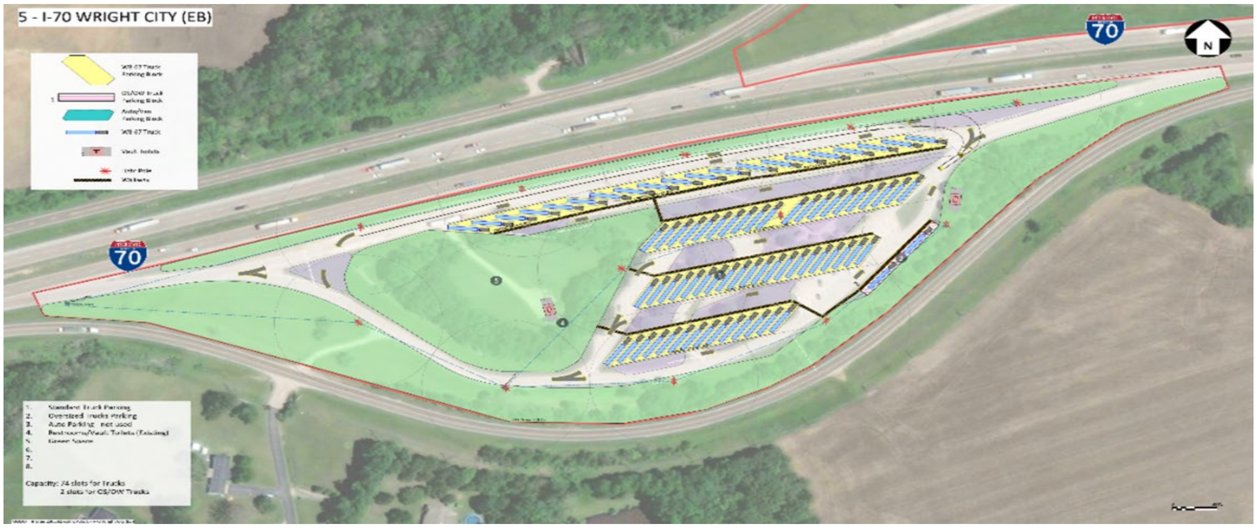
Truck Parking Investments for Missouri



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16. Abstract

Missouri's multimodal freight system is critical to the health of both the state and national economy, and as the economy and population grow, goods movement activity is expected to increase. This growing demand for goods will likely mean more trucks on the road, leading to a greater need to enhance the infrastructure necessary for trucks to improve safety for both truck drivers and the traveling public. The Missouri Department of Transportation (MoDOT) commissioned this study to develop a prioritized list of truck parking locations and immediate actions for near- and long-term changes in truck parking availability in Missouri. The key objectives of this study are to identify an initial list of locations for possible investment, develop a methodology to prioritize locations in Missouri for potential truck parking investments via truck parking demand and truck parking safety metrics, assign a prioritization score for the 18 most promising sites, and conduct an analysis of benefits and costs for each shortlisted site. The shortlist of 18 public truck parking facilities was prioritized by their benefit-cost ratio effectiveness. As Missouri considers strategies and policies to produce a lasting impact in the availability of truck parking, investment in these identified facilities will yield the highest positive impact with the lowest cost. However, given limited funding to develop all the facilities, the 12 with a benefit-cost ratio (BCR) effectiveness score greater than one should be considered first. For the development of these sites, next steps will involve more detailed engineering and design assessments to further understand the local costs and impacts. Overall, with a projected increase in truck traffic throughout Missouri, this study reaffirms the need for increased funding for truck parking investment and the increase of truck parking capacity.

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List of Abbreviations

AADTT	Average annual daily truck traffic
ATRI	American Transportation Research Institute
BCA	Benefit-cost analysis
BCR	Benefit-cost ratio
BTS	U.S. Bureau of Transportation Statistics
CMV	Commercial motor vehicle
DOT	Department of Transportation
FAF	Freight Analysis Framework
FHWA	Federal Highway Administration
KABCO	Established by FHWA: K=Killed, A=Incapacitating injuries, B=Non-Incapacitating, C=Possible Injury, O=Property Damage
GPS	Global positioning system
HOS	Hours of service
MoDOT	Missouri Department of Transportation
NPV	Net present value
OD	Origin-destination
O&M	Operations and maintenance
ROW	Right of way
SFRP	Missouri State Freight & Rail Plan
TAC	Technical Advisory Committee
V/C	Volume to capacity
VHT	Vehicle hours traveled
VMT	Vehicle miles traveled

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Executive Summary

Missouri's multimodal freight system is critical to the health of both the state and national economy. Nearly all items transported statewide are moved by trucks at some point in their supply chains. As the economy and population grow, goods movement activity is also expected to increase. This growing demand for goods will likely mean more trucks on the road, leading to a greater need to enhance the infrastructure necessary for trucks to improve safety for both truck drivers and the traveling public.

Access to safe and reliable truck parking is a key need for the trucking industry. This study consisted of several key steps to develop a prioritized list of truck parking locations and immediate actions for near and long-term changes in truck parking availability in Missouri. The literature review found that, of the 50 U.S. states, 38 have published some form of truck parking plan or study, 10 of which consist of prioritization methods that helped inform this study.

The truck parking demand analysis found that there are a total of 153 designated truck parking facilities in Missouri, of which 45 are public and 108 are private. Of the publicly owned sites, 26 are at or over capacity during the peak hour (between 2 a.m. and 3 a.m.), with the Wright City Rest Area on I-70 in Warren County having the largest gap of 20 spaces. This gap in truck parking demand and supply has had impacts on roadway safety. Between 2017 and 2021 in Missouri, 1,813 crashes occurred which involved parked commercial motor vehicles (CMV) off the roadway, not due to congestion. These consisted of 13 fatal crashes, 266 injury crashes, and 1,534 property damage-only crashes.

These truck parking demand and safety factors were used to prioritize truck parking needs in Missouri. 18 public truck parking sites with high demand and collision factors, coupled with a MoDOT feasibility assessment, were selected for further analysis. The final prioritization score was used as a criteria for identifying public facilities and opportunity sites appropriate for further analysis. This process also included discussion and validation from MoDOT in order to develop a final list of locations for developing conceptual drawings and cost estimates needed to assess benefits and costs.

These 18 potential truck parking locations in Missouri were then prioritized based on their estimated benefits and costs. Benefits were summed and discounted for 20 years, and then were compared to the capital and maintenance costs of the projects. Project costs were estimated from a conceptual level engineering analysis. A benefit-cost ratio (BCR) analysis framework was used to identify the truck parking projects that generate the most benefits per investment costs. Investing in these projects would generate the greatest benefits to the trucking sector and society at large. The ranking by total BCR identified:

- Four "High" BCR effectiveness facilities (BCR over 3.0): Wright City (WB), Wright City (EB), St. Clair Alternative Location A (EB, Proposed), and St. Clair Alternative Location B (WB, Proposed).

- Eight “Medium” BCR effectiveness facilities (BCR equal or greater than 1 but less than 3): Doolittle (EB), Doolittle (WB), Boonville (WB), Boonville (EB), St. Clair (EB) Weigh Station, Halltown (EB), Halltown (WB), and Mineola (WB).
- Six “Low” BCR effectiveness facilities (BCR less than 1.0): Lathrop (NB), Charlestown (NB), Charlestown (SB) Weigh Station (Proposed), Mineola (EB), Strafford (EB), and Joplin (EB).

As a next step, MoDOT should continue to procure funding sources for truck parking investment. Given limited funding to develop all the facilities, the 12 with a BCR effectiveness score greater than one should be considered first. For the development of these sites, next steps will involve more detailed engineering and design assessments to further understand the local costs and impacts. The findings of this study reaffirm the need for increased funding for truck parking investment and the increase of truck parking capacity in Missouri.

1.0 Introduction

Missouri's multimodal freight system is critical to the health of both the state and national economy. In addition, Americans' quality of life depends on the consistent delivery of goods along highway, rail, water, air, and pipeline networks. As the economy and population grow, goods movement activity is also expected to increase. At the same time, almost all items transported statewide are moved by trucks at some point in their supply chains. This growing demand for goods will likely mean more trucks on the road, leading to a greater need to enhance the infrastructure necessary for trucks to improve safety for both truck drivers and the traveling public.

Access to safe and reliable truck parking is a key need for the trucking industry. While many factors influence a truck driver's decision of where to park, hours of service (HOS) regulations have made a significant impact. Drivers are required to follow rest requirements and carefully time delivery schedules and rest periods, making the availability of sufficient parking critical along their routes. In order to plan for and address these challenges, the Missouri Department of Transportation (MoDOT) decided to develop the Truck Parking Investments for Missouri Study. Building on the findings of the Missouri State Freight & Rail Plan (SFRP)[1] and the 2022 Missouri Supply Chain Task Force[2], the goal of this study is to outline recommendations for both near and long-term changes in the availability of truck parking within the state.

1.1 Purpose of Investment Study

This study consisted of several key steps to develop a prioritized list of truck parking locations and immediate actions for near and long-term changes in truck parking availability. First, an extensive literature review was conducted to identify best practices from state departments of transportation to learn their methods for prioritizing truck parking investments. The results of this literature review are provided in Section 2.0.

