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**EAST  
WEST BRT**  
a feasibility study

MILWAUKEE COUNTY EAST-WEST BUS RAPID TRANSIT

Tech Memo #3:  
Environmental  
Impacts

REVISION #1

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DATE June 28, 2016



**Prepared for:**

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# 1. INTRODUCTION

## 1.1 Project Description

Milwaukee County and its partners have initiated a feasibility study to evaluate transit investment in the seven-mile East-West Corridor connecting major employment and activity centers between downtown Milwaukee, the Milwaukee Regional Medical Center (MRMC), and Milwaukee County Research Park (MCRP). Completing the feasibility study is a first step towards applying for funding through the Federal Transit Administration’s (FTA) Small Starts program.

**Figure 1-1: East-West Study Corridor**



## 2. OVERVIEW OF PROJECT EVALUATION PROCESS

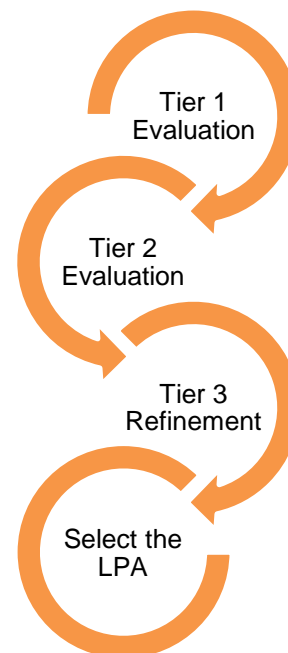
In order to evaluate the initial group of transit modes and alignment options and identify the appropriate mode-alignment pairings that will comprise the detailed alternatives, the East-West Corridor Study will follow a three-step method.

- The first step (“Tier 1 Evaluation”) will entail the assessment of each mode and alignment relative to overall implementation viability.
- The second step (“Tier 2 Evaluation”) will assess the mode/alignment pairings that passed the Tier 1 Evaluation and compare the benefits and impacts of each.
- The alternative(s) that fare(s) best against the detailed criteria in this second step will be identified as Preferred Alternative(s) and further refined in the third step (“Tier 3”). The Locally Preferred Alternative will be identified at the conclusion of the third step.

The evaluation criteria associated with each step are a combination of quantitative and qualitative performance measures.

- The Tier 1 Evaluation will apply fewer and broader measures, including information from previous corridor/area studies. The analysis will largely rely on order-of-magnitude estimates and the outcomes of similar transit projects from around the country.
- The Tier 2 Evaluation will apply more detailed and alternative-specific evaluation results.
- The Tier 3 Evaluation will evaluate the Preferred Alternative(s) against federal criteria to identify and refine the Locally Preferred Alternative.

This three-step process will result in the identification of an LPA that not only meets locally-identified project purpose and needs, but is also competitive for federal funding.



## 3. TECH MEMO #3 OVERVIEW

This report is the third in a series of technical memoranda (tech memos) that report the results of the Tier 2 Detailed Evaluation of Alternatives; the five other tech memos are available under separate cover:

- Tech Memo #1: Station Area
- Tech Memo #2: Transportation
- Tech Memo #3 (this memo): Environmental Impacts
- Tech Memo #4: Capital Costs
- Tech Memo #5: Operating and Maintenance Costs
- Tech Memo #6: Ridership

Results contained in the six tech memos are summarized in the Detailed Evaluation of Alternatives Report, also available under separate cover.

This tech memo includes the results of two sub-criteria that were used to evaluate the performance of the BRT alternatives that are under consideration as part of the Tier 2 evaluation.

The Tier 2 alternatives and station locations under evaluation are described in Section 4.

The two transportation evaluation sub-criteria are:

- Natural environment
- Cultural, social and historical impacts

A summary of the station area evaluation results can be found in Section 5; the methodology, data sources, and results of the evaluation are presented in Section 6 and 7.

