is presented and discussed below for all alternatives. Please see Sections 5.1 through 5.6 for specific details regarding impacts for the alternatives.

Table 5-1 provides a summary of the differences in long-term energy between the build alternatives and the No Build Alternative. The total long-term energy use for the No Build Alternative in 2030 would be approximately 368 trillion BTU, almost all of which would be the energy use of regional vehicular travel. The BRT Alternative would result in slightly less energy use than the No Build Alternative. The rail alternatives would require slightly more long-term energy than the No Build Alternative. Compared to the energy use for the No Build Alternative, the difference in energy use with any build alternative would be less than 0.02 percent of the total long-term energy use. The scale of the difference (less than 65 billion BTU annually) would be very small in comparison to the total operational energy use (approximately 368 trillion BTU annually). The percentage difference (less than 0.02 percent) would be less than the margin of error for regional modeling and less than the margin of error for assumptions regarding future automobile, bus, and rail vehicle energy efficiency. The additional demand from the project would be less than 0.02 percent of the surplus generating capacity in the regional transmission territory (See Section 4). Operation of any of the alternatives would not have an impact on regional energy consumption.

Table 5-2 provides a summary of the construction energy for alternatives. Energy used for construction is a one-time irreversible commitment of resources. Construction energy for the BRT Alternative would be relatively small compared to the rail alternatives, as the BRT Alternative features would be at grade. In contrast, construction for the rail alternatives would involve elevated structures and substantial stations.

Table 5-1: Estimated Difference in Long-Term Energy Use of Alternatives for Year 2030 (Billion BTU Annually)

Alternative	Regional Vehicular Travel	Operation of Alternative	Energy Use at Stations	Total Long-Term Energy
No Build	0	0	0	0
Bus Rapid Transit	(41.5)	21	0.2	(20.3)
UPRR Rail	(71.6)	128	6.8	63.2
Halsted Rail	(68.5)	121	7.5	59.9

() Parentheses indicate a negative difference in energy use (a lower estimate of energy use than for the No Build Alternative). All UPRR Rail Alternative Options would have the same operational energy use. Transit operational energy (including transit vehicle operations and energy use at stops/stations) for any of the rail alternatives would represent an increase of approximately 1.3 percent over existing CTA rail energy use.

BTU = British thermal unit, UPRR = Union Pacific Railroad

Table 5-2: Estimated Short-Term Energy Use of Alternatives

Alternative	Construction Energy Use - Billion BTU
No Build	0
Bus Rapid Transit	91
UPRR Rail - ROW Option	6,130
UPRR Rail - East Option	6,110
UPRR Rail - West Option	6,120
Halsted Rail	6,650

Energy use is rounded in this summary table.

BTU = British thermal unit, UPRR = Union Pacific Railroad,
ROW = right-of-way

5.1 No Build Alternative

The No Build Alternative is the baseline against which the build alternatives are compared. The baseline condition (year 2030 conditions) is the energy usage that would occur under the No Build Alternative. The energy usage under this alternative is based on the predicted increase (from existing conditions) in VMT if none of the build alternatives are implemented.

5.1.1 Permanent Impacts and Mitigations - No Build Alternative

Under the No Build Alternative, travel patterns are assumed to remain the same as under existing conditions. Existing bus routes within the project area are expected to remain the same as under existing conditions. Regional daily VMT is projected by the CMAP 2030 regional travel model to be 276,438,000 miles per day.

5.1.2 Construction Impacts and Mitigations - No Build Alternative

No new infrastructure would be constructed as part of the No Build Alternative other than projects already committed through the CMAP Transportation Improvement Program and regular maintenance of existing track and structures. This alternative would not result in energy impacts related to construction activities.

5.2 Bus Rapid Transit Alternative

The BRT Alternative would add a limited-stop, enhanced bus route along the existing #34 Michigan Avenue bus route to 130th Street. The BRT Alternative would utilize traffic signal priority at signalized intersections along 95th Street, Michigan Avenue, and 130th Street. No dedicated bus lanes would be provided for the BRT Alternative. The BRT Alternative would require a net increase of twelve 60-foot articulated buses plus two spares.

The BRT Alternative bus would run 24 hours per day. Bus frequencies would be adjusted during peak periods to a 4-minute frequency between 6 AM and 8 PM on weekdays and a 12-minute frequency on the existing route #34 to better serve anticipated demand.