Using findings from the literature review, a methodology was established to prioritize Missouri locations for potential truck parking investments. This methodology consisted of two key components – truck parking demand, at both designated facilities and in undesignated areas, and truck parking safety along Missouri's highway network – described in Section 3.0 and Section 4.0, respectively.

The overall prioritization process for these two factors, how they were combined into a final prioritization score, and how this score was used to identify an initial list of locations for possible investments is described in Section 5.0.

An analysis of benefits and costs was conducted to prioritize the shortlist of locations. Factors included the project costs, impacts, and benefits. The results of this analysis are discussed in Section 6.0.

[1] https://www.modot.org/2022-state-freight-and-rail-plan-documents

[2] https://www.modot.org/supplychaintaskforce

Section 7.0 provides the report conclusion and summarizes the immediate next steps for near- and long-term actions

Appendix A provides the detailed results of the literature review and Appendix B provides the conceptual site layouts for the 18 truck parking facilities.

2.0 Literature Review

This section summarizes the key findings of a literature review of truck parking prioritization methods used by 10. states to help inform Missouri's approach to truck parking investment prioritization. These findings came out of a more comprehensive review of publicly available truck parking studies across all 50 states, of which 38 had some form of truck parking plan/study or freight plan that discussed truck parking. In general, all states have challenges with truck parking, and while many approach this problem with similar methods (such as a supply and demand analysis), only a few take the additional step of prioritizing locations/solutions to address the problem. Table 2.1 summarizes the truck parking prioritization processes used by state departments of transportation in Arizona, California, Florida, Georgia, Maryland, Nevada, Ohio, Oregon, South Carolina, and Texas.

Table 2.1 Summary of literature review findings

State DOT	Study Name (Year)	Research Findings
Arizona	Truck Parking Study – Working Paper 4: Truck Parking Needs and Solutions (2019)	The prioritization process relied on three data sources: truck driver surveys, industry consultations, and GPS data obtained through ATRI. Using these sources, 15 clusters of significant undesignated parking were identified. These clusters were compared against eight scoring criteria across three categories, in order to assign a prioritization score to each project: location of undesignated truck parking; undesignated trucks; or truck traffic.
California	California Statewide Truck Parking Study (2022)	The process identifies roadway segments and scores them according to three factors – demand (60 percent), safety (30 percent), and stakeholder feedback (10 percent) – and combines them into a weighted scheme to determine a final prioritization score. • The demand factor is the total number of trucks parking in designated and undesignated locations for a segment at the statewide peak hour (12 am – 1 am) subtracted from the total number of designated truck parking spaces normalized by the segment length. • The safety factor is the total number of crashes on the segment, which are weighted by severity, normalized by segment length. • The stakeholder feedback factor combines three datasets – the Social Pinpoint Stakeholder survey, 2019 California Highway Patrol (CHP) truck parking citations, and an informal 2018 CHP survey of officers. Additional analysis compared these prioritized segments with other need criteria such as equity and environmentally sensitive areas. Segments were grouped into corridors/ regions in a sensible, non-quantitative manner to show priority areas for truck parking interventions.

State DOT	Study Name (Year)	Research Findings
Florida	Statewide Truck Parking Study (2020)	The study identifies areas of high truck parking utilization combining designated and undesignated truck parking into 20 specific areas. Then it focuses on areas of concern that have both a high volume-to-capacity (V/C) index and high excess truck parking demand. The results of this prioritization process were then compared to stakeholder feedback within FDOT and through a survey aimed at soliciting input from shippers, receivers, carriers, and truck stop operators. The study found that the feedback generally aligns with the analysis findings.
Georgia	Georgia Statewide Freight and Logistics Plan: Truck Modal Profile	This study prioritized corridors based on the deficit/surplus of truck parking spots during peak demand. Unlike most other truck parking studies, this study does not use truck GPS data to estimate the overall demand; rather, it uses average annual daily truck traffic (AADTT) and origin-destination (OD) trip data for trucks in the area gathered by the FHWA. The findings included a statewide map showing truck parking adequacy for corridors in Georgia, ranked on a scale from 1-9. The study only considered long-haul trucks in this analysis.
Maryland	Maryland Truck Parking Study Final Report (2020)	The methodology used truck GPS data from INRIX to identify truck parking occurrences as designated or undesignated, then identified and prioritized clusters of undesignated truck parking to focus the analysis and solutions on the most severely impacted areas. These clusters were assigned a prioritization score based on three criteria: safety, duration parked, and total number of trucks parked. Clusters that were within the top 10 percent, as measured by density were then used to count the total number of undesignated trucks parked within them. The top 20 polygons with the highest number of undesignated trucks for each type of cluster were prioritized.

State DOT	Study Name (Year)	Research Findings
Nevada	Nevada Truck Parking Implementation Plan (2019)	This report's prioritization process followed a multi-objective decision-making process, which was applied to truck parking projects that expand supply. Projects are scored across seven criteria as follows: • Improves Emergency Parking – either improves the "county" gap or "site" gap in parking • Safety – reduces distance between sites with truck parking • Economy – points awarded based on AADTT near the project site • Connect Communities – points awarded based on "landscaping and aesthetics" • Foster Sustainability – environmental and fiscal sustainability • Preservation – reuse of existing facilities • Project Readiness – within NDOT ROW, can be obligated within two years, consistent with other plans.
Ohio	Transport Ohio: Ohio Truck Parking Study	This study focused on clusters of undesignated truck parking. The process includes three steps: • Step 1: Identify clusters of undesignated truck parking. • Step 2: Apply three criteria to score the undesignated truck parking locations: – Safety Impacts – measured by multiplying the crash frequency by a monetization rate based on crash severity which is then compared to the property damage only crash cost. – Capacity Shortage – based on the number of trucks and the duration of their stay at undesignated parking locations. – Supporting Ohio's Economy – based on whether an undesignated truck parking cluster location is located on or adjacent to a freight corridor or NHS intermodal connector. • Step 3: Identifies clusters that are close enough so improvements in one cluster would improve conditions in another.

State DOT	Study Name (Year)	Research Findings
Oregon	Oregon Commercial Truck Parking Study (2020)	This prioritization process is unique compared to other states. Projects are assessed according to four criteria receiving a low, medium or high score in each. These criteria are more qualitative than other studies: • Effectiveness in achieving goal – the degree to which the strategy addresses the state's general truck parking goals, is applicable across many sites, and is easy to use/implement. • Cost – projects <$500k receive a low score, 500K to $2M receive a medium score, >$2M receive a high score. • Private resource utilization – strategies that utilize private partners or are controlled/implemented by private partners. • Ease of implementation – fewer phases implemented, less resources utilized, and previous successful examples.
South Carolina	South Carolina Statewide Truck Parking Assessment Study: Final Report (2022)	This report prioritizes truck parking needs at the corridor level based on two criteria: • Demand – scored based on the deficit of truck parking per mile on the corridor. Deficit is defined as the number of trucks parking in designated locations minus the supply of parking spaces plus the number of trucks parking in undesignated locations. • Safety – corridors are scored based on the number and severity of crashes along the corridor, per mile. These categories were combined by assigning point values to each category, combined with a weighting factor of 70 percent for demand scores and 30percent for safety scores.
Texas	Texas Statewide Truck Parking Study (2020)	This study prioritizes truck parking needs on the priority freight network. Three criteria are used to prioritize need by corridor: • Capacity Needs – truck parking shortage during peak hours (1 am – 2 am) per mile. • Safety Needs – the count and severity of crashes involving parked trucks per mile using data from 2013-2017 • Freight Network Significance – based on goods movements criteria (e.g. AADTT), market access criteria (e.g. proximity to ports), supply chain criteria (e.g. freight movement in target industries), and economic competitiveness criteria (e.g. workforce readiness). Corridors were given a high, medium, or low score in each criteria and then a combined score where each are summed with a 25 percent, 50 percent, 25 percent weighting scheme respectively.

Source: Cambridge Systematics, 2023.

3.0 Truck Parking Demand in Missouri

Identifying truck parking demand, or comparing the existing truck parking capacity against the total demand and use of designated facilities, is a crucial step in understanding the scope of truck parking challenges across the state. For this study, two truck parking demand metrics were collected and used to develop the overall demand statewide. These include designated truck parking at public and private parking facilities and undesignated truck parking occurring along highway right of way (ROW). The Missouri SFRP Truck Parking Profile[3], developed in November 2021, was used a basis for the demand analysis. This section will discuss the data collection and processing for these inputs.

3.1 Designated Truck Parking at Missouri Facilities

This analysis leverages data from the Missouri State Freight & Rail Plan Truck Parking Profile to understand truck parking demand statewide. The Truck Parking Profile includes an analysis of ATRI truck GPS data from 2019, and provides extensive detail on the data collection methods, processing, and analysis. This study considered the results of the analysis of the gap in truck parking at the peak hour for each facility, calculated by subtracting the final number of truck stops occurring at each facility from the number of truck parking spots provided.

Although this study focused on Missouri's interstate network, U.S. 36 was also included, as it is a crucial limited-access freeway for trucks. Since this corridor was not included in the SFRP Truck Parking Profile, parking utilization information was manually collected through TruckerPath, a popular crowd-source mobile application that allows truckers to report if a truck parking location has "lots of spots," "some spots," or if the "lot is full." Both the number of total spaces and occupied spaces were documented for each facility. By subtracting the truck parking demand from supply, a parking gap was developed, similar to that produced with the ATRI data. Not all sites have frequent reports, and the information is generalized and subjective, nevertheless it is useful for gauging truck parking demand estimates in the absence of ATRI data.