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## 4. THE ALTERNATIVES

Four modes are being evaluated as part of Tier 2:

- No Build
- BRT in Mixed Traffic
- BRT in Dedicated Center Lane
- BRT in Dedicated Curb Lane

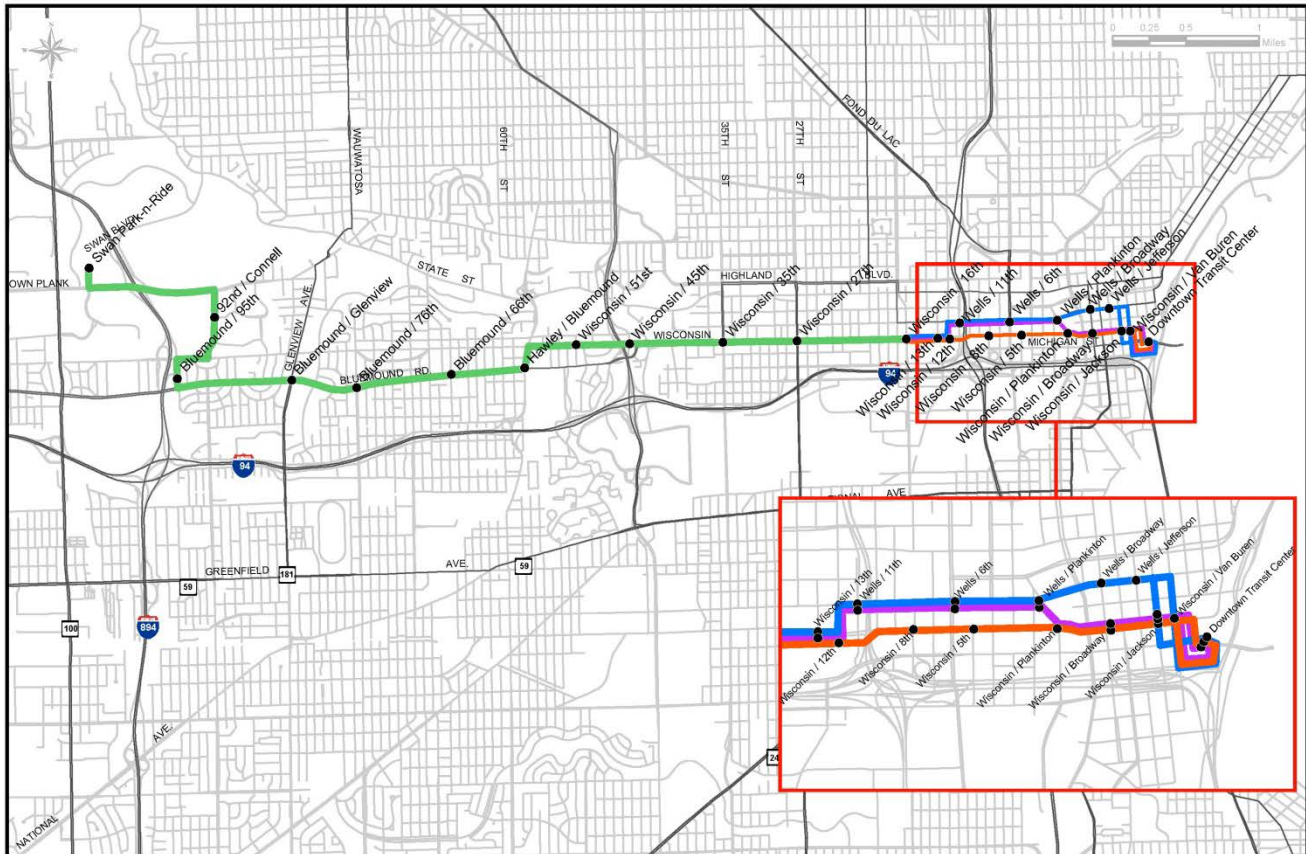
Three routes are being evaluated as part of Tier 2; any of the modes listed above (or combination of the modes) could operate on these routes:

- Alternative 1: from Swan Park-and-Ride lot to the Downtown Transit Center via Wisconsin Avenue through downtown Milwaukee
- Alternative 2: from Swan Park-and-Ride lot to the Downtown transit Center via Wells Avenue
- Alternative 3: from Swan Park-and-Ride lot to the Downtown Transit Center via a hybrid of Wisconsin Avenue and Wells Street through downtown Milwaukee (called the Hybrid alternative)

The routes and station locations are shown in Figure 4-1; the station locations for each alternative are listed in Table 4-1. Additional detail regarding these alternatives can be found in the Tier 2: Detailed Definition of Alternative Reports, which is available on the project website ([eastwestbrt.org](http://eastwestbrt.org)).