5.2.1 Permanent Impacts and Mitigations - Bus Rapid Transit Alternative

Permanent (long-term) impacts would include three components: change in regional VMT, energy use for the transit vehicles, and energy use for the stops. The BRT Alternative would decrease regional VMT due to changes in vehicular trip distance (as BRT stops with the project would be closer to trip origins) and mode shift from personal vehicles to transit. The projected regional daily VMT for this alternative in the CMAP 2030 model would be 276,407,000, or approximately 31,000 VMT per day lower (less than 0.02 percent) than with the No Build Alternative. At 3,650 BTU per vehicle mile traveled, this would equate to an annual difference in energy use of 41.5 billion BTU.

The BRT Alternative would result in approximately 583,000 more bus miles annually than with the No Build Alternative. At 36,000 BTU/bus-mile, energy use for bus operations associated with this alternative would be 21 billion BTU more than with the No Build Alternative (U.S. Department of Energy 2012).

The third component of energy use is the operation of additional bus stops. The BRT stops would have bus shelters; therefore, the energy use would primarily be for lighting. Using 18,000 BTU per square foot of platform, the BRT platforms would require approximately 216 million BTU annually. Energy consumption for stops would be primarily electric energy.

As shown in Table 5-1, the total annual operational energy for the BRT Alternative would be approximately 20.3 billion BTU less than with the No Build Alternative. The total annual difference in long-term energy includes the total of the difference in energy for regional vehicular travel plus operational energy requirements for the transit vehicles and BRT stops.

5.2.2 Construction Impacts and Mitigations - Bus Rapid Transit Alternative

Energy impacts from construction activities were computed based on typical values for construction categories. Table 5-3 provides a summary of construction energy consumption for the BRT Alternative. Construction energy use would be a very small fraction of energy use in the region. The estimated 91 billion BTU for construction of the BRT Alternative would be less than 0.02 percent of the Cook County annual energy use, which is 530 trillion BTU. This 0.02 percent portion is well within the variations in annual energy use due to fluctuations in average temperature, regional employment, and manufacturing. The BRT Alternative would result in no construction energy impact and no mitigation is proposed.

Table 5-3: Estimated Energy Consumption from Construction Activities - Bus Rapid Transit Alternative

Construction Component	BTU/2012$	Construction Estimate (2012 $1,000)	Billion BTU	Typical Elements
Guideway	5,940	239	1	Concrete, Reinforcing Steel
Stops	5,940	702	4	Concrete, Reinforcing Steel, Canopy, Conduits, Lighting Fixtures
Maintenance Facilities	7,310	0	0	Maintenance Building, Equipment, Heating, Ventilation, Air Conditioning
Site Work	5,940	7,990	48	Earthwork, Removals, Utility Relocations
Systems	9,130	4,130	38	Signals, Fare Vending, Communications, Traffic Signal Priority System
Total Estimated Construction BTU			91	

BTU = British thermal units *All construction estimates in this document use April 2013 draft estimates.*

5.3 Union Pacific Railroad Rail Alternative - Right-of-Way Option

The UPRR Rail Alternative ROW Option would place the CTA tracks in the UPRR ROW between I-57 and the Canadian National/Metra Electric tracks. The UPRR trains would relocate to another corridor as part of a separate, earlier project that may occur regardless of RLE implementation.

Operation for the ROW Option would have train sets consisting of eight cars. Although the proposed platform design would accommodate ten-car trains, the service plan would be for eight-car trains as are in operation today. The hours of operation for the UPRR Rail Alternative would be the same as for the current Red Line, which operates 24 hours every day of the year.

5.3.1 Permanent Impacts and Mitigations - Union Pacific Railroad Rail Alternative - Right-of-Way Option

The ROW Option would result in lower regional VMT than the No Build Alternative because of vehicular trip distance changes (people would be nearer to transit stations) and mode changes (people would change their travel mode from personal vehicles to transit). The projected regional daily VMT for the UPRR Rail Alternative in the CMAP 2030 model is 276,384,000, which would be approximately 53,700 VMT per day less than with the No Build Alternative. At 3,650 BTU per vehicle mile traveled, the annual energy use with the ROW Option would be 71.6 billion BTU less than with the No Build Alternative.

The ROW Option would result in approximately 4,774,000 more railcar-miles annually than with the No Build Alternative. At 26,785 BTU/railcar-mile, annual energy use for rail operations associated with the ROW Option would be 127,873 million BTU more than with the No Build Alternative. Energy use per railcar-mile is based on CTA's actual traction power use and actual revenue railcar-miles.