Figure 3.1 shows the statewide truck parking gap score results of the ATRI truck GPS data along Missouri's interstate network, as well as the TruckerPath data collected along U.S. 36[4]. Facilities are separated into public versus private ownership categories and ranked by total gap score. There were a total of 153 designated sites, consisting of 45 public facilities and 108 private facilities.

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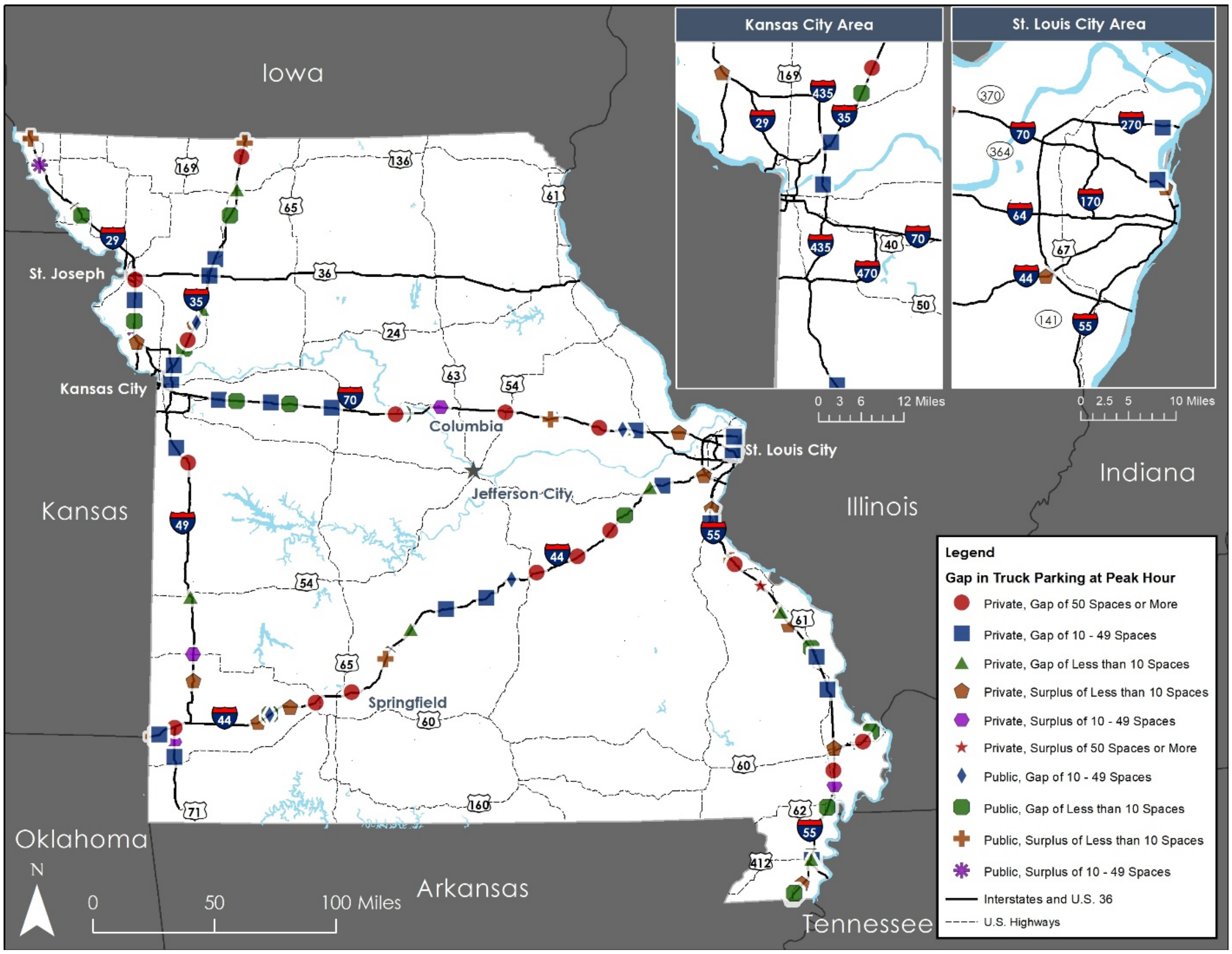
3 https://www.modot.org/sites/default/files/documents/Truck%20Parking%20Profile%20%20FINAL.pdf.

4 During the demand assessment period, several major projects affected drivers' use of the Mineola facilities. Safety concerns prompted several temporary facility closures. Storage of project materials in the areas limited parking availability. Nighttime construction lights and noise also likely affected driver demand in these two locations. For these reasons, the Mineola WB demand figures have been calculated using the peak utilization rates of the nearest designated public truck parking facility, Wright City (WB).

Figure 3.1 Truck parking demand at Missouri's designated facilities

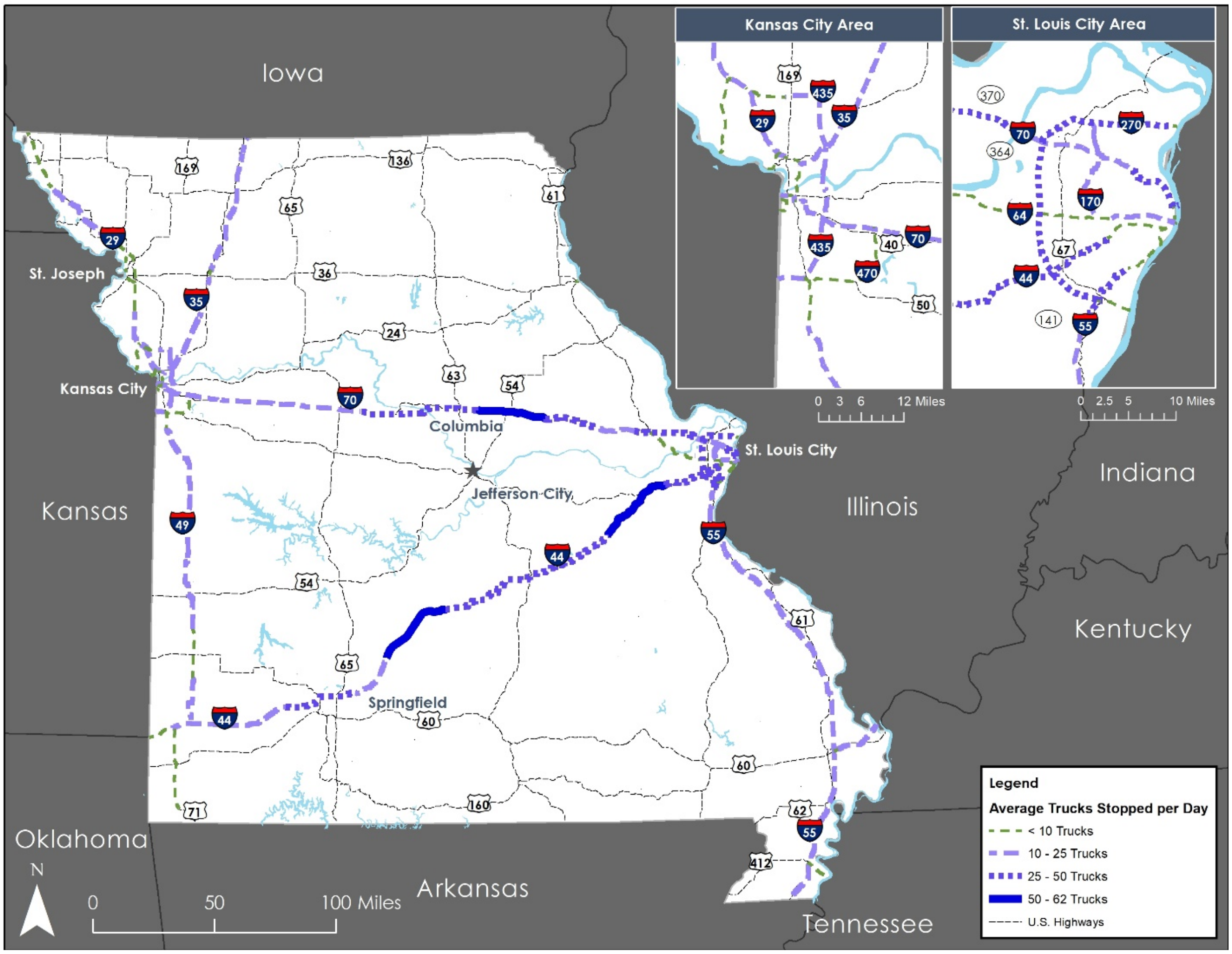


Source: ATRI. Analysis by Cambridge Systematics (2020).

3.2 Undesignated Parking along Missouri's Interstates

Undesignated truck parking demand was also estimated in the SFRP Truck Parking Profile using the same ATRI truck GPS dataset described in the previous section. Polygons were drawn along the Missouri interstate ROW to capture parked trucks, and the total number of stops per segment was divided by the interstate segment length to estimate trucks parked per mile. These results are shown in Figure 3.2. The peak hour for trucks stopped on the interstate ROW occurred between 5 a.m. and 6 a.m., which is different than the designated truck parking facilities' peak demand of 2 a.m. to 3 a.m.

Figure 3.2 Truck parking demand along Missouri's interstate right of way



Source: ATRI. Analysis by Cambridge Systematics (2020).