Figure 4-1: Alternative Alignments and Stations



Study Area  
DRAFT

- Legend
- Western Corridor Alternative Segment
  - Alternative 1 Wisconsin and Bluemound
  - Alternative 2 Wells and Bluemound
  - Alternative 3 Hybrid and Bluemound
  - Proposed Stations

Table 4-1: Stop Location by Route Alternative

Stop Locations	Route Alternatives		
	Wisconsin	Wells	Wells/Wisconsin Hybrid
Downtown Transit Center	X	X	X
Van Buren/Wisconsin		X	

Stop Locations	Route Alternatives		
	Wisconsin	Wells	Wells/Wisconsin Hybrid
Wisconsin/Jefferson	X	X	X
Wisconsin/Broadway	X		X
Wells/Jefferson		X	
Wells/Broadway		X	
Wisconsin/Plankinton	X		
Wells/Plankinton		X	X
Wisconsin/5th St.	X		
Wells/6th St.		X	X
Wisconsin/8th St.	X		
Wells/11th St.		X	X
Wisconsin/12th St.	X		
Wisconsin/13th St.		X	X
Wisconsin/16th St.	X	X	X
Wisconsin/27th St.	X	X	X
Wisconsin/35th St.	X	X	X
Wisconsin/45 <sup>th</sup> St.	X	X	X
Wisconsin/51st St.	X	X	X
Hawley/Bluemound	X	X	X
Bluemound/66th St.	X	X	X
Bluemound/76th St.	X	X	X
Bluemound/Glenview	X	X	X
Bluemound/95th St.	X	X	X
92nd & Connell (MRMC)	X	X	X
Swan Road Park & Ride	X	X	X

## 5. SUMMARY OF RESULTS

### 5.1 Natural Environment

The total vehicle miles traveled (VMT) is expected to decrease under each of the three alternatives, compared to the No Build Alternative. For environmental benefits, there is not a substantial difference between the alternatives except for particulate matter. Particulate matter is anticipated to be reduced further under Alternative 1 via Wisconsin than under Alternative 2 via Wells or Alternative 3 Hybrid. While all alternatives are anticipated to have a reduction in disabling injuries and fatalities, there is not a significant difference between the three alternatives in terms of their safety benefits.

### 5.2 Cultural, Social and Historical Impacts

There are 75 historic structures, nine historic districts, and 19 cultural resources located within the half-mile buffer of the in the East-West BRT corridor alternative alignments, a walkable distance from the alignments and BRT stations. The BRT will provide better access to these historic and cultural resources activity centers that are listed in this memorandum. For the Tier 2 BRT alignment, the downtown Milwaukee alternatives on Wells Street and Wisconsin Street, on the eastern end of the corridor, are the only remaining alternatives to be decided for the East-West BRT alignment. Wells Street is located only one block north of the Wisconsin Avenue alternative, so it does provides slightly better access to the historic and cultural resources north and northeast of the alignment that are located on the southern end of Milwaukee's lower east side neighborhood.

## 6. NATURAL ENVIRONMENT

Environmental benefits are one aspect that will be considered in evaluating the performance of potential transit solutions. This memorandum describes the methodology that was used to determine the environmental effects and the results of these calculations.

### 6.1 Methodology

Each of the alternatives was evaluated for the impact that it would have on regional air quality pollutants, energy use, greenhouse gas emissions by following the FTA methodology for Small Starts projects. Small Starts guidance includes safety as an environmental benefit, which is discussed in Section 6.3.1. This methodology incorporates the change in distance traveled by automobiles and transit vehicles. The calculations take into account the differences between vehicle types, e.g. automobile, diesel bus, hybrid bus. Table 6-1 presents the factors used in quantifying the impact of the alternatives on regional air quality pollutants, energy use, greenhouse gas emissions, and safety. Regional air quality pollutants include: carbon monoxide (CO), mono-nitrogen oxides (NO<sub>x</sub>), volatile organic compounds (VOC), and particulate matter (PM<sub>2.5</sub>).