The third component of energy use is operation of stations. Using the methods described in Section 3.4, the four stations associated with the ROW Option would use approximately 6.8 billion BTU annually.

The total annual long-term energy for the ROW Option would be a 63.2 billion BTU higher than it would be with the No Build Alternative. The rail alternatives would be more operationally intensive than the BRT Alternative, so overall energy use would be greater. The rail alternatives would provide six times the annual passenger capacity of the BRT Alternative.

5.3.2 Construction Impacts and Mitigations - Union Pacific Railroad Rail Alternative - Right-of-Way Option

Energy impacts from construction activities were computed based on typical values for construction categories. Construction energy use would vary slightly between the UPRR Rail Alternative options. For the UPRR Rail Alternative ROW Option, Table 5-4 provides a summary of the energy use during construction. Construction energy use would be a very small fraction of energy use in the region—approximately 6 trillion BTU compared to the total annual Cook County energy consumption of 530 trillion BTU, or less than 1.2 percent of the total annual Cook County energy consumption. There would be no temporary energy impacts and no mitigation is proposed.

Table 5-4: Estimated Energy Consumption from Construction Activities - Union Pacific Railroad Rail Alternative - Right-of-Way Option

Construction Component	BTU/2012$	Construction Estimate (2012 $1,000)	Billion BTU	Typical Elements
Track and Guideway	5,940	245,000	1,455	Structural Steel, Track, Concrete, Reinforcing Steel
Stations	5,940	138,000	820	Concrete, Reinforcing Steel, Canopy, Conduits, Lighting Fixtures, Glass
Maintenance Facilities	7,310	154,000	1,126	Maintenance Building, Equipment, Heating, Ventilation, Air Conditioning
Site Work	5,940	104,000	618	Earthwork, Removals, Utility Relocations

Construction Component	BTU/2012$	Construction Estimate (2012 $1,000)	Billion BTU	Typical Elements
Systems	9,130	231,000	2,109	Signals, Fare Vending, Communications, Traction Power, Substations
Total Estimated Construction BTU			6,128	

BTU = British thermal units

5.4 Union Pacific Railroad Rail Alternative - East Option

In the UPRR Rail Alternative East Option, CTA tracks would be placed immediately adjacent to and east of the UPRR ROW between I-57 and the Canadian National/Metra Electric tracks. The service plan would be for eight-car trains and 24-hour service, as described for the ROW Option in Section 5.3.

5.4.1 Permanent Impacts and Mitigations - Union Pacific Railroad Rail Alternative - East Option

Because the operational energy consumption is calculated based on regional VMT and operation of the trains and stations, the energy consumption for the UPRR Rail Alternative East Option would be the same as for the ROW Option. The total annual operational energy would be 68.6 billion BTU more than with the No Build Alternative.

5.4.2 Construction Impacts and Mitigations - Union Pacific Railroad Rail Alternative - East Option

Table 5-5 provides a summary of construction-related energy use for the UPRR Rail Alternative East Option. Construction energy use would be a very small fraction of the energy use in the region—approximately 6 trillion BTU compared to the total annual Cook County energy consumption of 530 trillion BTU, or less than 1.2 percent of the total annual Cook County energy consumption. There would be no temporary impacts on energy and no mitigation is proposed.

Table 5-5: Estimated Energy Consumption from Construction Activities - Union Pacific Railroad Rail Alternative - East Option

Construction Component	BTU/2012$	Construction Estimate (2012 $1,000)	Billion BTU	Typical Elements
Track and Guideway	5,940	243,000	1,443	Structural Steel, Track, Concrete, Reinforcing Steel
Stations	5,940	138,000	820	Concrete, Reinforcing Steel, Canopy, Conduits, Lighting Fixtures, Glass
Maintenance Facilities	7,310	154,000	1,126	Maintenance Building, Equipment, Heating, Ventilation, Air Conditioning
Site Work	5,940	100,000	594	Earthwork, Removals, Utility Relocations
Systems	9,130	233,000	2,127	Signals, Fare Vending, Communications, Traction Power, Substations
Total Estimated Construction BTU			6,110	

BTU = British thermal units

5.5 Union Pacific Railroad Rail Alternative - West Option

In the UPRR Rail Alternative West Option, CTA tracks would be placed immediately adjacent to and west of the UPRR ROW between I-57 on the north end and the UPRR tracks near Kensington Park on the south end. The service plan would be for eight-car trains and 24-hour service, as described for the ROW Option in Section 5.3.