Although not shown in Figure , undesignated truck parking demand was estimated along U.S. 36 in Missouri. Since ATRI truck GPS data was also not available for the ROW along this route, existing data on both designated and undesignated truck parking along other routes was used to estimate it. At designated truck parking facilities on U.S. 36, the truck stop utilization rate, given as a value of the total number of parking spaces occupied by trucks versus the total available, was divided by the number of trucks parked per mile on the interstate ROW of the nearest interstate segment.

The results determined the ratio of truck stop utilization to the number of trucks parked on the interstate ROW to be 0.85, meaning that 0.85 trucks parked on the ROW when a designated facility is 100 percent full or approximately one truck when a facility is 118 percent full. For the truck parking facilities and nearby interstate segments along U.S. 36, this ratio was used to estimate undesignated parking demand, which is reflected in the total demand, a combination of designated and undesignated truck parking demand at each facility, which is discussed later in this report.

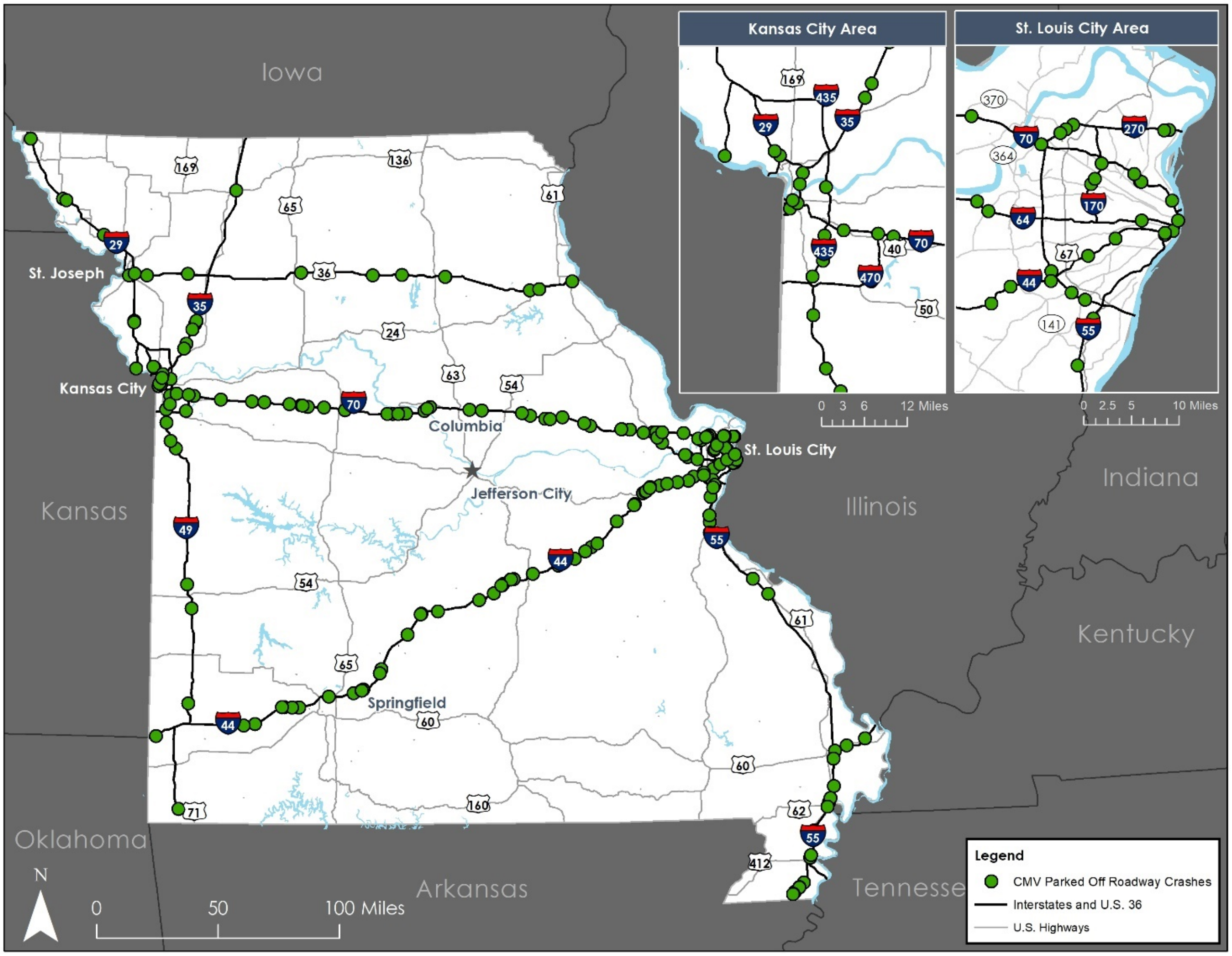
4.0 Truck Parking Safety in Missouri

Truck parking safety is often directly related to the supply and demand of designated truck parking facilities. Where designated truck parking is lacking, truck drivers may be forced to park in undesignated parking spots, such as along the side of the highway or on interchange ramps, in order to meet hours of service (HOS) mandates. These improperly parked trucks can create safety concerns for both drivers and the general traveling public. To fully understand truck parking challenges in Missouri, it is essential to also look at crashes caused by trucks parked in undesignated areas. This section discusses data collection and processing of the safety data used in this study.

Statewide crash data for a five-year period between 2017 and 2021 was obtained from MoDOT's Highway Safety and Traffic Division. Several key filters were applied to isolate the crashes most related to undesignated truck parking, as opposed to crashes that occurred on the roadway. Filters for "CMV" and "Parked" ensured that all crashes involved parked trucks. The "Off-Roadway" filter ensured that the trucks causing the crashes were located off of the roadway mainline. Lastly, excluding "Congestion Ahead" as the "Traffic Control" filter ensured that trucks were parked and not stopped solely due to congestion. With these filters applied, the dataset totaled 1,813 crashes, consisting of 13 fatal crashes, 266 injury crashes, and 1,534 property damage-only crashes.

To further refine the crash data to this study's scope of Missouri's interstate network and U.S. 36, only crashes occurring within 50 feet of the study network were retained in the analysis. As a result, the final dataset contained 202 crashes, consisting of eight fatal crashes, 48 injuries, and 146 property damage only crashes. These crashes involving parked trucks are shown in Figure 4.1.

Figure 4.1 Truck parking safety in Missouri – crashes



Source: MoDOT, 2023; analysis by Cambridge Systematics.

5.0 Prioritization of Truck Parking Needs

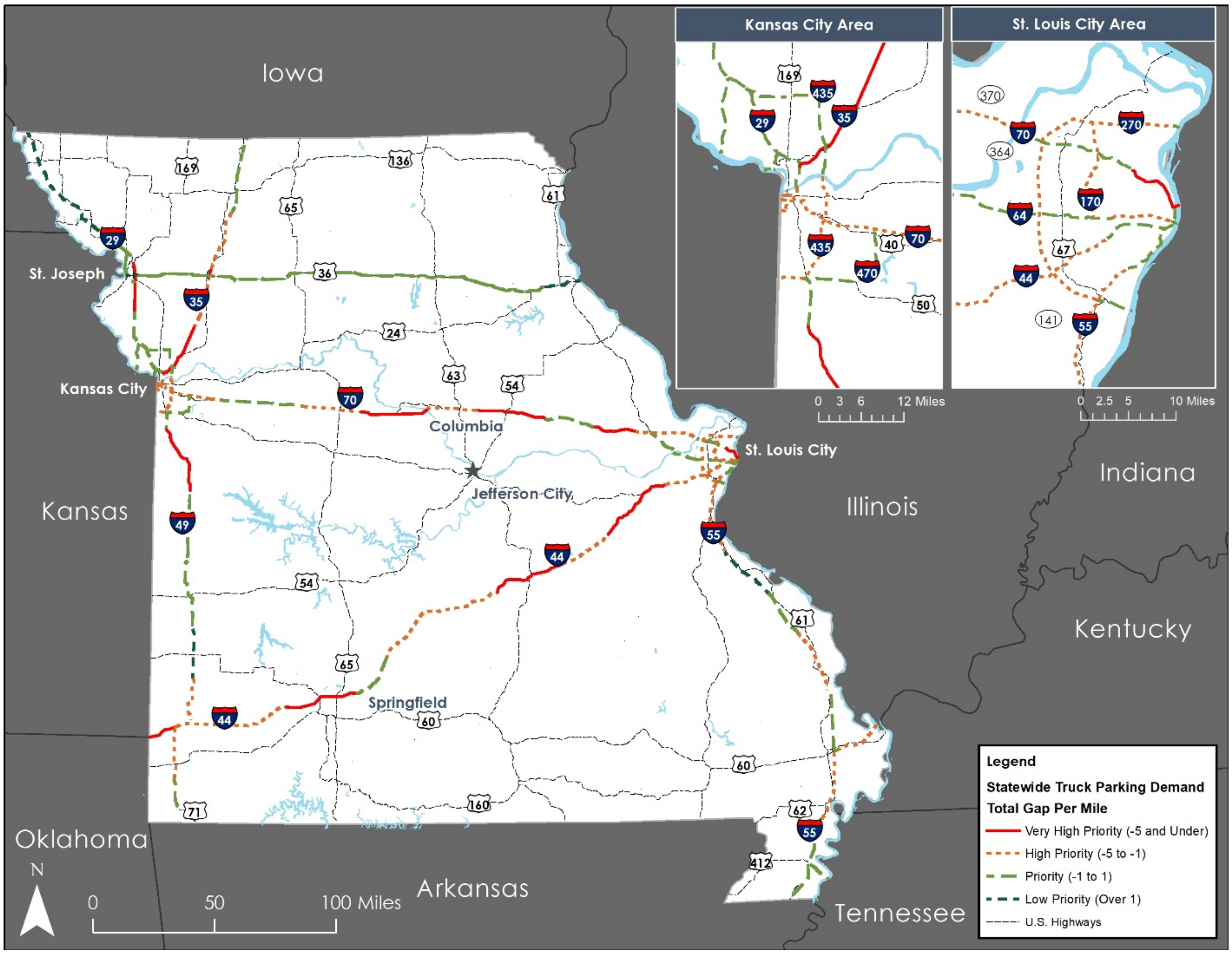
Truck parking demand and safety factors were used to prioritize truck parking needs in Missouri. A methodology was developed to combine these two factors into a needs prioritization score. This section will detail this prioritization process. The final prioritization score was used as a criteria for identifying public facilities and opportunity sites appropriate for further analysis. This process also included discussion and validation from MoDOT in order to develop a final list of locations for developing conceptual drawings and cost estimates needed to assess benefits and costs.