**Table 6-1: Factors used to determine Air Pollutants, Energy Use, Greenhouse Gas Emissions, and Safety Changes**

Mode	Air Pollutants (grams/VMT)				Energy Use (Btu/VMT)	Greenhouse Gas Emissions (g CO <sub>2</sub> e/VMT)	Safety (per million VMT)	
	CO	NO <sub>x</sub>	VOC	PM <sub>2.5</sub>			Fatal Crashes	Injuries
Automobile	16.77	0.91	0.6	0.01	7,559	532	0.013	0.195
Bus - Diesel	5.83	8.67	0.73	0.48	41,436	3,319	0.004	1.824
Bus - Hybrid	5.83	8.67	0.73	0.48	33,149	2,655	0.004	1.824

Mode	Air Pollutants (grams/VMT)				Energy Use (Btu/VMT)	Greenhouse Gas Emissions (g CO <sub>2</sub> e/VMT)	Safety (per million VMT)	
	CO	NO <sub>x</sub>	VOC	PM <sub>2.5</sub>			Fatal Crashes	Injuries
Bus - CNG	39.62	3.84	1.46	0.01	N/A	2,935	0.004	1.824

Reporting Instructions for the Section 5309 Small Starts Criteria, FTA 2015

## 6.2 Data Sources

The data source for the analysis was the FTA Methodology for Small Starts projects.

## 6.3 Summary of Results

### 6.3.1 Change in Annual VMT

The calculations for evaluating the impacts to regional air quality pollutants, energy use, greenhouse gas emissions, and safety are related to the VMT by automobiles and transit vehicles. Table 6-2 shows the change in VMT between the three BRT alternatives and the No Build Alternative. Total VMT is expected to decrease under each of the three alternatives in comparison to the No Build Alternative. The change in VMT in automobiles was provided by the ridership model. The change in VMT for transit vehicles was provided by the transit operating plan.

**Table 6-2: Changes in Annual VMT**

Mode	Alternative 1 via Wisconsin	Alternative 2 via Wells	Alternative 3 Hybrid via Wisconsin/Wells
Automobile	-14,516,000 to -17,742,000	-14,523,000 to -17,751,000	-14,051,000 to -17,173,000
Bus - Diesel	-249,000 to -304,000	-249,000 to -304,000	-249,000 to -304,000
Bus - Hybrid	+528,000 to +645,000	+547,000 to +668,000	+538,000 to +657,000
<b>Total</b>	<b>-14,237,000 to -17,401,000</b>	<b>-14,226,000 to -17,387,000</b>	<b>-13,762,000 to -16,821,000</b>

Source: East-West BRT Ridership Technical Memorandum, East-West BRT Transit Operating Plan

### 6.3.2 Environmental Benefits

Each alternative was evaluated for the potential change in regional air quality pollutants, energy use, greenhouse gas emissions, and safety. Anticipated reductions as a result of the East-West BRT Project are reported in Table 6-3 by alternative. As noted in the table, there is not a substantial difference between the alternatives except for particulate matter. Particulate matter is anticipated to be reduced further under Alternative 1 via Wisconsin than under Alternative 2 via Wells or Alternative 3 Hybrid.