5.5.1 Permanent Impacts and Mitigations - Union Pacific Railroad Rail Alternative - West Option

Because the operational energy consumption is calculated based on regional VMT and operation of the trains and stations, the energy consumption for the UPRR Rail Alternative West Option would be the same as for the ROW and East Options. The total annual operational energy would be 68.6 billion BTU more than it would be with the No Build Alternative.

5.5.2 Construction Impacts and Mitigations - Union Pacific Railroad Rail Alternative - West Option

Table 5-6 provides a summary of construction-related energy use for the UPRR Rail Alternative West Option. Construction energy use would be a very small fraction of the energy use in the region—approximately 6 trillion BTU compared to the total annual Cook County energy consumption of 530 trillion BTU, or less than 1.2 percent of the total annual Cook County energy consumption. There would be no temporary energy impacts and no mitigation is proposed.

Table 5-6: Estimated Energy Consumption from Construction Activities - Union Pacific Railroad Rail Alternative - West Option

Construction Component	BTU/2012$	Construction Estimate (2012 $1,000)	Billion BTU	Typical Elements
Track and Guideway	5,940	246,000	1,461	Structural Steel, Track, Concrete, Reinforcing Steel
Stations	5,940	138,000	820	Concrete, Reinforcing Steel, Canopy, Conduits, Lighting Fixtures, Glass
Maintenance Facilities	7,310	154,000	1,126	Maintenance Building, Equipment, Heating, Ventilation, Air Conditioning
Site Work	5,940	102,000	606	Earthwork, Removals, Utility Relocations
Systems	9,130	231,000	2,109	Signals, Fare Vending, Communications, Traction Power, Substations
Total Estimated Construction BTU			6,122	

BTU = British thermal unit

5.6 Halsted Rail Alternative

The proposed Halsted Rail Alternative is a 5.0-mile extension of the existing Red Line. It would operate on an elevated structure running south from 95th Street along I-57 until Halsted Street. The service plan would be for eight-car trains and 24-hour service, as described for the ROW Option in Section 5.3.

5.6.1 Permanent Impacts and Mitigations - Halsted Rail Alternative

The Halsted Rail Alternative would result in lower regional VMT than the No Build Alternative because of vehicular trip distance changes (people would be nearer to transit stations) and mode changes (people would change their travel mode from personal vehicles to transit). The projected regional daily VMT for the Halsted Rail Alternative in the CMAP 2030 model is 276,387,000, which would be approximately 51,400 vehicle miles per day less than with the No Build Alternative. At 3,650 BTU per vehicle mile traveled, the annual energy use would be 68.5 billion BTU less than with the No Build Alternative.

The Halsted Rail Alternative would result in approximately 4,504,000 more railcar-miles annually than with the No Build Alternative. At 26,785 BTU/railcar-mile, additional annual energy use for rail operations associated with this alternative would be 121 billion BTU more than with the No Build Alternative.

The four stations associated with the Halsted Rail Alternative would use approximately 7.5 billion BTU annually. This energy use would be higher than with the UPRR Alternative options because the Halsted Alternative's side platforms would require additional vertical circulation.

The total annual long-term energy for the Halsted Rail Alternative would be a 59.9 billion BTU higher than it would be with the No Build Alternative.

5.6.2 Construction Impacts and Mitigations - Halsted Rail Alternative

Table 5-7 provides a summary of the energy use during construction for the Halsted Rail Alternative. Construction energy use would be a very small fraction of energy use in the region—approximately 7 trillion BTU compared to the total annual Cook County energy consumption of 530 trillion BTU, or less than 1.3 percent of the total annual Cook County energy consumption. There would be no temporary energy impacts and no mitigation is proposed.

Table 5-7: Estimated Energy Consumption from Construction Activities - Halsted Rail Alternative

Construction Component	BTU/2012$	Construction Estimate (2012 $1,000)	Billion BTU	Typical Elements
Track and Guideway	5,940	337,000	2,002	Structural Steel, Track, Concrete, Reinforcing Steel
Stations	5,940	140,000	832	Concrete, Reinforcing Steel, Canopy, Conduits, Lighting Fixtures, Glass
Maintenance Facilities	7,310	147,000	1,075	Maintenance Building, Equipment, Heating, Ventilation, Air Conditioning
Site Work	5,940	93,000	552	Earthwork, Removals, Utility Relocations
Systems	9,130	240,000	2,191	Signals, Fare Vending, Communications, Traction Power, Substations
Total Estimated Construction BTU			6,652	

BTU = British thermal unit

5.7 Cumulative Impacts

As energy use for all build alternatives would be a small fraction of regional energy use, and as projected surplus generating capacity also far outweighs energy use for any build alternative, there would be no cumulative impacts.