5.1 Prioritized Demand Factor

As discussed in Section 3.1, designated truck parking demand was calculated as a gap in truck parking value, a result of subtracting the demand for parking from the supply of parking spaces. The score for each facility was joined to the nearest roadway segment. When divided by the length of each segment, a demand per mile value was produced. Undesignated truck parking demand, discussed in Section 3.2, was already calculated as a value of trucks per mile. Therefore, this value was added to the per mile designated truck parking demand to produce total demand per mile, a combination of both designated and undesignated parking demand.

In order to produce a gap score per mile, the number of spaces provided by each designated facility was also joined to the roadway network, and when divided by each segment length, produced a value of the number of spaces provided per mile. For each roadway segment on the study network, the total demand per mile was subtracted from the spaces provided per mile to produce a final gap per mile score. Shown in Figure , the final score was divided into four categories of increasing priority, with gap score greater than 1 assigned Low Priority, - 1 to 1 assigned Priority, -5 to -1 assigned High Priority, and scores lower than -5 assigned Very High Priority.

Figure 5.1 Prioritized segments: Truck parking demand factor



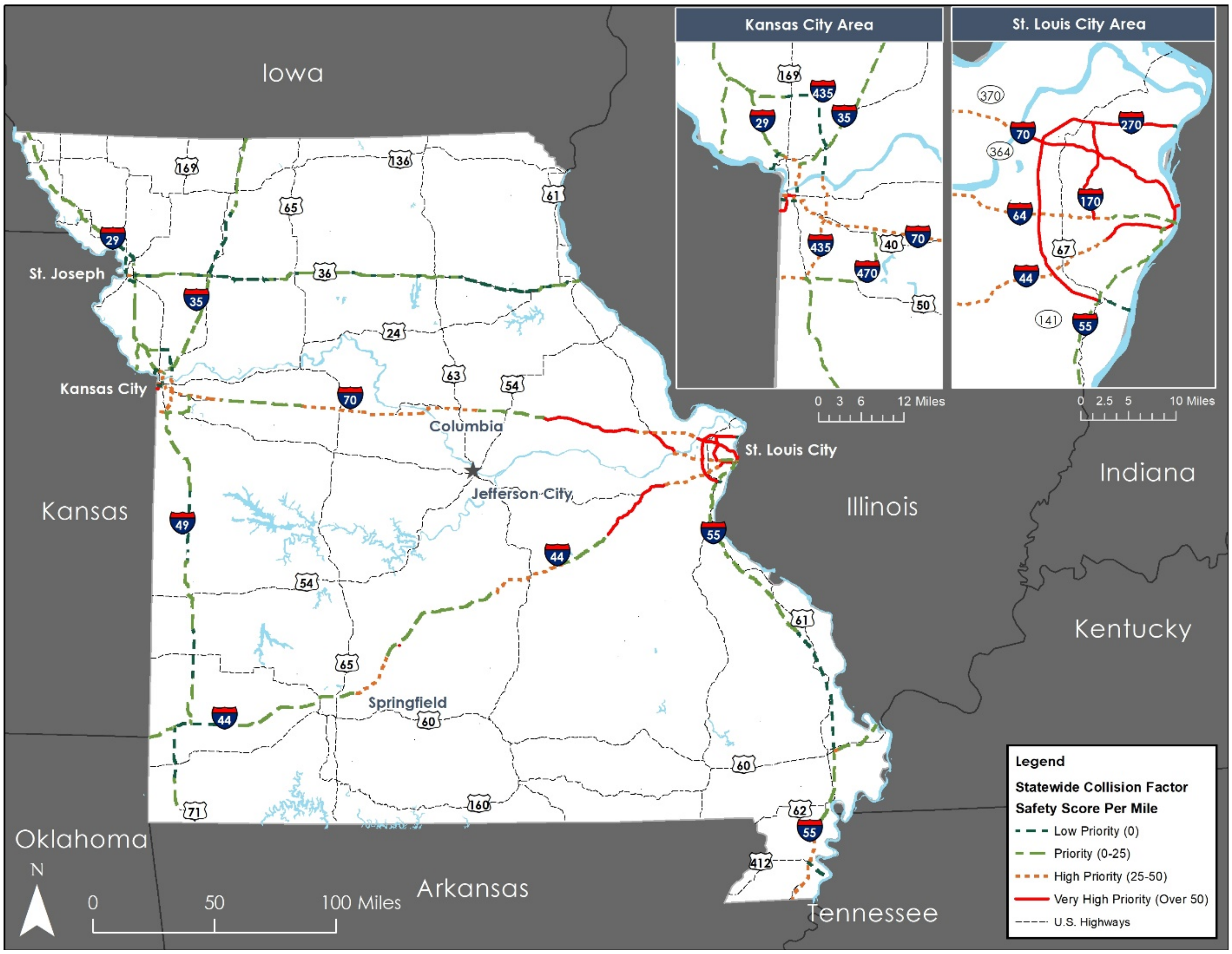
Source: MoDOT; analysis by Cambridge Systematics, 2023.

5.2 Prioritized Collision Factor

Using the crash dataset that was obtained from MoDOT, discussed in Section 4.0, crash occurrences along the study network were weighted by severity for later prioritization across the state. Each crash was assigned a number of points, with fatal crashes receiving the highest value of 5 points, injury crashes given 3 points, and property damage only crashes given 1 point. With crash points assigned, the crash dataset was joined to the study network. Each crash occurrence was joined to its nearest roadway segment and each roadway segment was then given a crash summary field, a sum of the total crash points assigned to the segment. For instance, a segment with a fatal, injury, and property damage only crash would receive a summary score of 9 points.

In order to account for varying roadway segment lengths, the total safety score for each segment was divided by the segment's length. The resulting value was then multipled by 100 to produce values on a scale of 0 to 100. Shown in Figure 5.2, this final collision factor was divided into the same four categories of increasing priorities as the demand factor, with collision factors of 0 assigned Low Priority, 0 to 25 assigned Priority, 25-50 assigned High Priority, and over 50 assigned Very High Priority.

Figure 5.2 Prioritized segments: truck parking collision factor



Source: MoDOT; analysis by Cambridge Systematics, 2023.