**Table 6-3: Annual Reductions in Air Pollutants, Energy Use, and Greenhouse Gas Emissions**

Factor Reduction	Alternative 1 via Wisconsin	Alternative 2 via Wells	Alternative 3 Hybrid via Wisconsin/Wells
Carbon Monoxide (metric tons)	200 to 300	200 to 300	200 to 300
Mono-Nitrogen Oxides (metric tons)	11 to 13	11 to 13	10 to 13
Volatile Organic Compounds (metric tons)	9 to 10	8 to 10	8 to 10
Particulate Matter (kg)	11 to 14	2 to 3	2 to 2
Greenhouse Gases (Carbon Dioxide Equivalent) (metric tons)	7,100 to 8,700	7,100 to 8,700	6,900 to 8,400
Energy Use (million Btu)	103,000 to 125,000	102,000 to 125,000	99,000 to 121,000

*Small Starts Templates Part 1, FTA 2015*

### 6.3.3 Safety Benefits

The FTA Small Starts methodology assesses the change in disabling injuries and fatalities for automobile and transit modes by relating these measures to the change in VMT. The FTA methodology does not include safety changes related to bicycle or pedestrian modes due to the lack of readily available national data. Using the safety-to-VMT conversion factors presented in Table 6-1, the reductions in injuries and fatalities were estimated for this project

in Table 6-4. As noted in the table, there is not a significant difference between the three alternatives in terms of their safety benefits.

**Table 6-4: Reductions in Disabling Injuries and Fatalities**

Factor Reduction	Alternative 1 via Wisconsin	Alternative 2 via Wells	Alternative 3 Hybrid via Wisconsin/Wells
Disabling Injuries	Approximately 11 to 14 fewer disabling injuries every 5 years		
Fatalities	Approximately one less fatality every 5 years		

*Small Starts Templates Part 1, FTA 2015*

## 7. CULTURAL, SOCIAL AND HISTORICAL IMPACTS

One of the goals in accommodating the increased travel demand in the East-West Corridor is to improve access to activity centers, such as cultural resources, while also minimizing any negative impacts a new transit line could have to those resources. This memo documents the cultural resources within close proximity of the proposed alignments.