There are no planned major highway projects (such as I-94 or I-57) that would affect regional energy use. Other than the 95th Street Terminal, there are no planned CTA projects in the projects beyond the RLE Project. One CREATE (Chicago Region Environmental and Transportation Efficiency Program) project (grade separation of 95th Street and the Union Pacific tracks, CREATE project GS21a) is located within the project area and is listed as a future grade separation project that depends on future availability of funding.

Section 6
Conclusions

For any of the build alternatives, the permanent changes in energy use would amount to less than 0.02 percent of transportation-related energy use for the region (63 billion BTU more for the UPRR Alternative than for the No Build Alternative, which would require 368 trillion BTU). The energy needed for operations would be far less than the existing surplus generating capacity for the region (which is 17 percent greater than existing generating demand). The net difference in energy use for any of the build alternatives would be less than +/- 0.02 percent, which is smaller than the margin of error for regional modeling. The difference in energy use would be negligible for any of the alternatives compared to the energy use for the No Build Alternative (368 trillion BTU for regional vehicular travel in 2030) and would not have an impact on regional energy consumption.

For all of the build alternatives, the total temporary construction energy use would be less than 1.3 percent of the total annual energy consumption in Cook County. Construction energy use would be spread out over the duration of construction, approximately 3 to 5 years. The one-time irreversible commitment of energy resources for construction would have negligible impacts, if any.

Section 7
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Appendix A
2014–2015 Red Line Extension Project Update

2014–2015 Red Line Extension Project Update

From 2012-2014, CTA evaluated benefits and impacts of four alternatives: the No Build Alternative, the Bus Rapid Transit Alternative (along Michigan Avenue), the Union Pacific Railroad (UPRR) Rail Alternative, and the Halsted Alternative. CTA evaluated three options of the UPRR Rail Alternative: Right-of-Way Option, East Option, and West Option. CTA also evaluated two options of the UPRR Rail Alternative 130th Street station: a South Station Option and a West Station Option. Based on the project description provided in Section 2 of this technical memorandum, CTA analyzed the impacts of these alternatives and station options. The benefits and impacts are included in the technical memoranda prepared in 2012-2014.

In August 2014, based on the technical analysis and public input, CTA announced the NEPA Preferred Alternative—the UPRR Rail Alternative. Additional conceptual engineering was conducted on the UPRR Rail Alternative to refine the East and West Option alignments. In addition, CTA is considering only the South Station Option of the 130th Street Station.

In late 2014 and early 2015, CTA conducted additional engineering and revised assumptions on the East and West Options to refine the alignments. The refinement of the East and West Options consisted of the following items:

- For the segment of the alignment along I-57, CTA shifted the proposed alignment from the median of I-57 to the north side of I-57 within the existing expressway right-of-way. The construction would be less complex, safer for construction workers, and have a shorter duration. The shift would also allow for fewer impacts to Wendell Smith Park for the East Option, and would allow for no permanent impacts to Wendell Smith Park for the West Option.

- CTA modified the curve speeds as the alignment heads south from I-57 along the UPRR tracks. The curve speed for both the East and West Options would be 35 mph.

- CTA shifted the East Option alignment near 103rd Street station to minimize impacts to Block Park and the Roseland Pumping Station.

- CTA modified the curves south of 103rd Street for both the East and West Options to 55 mph to maximize the train speed.

- CTA refined the layout of the 120th Street yard and shop to optimize yard operations. The refined layout of the yard would accommodate 340 train cars.

The refinement of the East and West Option alignments minimizes potential impacts to parks while providing flexibility for future design phases. The Draft Environmental Impact Statement contains the benefits and impacts of the refined East and West Option alignments and supersedes information presented in other chapters of this technical memorandum

Energy

CTA revised cost estimates for the East and West Options after completing the additional engineering on those options in late 2014 and early 2015. Based on the refined alignments, the East Option would use approximately 6,130 billion BTU for construction and the West Option would use approximately 6,170 billion BTU for construction.

The one-time irreversible commitment of energy resources for construction would amount to less than 1.2 percent of the total annual energy consumption for Cook County, which is 530 trillion BTU (CNT Energy 2009).