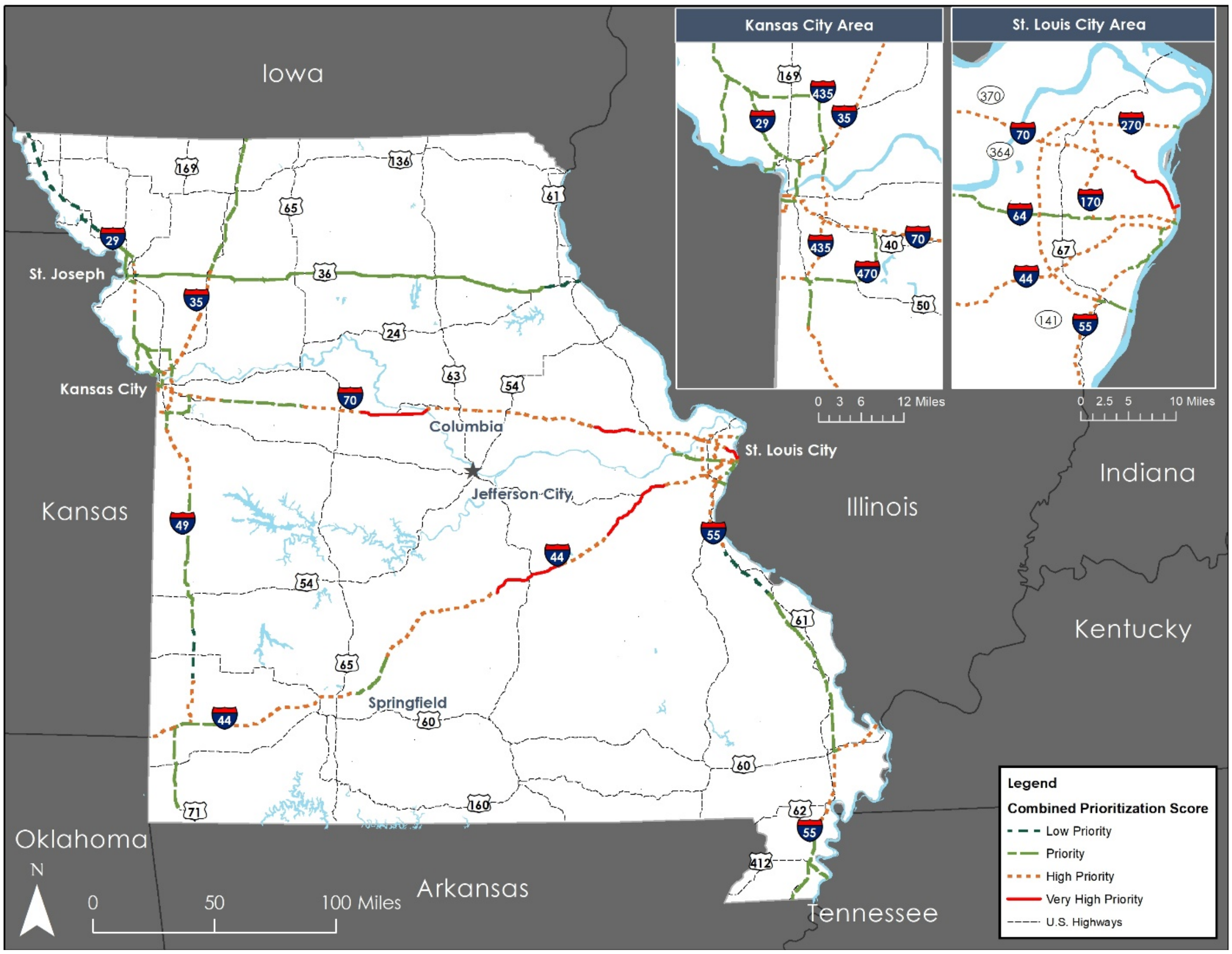
5.3 Combined Prioritization Score

The combined prioritization score is intended to incorporate both the demand and collision factors, which are crucial elements to consider for future truck parking investment. The final rankings for both the demand and collision factors were divided into four categories of priority – Low Priority, Priority, High Priority, and Very High Priority. These priority rankings were converted into numerical values of 1 through 4, in order of low to high priority. An equation was used to combine these two sets of values into a final prioritization value, on a scale of 0 to 100, shown below:

$$Combined\ Prioritization\ Score = (Demand\ Factor\ \times\ 0.70) + (Collision\ Factor\ \times 0.30)$$

The combined prioritization score assigns a higher weight to the demand factor than the collision factor. This is due to truck parking demand being considered a more reliable indicator of both need and safety than safety alone. Truck parking demand, as a result of the lack of designated parking facilities, is directly related to safety issues caused by undesignated parking. Therefore, the combined prioritization score gives 70 percent of the weight to the demand factor and 30 percent to the collision factor. With the final result also being a score of 1 through 4, the combined prioritization score is assigned rankings of Low Priority, Priority, High Priority, and Very High Priority. The results of the combined prioritization score are shown in Figure 5.3.

Figure 5.3 Combined prioritization score



Source: MoDOT; analysis by Cambridge Systematics, 2023.

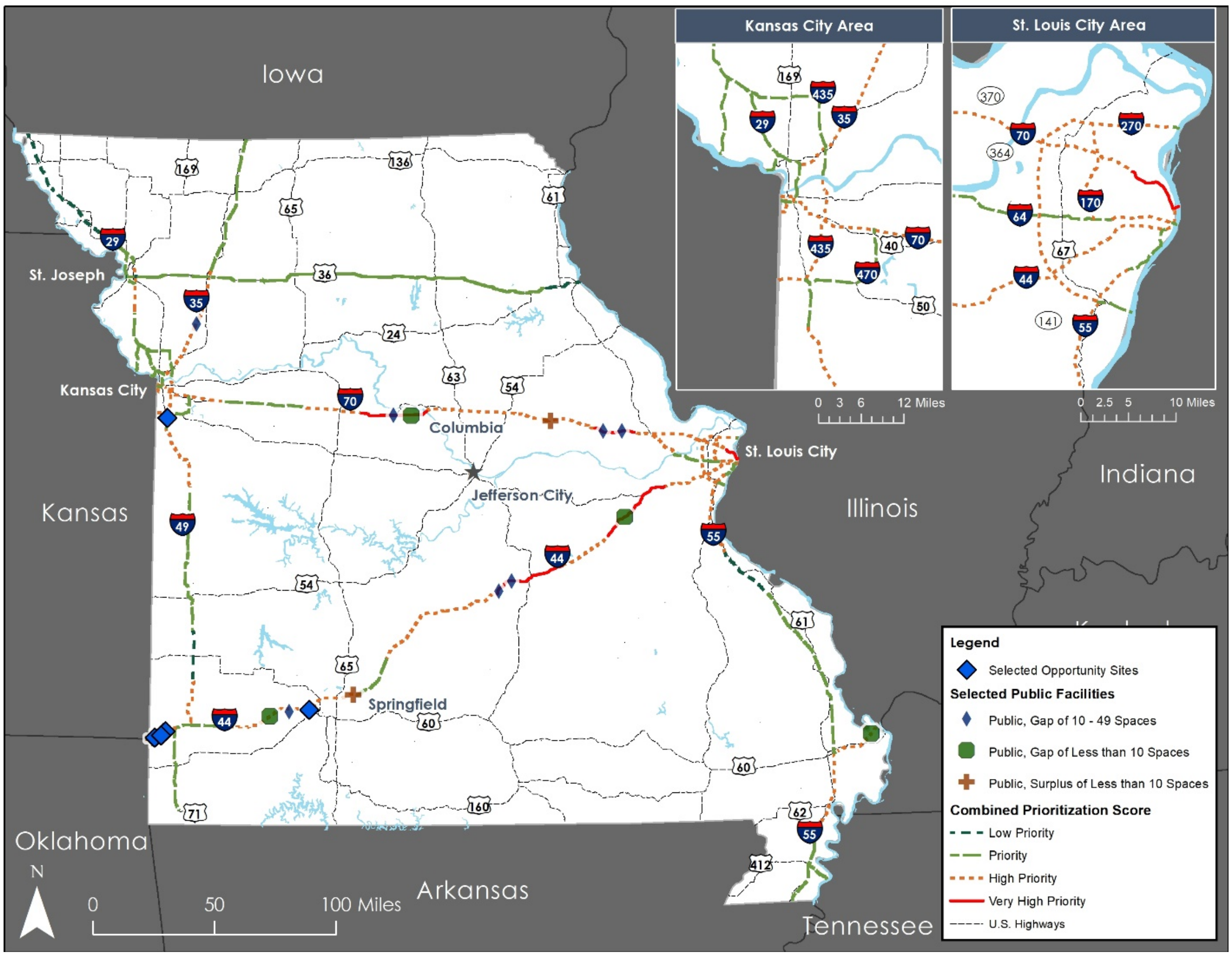
5.4 Identification of Locations for Possible Investments

Using the combined prioritization score, rankings for each of the 45 public truck parking facilities in Missouri were compared in order to identify the most crucial facilities for truck parking investment. This initial prioritization selected all facilities near Very High and High Priority segments, which included a total of 21 facilities.

In addition to existing public facilities, opportunity sites were also compared to the combined prioritization score. These sites were defined as MoDOT-owned parcels consisting of over five acres of land and were identified using internal MoDOT ROW data. While these locations may not currently have existing access to the roadway network, they are considered potential sites for future truck parking facilities. Opportunity sites along Very High and High Priority segments were selected, resulting in a total of seven sites.

Overall, considering both public truck parking facilities and opportunity sites, there were 28 sites selected as part of this preliminary site selection process, shown in Figure 5.4.