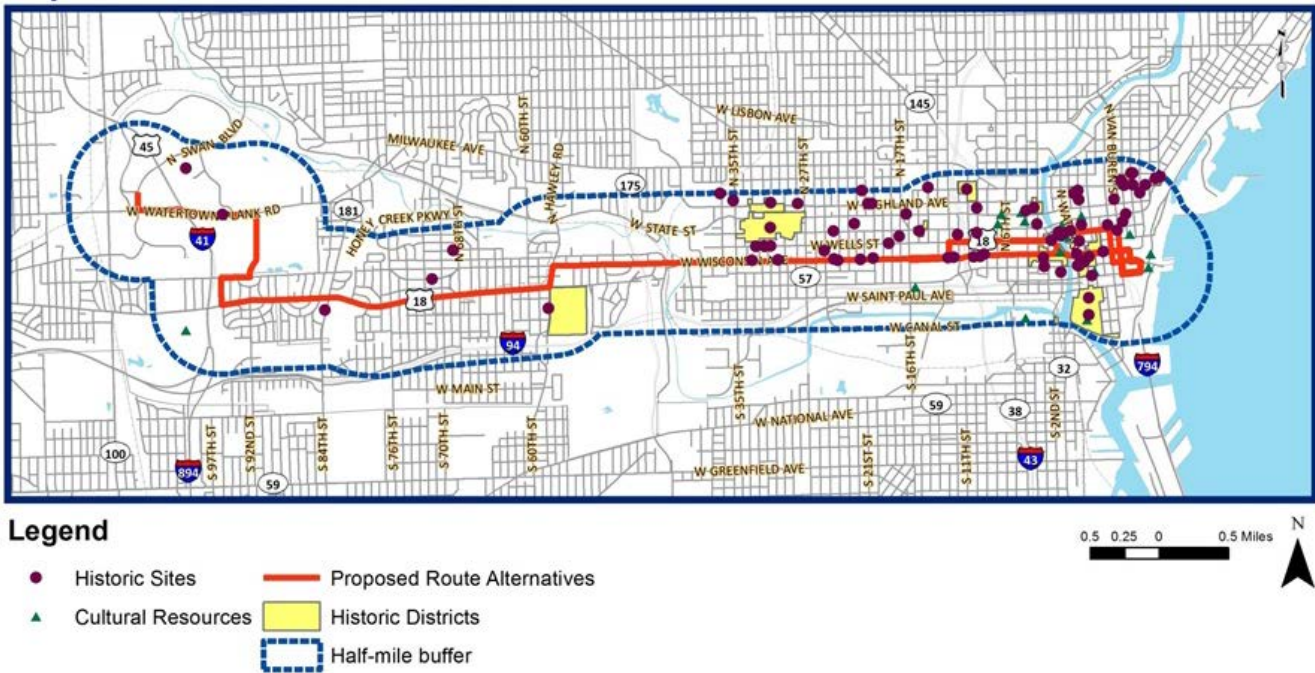
### 7.1 Methodology

An analysis of the study corridor was conducted to determine the cultural resources that are within a half-mile to the proposed alignments. The cultural resources identified include:

- Attractions such as museums, performance venues and the zoo.
- Historic buildings and districts.

These sites were mapped using GIS and the sites within a half-mile of each of the alignments are included in this analysis (see Figure 7-1).

**Figure 7-1: Historic and Cultural Resources**



## 7.2 Data Sources

The historical and cultural resources were compiled from various sources including the National Register of Historic Places, the City of Milwaukee, the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and an inventory of field-identified and mapped (Google Maps) resources.

## 7.3 Summary of Results

### 7.3.1 Historic Resources near the BRT Alignments

The following Historical resources listed in Table 7-1 were identified as being within a half-mile of the proposed alignments.



**Table 7-1: Historic Resources within a Half-Mile of the Proposed Alignments**

Resource	Address	City	Source
Old World Third St.	800 N Old World Third St	Milwaukee	NRHP
Pabst Brewing Company Brewery Complex	900 W Juneau Ave	Milwaukee	NRHP
Cass -Juneau Street Historic District	800 E Juneau Ave	Milwaukee	NRHP
Highland Blvd. Historic District	3000 W Highland Blvd	Milwaukee	NRHP
Historic Third Ward	300 E St. Paul Ave	Milwaukee	NRHP
Kilbourn Avenue Row House Historic District	1500 W Kilbourn Ave	Milwaukee	NRHP
Plankinton Ave./Wells/Water St. Historic District	700 N Plankinton Ave	Milwaukee	NRHP
South First and Second Street Historic District	160 S 2nd St	Milwaukee	NRHP
West Side Commercial	800 N 2nd St	Milwaukee	NRHP
Blatz Brewery Complex	270 E Highland Ave	Milwaukee	NRHP
All Saints' Episcopal Cathedral Complex	818 E Juneau Ave	Milwaukee	NRHP
Calvary Cemetery	5503 W Bluemound Rd	Milwaukee	City of Milwaukee
Cass & Wells Street	750 N Cass St	Milwaukee	NRHP
Concordia Historic District	3000 W Kilbourn Ave	Milwaukee	NRHP
East Side Commercial District	625 N Broadway St	Milwaukee	NRHP

Resource	Address	City	Source
First Ward Triangle	1200 N Prospect Ave	Milwaukee	NRHP
Charles Abresch House	2126 W Juneau Ave	Milwaukee	NRHP
Astor on the Lake	924 E Juneau Ave	Milwaukee	NRHP
Baumbach Building	300 E Buffalo St	Milwaukee	NRHP
Blatz, Valentin, Brewing Company Office Building	270 E Highland Ave	Milwaukee	NRHP
Calvary Presbyterian Church	935 W Wisconsin Ave	Milwaukee	NRHP
Michael Carpenter House	1115 35th St	Milwaukee	NRHP
Central Library	814 W Wisconsin Ave	Milwaukee	NRHP
Thomas Cook House	853 N 17th St	Milwaukee	NRHP
Dahinden, Edward J., House	3316 W Wisconsin Ave	Milwaukee	NRHP
H. R. Davis House	6836 Cedar St	Wauwatosa	NRHP
Eagles Club	2401 W Wisconsin Ave	Milwaukee	NRHP
Abraham H. Esbenshade House	3119 W Wells St	Milwaukee	NRHP
Exton Apartments Building	1260 N Prospect Ave	Milwaukee	NRHP
Federal Building	517 E Wisconsin Ave	Milwaukee	NRHP
Otto F. Fiebing House	302 N Hawley Rd	Milwaukee	NRHP
Warren B. George House	7105 Grand Parkway	Wauwatosa	NRHP
German-English Academy	1020 N Broadway	Milwaukee	NRHP