Figure 5.4 Preliminary location of selected public facilities

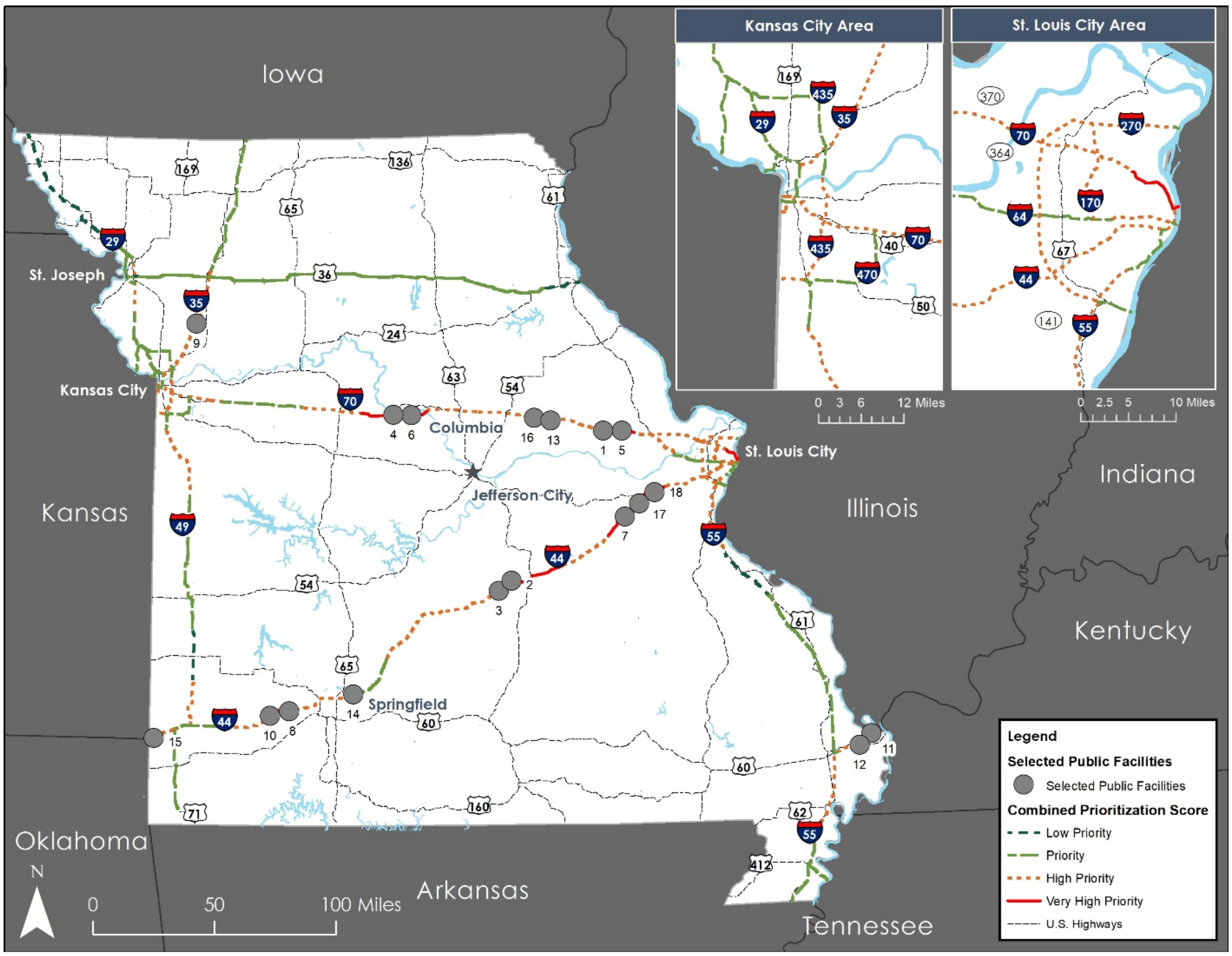


Source: MoDOT; analysis by Cambridge Systematics, 2023.

The second phase of the prioritization process involved high-level feasibility assessments by members of the study's Technical Advisory Committee (TAC), which included MoDOT engineers, motor carrier services and maintenance staff, and planners, among others, followed by two consecutive workshops to narrow the list to the most viable sites for further analysis. Following these discussions, the initial list of 28 facilities and opportunity sites was narrowed down to 18 sites, which includes 15 existing facilities and 3 proposed new facilities (Charleston SB Weigh Station, St. Clair Alternative Location A, and St. Clair Alternative Location B). Figure 5.5 shows the location of the 18 public facilities in Missouri, along with the combined prioritization scores, and Table 5.1 details the 18 facility locations as well as their demand, crash and combined prioritization scores.

These 18 facilities were selected for the development of conceptual site layouts and cost estimates, discussed in the following section. Appendix B contains the conceptual site layouts. The results of this next step were inputs for the benefit-cost ratio, the final step in prioritizing these locations for Missouri truck parking investment.

Figure 5.5 Public facilities selected for further analysis



Source: MoDOT; analysis by Cambridge Systematics, 2023.

Table 5.1 Facility locations and identified priority scoring

Site ID + Name	Demand Score	Crash Score	Combined Score
1 – Wright City (WB)	4 (Very High Priority)	4 (Very High Priority)	4 (Very High Priority)
2 – Doolittle (EB)	4 (Very High Priority)	3 (High Priority)	4 (Very High Priority)
3 – Doolittle (WB)	4 (Very High Priority)	3 (High Priority)	4 (Very High Priority)
4 – Boonville (WB)	4 (Very High Priority)	3 (High Priority)	4 (Very High Priority)
5 – Wright City (EB)	4 (Very High Priority)	4 (Very High Priority)	4 (Very High Priority)
6 – Boonville (EB)	4 (Very High Priority)	3 (High Priority)	4 (Very High Priority)
7 – St. Clair (EB) Weigh Station	4 (Very High Priority)	4 (Very High Priority)	4 (Very High Priority)
8 – Halltown (EB)	3 (High Priority)	2 (Priority)	3 (High Priority)
9 – Lathrop (NB)	3 (High Priority)	2 (Priority)	3 (High Priority)
10 – Halltown (WB)	3 (High Priority)	2 (Priority)	3 (High Priority)
11 – Charleston (NB)	3 (High Priority)	2 (Priority)	3 (High Priority)
12 – Charleston (SB) Weigh Station (Proposed)	3 (High Priority)	2 (Priority)	3 (High Priority)
13 – Mineola (EB)	2 (Priority)	4 (Very High Priority)	3 (High Priority)
14 – Strafford (EB)	4 (Very High Priority)	2 (Priority)	3 (High Priority)
15 – Joplin (EB)	4 (Very High Priority)	2 (Priority)	3 (High Priority)
16 – Mineola (WB)	4 (Very High Priority)	4 (Very High Priority)	4 (Very High Priority)
17 – St. Clair Alternative Location A (Proposed) EB	4 (Very High Priority)	4 (Very High Priority)	4 (Very High Priority)
18 – St. Clair Alternative Location B (Proposed) WB	4 (Very High Priority)	4 (Very High Priority)	4 (Very High Priority)

Source: Cambridge Systematics (2023).

6.0 Prioritized Locations by Comparing Benefits and Costs

An analysis was conducted to prioritize the 18 potential truck parking locations in Missouri based on their estimated benefits and costs. Benefits were summed and discounted for 20 years, and then were compared to the capital and maintenance costs of the projects. Project costs were estimated from a conceptual level engineering analysis. A benefit-cost ratio (BCR) analysis framework was used to identify the truck parking projects that generate the most benefits per investment costs. Investing in these projects would generate the greatest benefits to the trucking sector and society at large.

6.1 BCR Analysis Framework

A BCR is an evaluation criterion to assess the economic advantages (benefits) and disadvantages (costs) of an investment alternative. Benefits and costs are broadly defined and are quantified in monetary terms to the extent possible. The overall goal of a BCR analysis is to assess whether the expected benefits of a project justify the costs from a macroeconomic perspective. A BCR analysis framework attempts to capture the net welfare change created by a project, including cost savings and increases in welfare (benefits such as improved trucker productivity and safety for all drivers), as well as disbenefits where costs can be identified (e.g., project capital costs and incremental maintenance costs), and welfare reductions where some groups are expected to be made worse off as a result of the proposed project.

The BCR analysis framework involves defining a Base Case or "No Build" Case, which is compared to the "Build" Case, where the project receives approval and the parking project is built as proposed. The BCR analysis assesses the incremental difference between the Base Case and the Build Case, which represents the net change in welfare. BCRs are forward-looking exercises that seek to assess the incremental change in welfare over a project lifecycle. The importance of future welfare changes is determined through discounting, which is meant to reflect both the opportunity cost of capital as well as the societal preference for the present.

The BCR analysis was conducted generally in accordance with the benefit-cost methodology as recommended by the USDOT in the 2023 Benefit-Cost Analysis Guidance for Discretionary Grant Programs. This methodology includes the following analytical assumptions:

- Defining existing and future conditions under a No Build base case as well as under the Build Case.
- Estimating benefits and costs during project construction and operation, including 20 years of operations beyond the project completion when benefits accrue.
- Using USDOT recommended monetized values for reduced fatalities, injuries, property damage, travel time savings, and emissions, while relying on best practices for monetization of other benefits.
- Presenting dollar values in real 2021 dollars (2021$). In instances where cost estimates and benefits valuations are expressed in historical or future dollar years, using an appropriate inflation rate to adjust the values.

- Discounting future benefits and costs with a real discount rate of seven percent consistent with USDOT guidance.

Project prioritization was performed by consistently utilizing this BCR analysis framework for all projects under consideration to provide robust results that present a compelling case for investing in these types of truck parking projects. While the BCR analysis framework generally follows standard practices and USDOT guidance, some simplifications were needed to be able to develop BCR results for 18 projects. The objective of this analysis was to evaluate different projects with consistent methodology to support prioritization, rather than developing in-depth analyses and estimation of benefits and costs for individual projects. Federal grant applications in support of individual projects are likely to require a more in-depth benefit-cost analysis (BCA), which could use the assumptions and results of this analysis contained in this memo as a starting point.

6.2 Project Costs

For project investments, dollar figures in this analysis are expressed in constant 2021 dollars (2021$). Capital costs provided for this analysis expressed in 2023 dollars were converted to 2021$ using consumer price index based adjustments. The real discount rate used for this analysis was seven percent, consistent with USDOT 2023 Benefit-Cost Analysis Guidance for Discretionary Grant Programs. For the project, the evaluation period includes the one-year design/construction period during which capital expenditures are undertaken, plus 20 years of operations beyond the project completion within which to accrue benefits. All benefits and costs are conservatively assumed to occur at the end of each year for purposes of present value discounting. Benefits accruing from the improvements are assumed to begin in the calendar year following construction's completion.