Resource	Address	City	Source
Germania Building	135 W Wells St	Milwaukee	NRHP
Church of the Gesu	1145 W Wisconsin Ave	Milwaukee	NRHP
Gimbels Parking Pavilion	555 N Plankinton Ave	Milwaukee	NRHP
Grand Avenue Congregational Church	2133 W Wisconsin Ave	Milwaukee	NRHP
Harley Davidson Motorcycle Factory Building	3700 W Juneau Ave	Milwaukee	NRHP
Highland Avenue Methodist Church	2024 W Highland Ave	Milwaukee	NRHP
Northwestern Mutual Life Insurance Company	720 E Wisconsin Ave	Milwaukee	NRHP
Hopkins, Willis, House	325 Glenview Ave	Wauwatosa	NRHP
David W. Howie House	3026 W Wells St	Milwaukee	NRHP
Immanuel Presbyterian Church	1105 N Waverly Pl	Milwaukee	NRHP
Iron Block Building	205 E Wisconsin Ave	Milwaukee	NRHP
Johnston Hall	1121 W Wisconsin Ave	Milwaukee	NRHP
Kalvelage, Joseph B., House	2432 W Kilbourn Ave	Milwaukee	NRHP
Kilbourn Masonic Temple	827 N 11th St	Milwaukee	NRHP
Knapp-Astor House	903 E Knapp St	Milwaukee	NRHP
Knickerbocker Hotel	1028 E Juneau Ave	Milwaukee	NRHP
Mackie Building	225 E Michigan St	Milwaukee	NRHP

Resource	Address	City	Source
Milwaukee City Hall	200 E Wells St	Milwaukee	NRHP
Milwaukee County Courthouse	901 N 9th St	Milwaukee	NRHP
Milwaukee County Dispensary and Emergency Hospital	2430 W Wisconsin Ave	Milwaukee	NRHP
Milwaukee County Historical Center	910 N Old World 3rd St	Milwaukee	NRHP
Milwaukee County Home for Dependent Children-- Administration Building	9480 Watertown Plank Road	Wauwatosa	NRHP
Milwaukee County School of Agriculture and Domestic Economy Historic District	9722 Watertown Plank Road	Wauwatosa	NRHP
Milwaukee Hospital	2200 W Kilbourn Ave	Milwaukee	NRHP
Milwaukee News Building and Milwaukee Abstract Association Building	220 E Mason St	Milwaukee	NRHP
Milwaukee Normal School - Milwaukee Girls' Trade and Technical High School	1820 W Wells St	Milwaukee	NRHP
Mitchell Building	207 E Michigan St	Milwaukee	NRHP
Old St. Mary's Church	836 N Broadway	Milwaukee	NRHP
Oneida Street Station	108 E Wells St	Milwaukee	NRHP
Pabst Brewery Saloon	901 W Juneau Ave	Milwaukee	NRHP
Pabst Theater	144 E Wells St	Milwaukee	NRHP

Resource	Address	City	Source
Frederick Pabst House	2000 W Wisconsin Ave	Milwaukee	NRHP
Public Service Building	231 W Michigan St	Milwaukee	NRHP
Saint George Melkite Catholic Church	1617 W State St	Milwaukee	NRHP
Schlitz, Victor, House	2004 W Highland Ave	Milwaukee	NRHP
George Schuster House and Carriage Shed	3209 W Wells St	Milwaukee	NRHP
Second Church of Christ Scientist	2722 W Highland Blvd	Milwaukee	NRHP
Fred Sivyer House	761 N 25th St	Milwaukee	NRHP
Sixth Church of Christ, Scientist	1036 N Van Buren St	Milwaukee	NRHP
St. James Episcopal Church	833 W Wisconsin Ave	Milwaukee	NRHP
St. John's Roman Catholic Cathedral	812 N Jackson St	Milwaukee	NRHP
St. Paul's Episcopal Church	914 E Knapp St	Milwaukee	NRHP
State Bank of Wisconsin	210 E Michigan St	Milwaukee	NRHP
Sunnyhill Home	8000 Milwaukee Ave	Milwaukee	NRHP
Trinity Evangelical Lutheran Church	1046 N 9th St	Milwaukee	NRHP
Tripoli Temple	3000 W Wisconsin Ave	Milwaukee	NRHP
Turner Hall	1034 N 4th St	Milwaukee	NRHP
Walker, Harry B., House	3130 W Wells St	Milwaukee	NRHP

Resource	Address	City	Source
Wisconsin Consistory Building	790 N. Van Buren St	Milwaukee	NRHP
Wisconsin Leather Company Building	320 E Clybourn St	Milwaukee	NRHP
Woman's Club of Wisconsin	813 E Kilbourn Ave	Milwaukee	NRHP

These historic resources are located within the half-mile buffer of the BRT alternative alignments. Listed in the historic resources are nine historic districts including Old World Third Street, Cass-Juneau Street Historic District Highland Blvd. Historic District, Historic Third Ward, Kilbourn Avenue Row House Historic District, Plankinton Ave./Wells/Water St. Historic District and South First, Second Street Historic District, and West Side Commercial. There are 75 historic structures within half-mile of the BRT alternatives as listed in Table 7-1.

### 7.3.2 Cultural Resources near the BRT Alignments

The following cultural resources listed in Table 7-2 were identified as being within a half-mile of the proposed alignments.

**Table 7-2: Cultural Resources within a Half-Mile of the Proposed Alignments**

Resource	Address	City	Source
Milwaukee Art Museum	700 N Art Museum Dr	Milwaukee	SEWRPC
Wisconsin Center	400 W Wisconsin Ave	Milwaukee	SEWRPC
Henry W. Maier Festival Park (Summerfest)	200 North Harbor Drive	Milwaukee	Google Maps
Bradley Center	1001 N 4th St	Milwaukee	SEWRPC
Milwaukee Public Museum	800 W Wells St	Milwaukee	SEWRPC
Marcus Center for the Performing Arts	929 N Water St	Milwaukee	SEWRPC
Milwaukee County Zoo	10001 W Bluemound Rd	Milwaukee	Google Maps
Grohmann Museum	1000 N Broadway	Milwaukee	Google Maps
Betty Brinn Children's Museum	929 E Wisconsin Ave	Milwaukee	Google Maps

Resource	Address	City	Source
Discovery World	500 N Harbor Dr	Milwaukee	Google Maps
Chudnow Museum of Yesteryear	839 N 11 <sup>th</sup> St	Milwaukee	Google Maps
Harley Davidson Museum	400 W Canal St	Milwaukee	Google Maps
Haggerty Museum of Art	530 N 13 <sup>th</sup> St	Milwaukee	Google Maps
Pabst Theater	144 E Wells St	Milwaukee	Google Maps
Milwaukee Repertory Theater	108 E Wells St	Milwaukee	Google Maps
Milwaukee Theater	500 W Kilbourn Ave	Milwaukee	Google Maps
Milwaukee Youth Theatre	820 E Knapp St	Milwaukee	Google Maps
Riverside Theater	116 W Wisconsin Ave	Milwaukee	Google Maps
Skylight Music Theatre	158 N Broadway	Milwaukee	Google Maps

There are 75 historic structures, nine historic districts, and 19 cultural resources located within the half-mile buffer of the in the East-West BRT corridor alternative alignments, a walkable distance from the alignments and BRT stations. The BRT will provide better access to these historic and cultural resources activity centers that are listed in this memorandum. For the Tier 2 BRT alignment, the downtown Milwaukee alternatives on Wells Street and Wisconsin Street, on the eastern end of the corridor, are the only remaining alternatives to be decided for the East-West BRT alignment. Wells Street is located only one block north of the Wisconsin Avenue Alternative, so it does provides slightly better access to the historic and cultural resources north and northeast of the alignment that are located on the southern end of Milwaukee’s lower east side neighborhood.