For the purposes of this study, it is assumed that design and construction of the project begins as early as July 2024 and continues through the end of June 2025. It is assumed that the projects would be fully complete and operational starting in 2026. The analysis period, therefore, begins in 2024, when design begins, and continues through 20 years of operations starting in 2026 (or through 2045).

6.2.1 Capital Costs

Methodology

Capital costs were estimated by first developing layouts in PRIME software from which quantities were produced for estimation. PRIME, a planning and analysis toolkit developed in-house by WSP, was initially designed to assist port designers and planners efficiently and effectively in preparing terminal layouts, including truck parking, and conducting operational and cost calculations. Over time, its flexibility has led to its use in planning interstate truck parking across several U.S. states. The layouts developed in PRIME provide quantities for various component bid items, which were used to develop capital expenditures for each site. These component items include: site vegetation removal; cut and fill for site; existing pavement wearing surface removal; new pavement for heavy vehicle parking lot; striping for parking slots and walkways; electrical utilities; light poles; and vault-style toilets.

Standard bid items pertaining to the construction of truck parking lots in Missouri were then identified and bid. TABS, a software that assists in the analysis of bid tabulation data for construction projects, was used to analyze associated unit costs. Based on the number of slots added and modifications required at the site for operations such as pavement and utilities, these unit costs were used to calculate overall project development costs. The total estimated cost also includes additional expenditures of 20 percent for contingency and seven percent for design and construction management. The contingency accounts for unknowns and unanticipated cost increases as these estimates are based on planning level concepts.

Results

Table 6.1 shows the development cost for each site along with the number of truck parking slots.

Table 6.1 Estimated capital expenditures for facilities under review (2023 dollars)

Station	Existing Truck Slot Equivalent*	Revised Truck Slot Equivalent*	Net Slot Gain	Build Capital Expenditures	Capital Expenditures per Slot
1 – Wright City (WB)	18	77	59	$5,594,088	$94,815
2 – Doolittle (EB)	14	107	93	$7,420,528	$79,791
3 – Doolittle (WB)	14	93	79	$6,419,850	$81,264
4 – Boonville (WB)	21	83	62	$5,917,745	$95,447
5 – Wright City (EB)	20	76	56	$5,056,252	$90,290
6 – Boonville (EB)	21	81	60	$6,565,568	$109,426
7 – St. Clair (EB) Weigh Station	10	23	13	$2,449,355	$188,412
8 – Halltown (EB)	22	61	39	$4,137,482	$106,089
9 – Lathrop (NB)	9	61	52	$7,628,636	$146,705
10 – Halltown (WB)	22	62	40	$4,855,391	$121,385
11 – Charleston (NB)	16	35	19	$2,986,547	$157,187
12 – Charleston (SB) Weigh Station (Proposed)	5	55	50	$4,367,861	$87,357
13 – Mineola (EB)	29	48	19	$3,690,914	$194,259
14 – Strafford (EB)	17	22	5	$2,840,669	$568,134
15 – Joplin (EB)	61	106	45	$6,995,131	$155,447
16 – Mineola (WB)	64	106	42	$5,811,804	$138,376
17 – St. Clair Alternative Location A (EB) (Proposed)	0	35	35	$2,625,684	$75,020

Station	Existing Truck Slot Equivalent*	Revised Truck Slot Equivalent*	Net Slot Gain	Build Capital Expenditures	Capital Expenditures per Slot
18 – St. Clair Alternative Location B (WB) (Proposed)	0	19	19	$1,895,870	$99,783

* In reviewing site geometry and estimating capital and operating expenditures, a truck slot equivalent value was calculated to take into account the total number of truck spaces and car spaces available at each site. These truck slot equivalent values are used for estimating expenditures only. Actual number of truck spaces in Build and No Build scenarios are detailed in Table 6.4. The Net Slot Gain column is also accurate, as these are actual truck spaces added.

Source: WSP (2023).

Table 6.2 details the timing of capital expenditures for each of the sites under review. As mentioned earlier, all capital expenditures are estimated to be spent in 2024 and 2025, with operations beginning in 2026.

Table 6.2 Capital expenditures by year (2023 dollars)

Station	2023	2024	2025	2026	Total
1 – Wright City (WB)	$–	$2,797,044	$2,797,044	$–	$5,594,088
2 – Doolittle (EB)	$–	$3,710,264	$3,710,264	$–	$7,420,528
3 – Doolittle (WB)	$–	$3,209,925	$3,209,925	$–	$6,419,850
4 – Boonville (WB)	$–	$2,958,872	$2,958,872	$–	$5,917,745
5 – Wright City (EB)	$–	$2,528,126	$2,528,126	$–	$5,056,252
6 – Boonville (EB)	$–	$3,282,784	$3,282,784	$–	$6,565,568
7 – St. Clair (EB) Weigh Station	$–	$1,224,678	$1,224,678	$–	$2,449,355
8 – Halltown (EB)	$–	$2,068,741	$2,068,741	$–	$4,137,482
9 – Lathrop (NB)	$–	$3,814,318	$3,814,318	$–	$7,628,636
10 – Halltown (WB)	$–	$2,427,696	$2,427,696	$–	$4,855,391
11 – Charleston (NB)	$–	$1,493,274	$1,493,274	$–	$2,986,547
12 – Charleston (SB) Weigh Station (Proposed)	$–	$2,183,930	$2,183,930	$–	$4,367,861
13 – Mineola (EB)	$–	$1,845,457	$1,845,457	$–	$3,690,914
14 – Strafford (EB)	$–	$1,420,335	$1,420,335	$–	$2,840,669

Station	2023	2024	2025	2026	Total
15 – Joplin (EB)	$–	$3,497,565	$3,497,565	$–	$6,995,131
16 – Mineola (WB)	$–	$2,905,902	$2,905,902	$–	$5,811,804
17 – St. Clair Alternative Location A (EB) (Proposed)	$–	$1,312,842	$1,312,842	$–	$2,625,684
18 – St. Clair Alternative Location B (WB) (Proposed)	$–	$947,935	$947,935	$–	$1,895,870

Source: WSP (2023).

6.2.2 Operations and Maintenance (O&M) Costs

Methodology

The approach for the operations and maintenance (O&M) costs was to analyze each operating expense through the design life of a heavy vehicle parking lot which was assumed to be a span of 20 years. The following costs were considered:

- Daily routine and janitorial services: These costs were provided by MoDOT in a three-year format ending in the fall of 2024 for existing sites. Routine maintenance costs were extrapolated for the Build scenario based on the future number of truck and car slot number whereas janitorial costs were extrapolated based on the future building size. For sites that do not have an existing operation (e.g., St. Clair), average costs for nearby sites were used.
- Utilities costs: MoDOT provided annual utility costs for most of the existing sites. Costs were extrapolated for the Build scenario based on the future truck and car slot number and adjusted to consider extra facilities such as a Visitor Center. For sites that do not have an existing operation (e.g. St. Clair), average costs for nearby sites were used.
- Snow removal and long-term maintenance for heavy-vehicle parking lot: Local vendors were researched for prices based on the scale and magnitude of an individual parking lot. From this research, unit costs were developed for snow removals and long-term care to account for preventative measures aimed at slowing down the depreciation of the asset. These preventive measures include periodic restriping, seal coating every 3 years, potholes repair, and one asphalt overlay in the twenty-year lifecycle. WSP then used the footprints of the existing and proposed configurations to calculate monthly costs to maintain a single parking slot.

Results

Table 6.3 shows a summary of O&M costs for each site for existing operations (No Build) as well as the proposed revised operations (Build) for each site under review. The No Build cost assumes there is no new development, and the site will continue to incur O&M costs for existing operations. The Build cost assumes new truck parking area development and the associated O&M costs.

Table 6.3 O&M costs for facilities under review (2023 dollars)

Station	No Build Operations & Maintenance (monthly)	Build Operations & Maintenance (monthly)	Incremental Operations & Maintenance (monthly)
1 – Wright City (WB)	$19,685	$36,458	$16,773
2 – Doolittle (EB)	$10,708	$38,269	$27,561
3 – Doolittle (WB)	$10,869	$33,398	$22,528
4 – Boonville (WB)	$27,508	$55,204	$27,696
5 – Wright City (EB)	$21,169	$30,151	$8,981
6 – Boonville (EB)	$26,984	$54,448	$27,463
7 – St. Clair (EB) Weigh Station	$4,217	$9,826	$5,609
8 – Halltown (EB)	$7,778	$16,516	$8,737
9 – Lathrop (NB)	$21,175	$43,001	$21,826
10 – Halltown (WB)	$7,899	$17,113	$9,214
11 – Charleston (NB)	$7,597	$19,175	$11,577
12 – Charleston (SB) Weigh Station (Proposed)	$2,781	$24,940	$22,159
13 – Mineola (EB)	$12,953	$19,904	$6,951
14 – Strafford (EB)	$5,124	$8,331	$3,207
15 – Joplin (EB)	$43,234	$57,456	$14,222
16 – Mineola (WB)	$15,951	$24,649	$8,698
17 – St. Clair Alternative Location A (EB) (Proposed)	$0	$15,989	$15,989
18 – St. Clair Alternative Location B (WB) (Proposed)	$0	$8,531	$8,531

Source: WSP (2023).

Per USDOT guidance, incremental O&M costs in the Build scenario (compared to the No Build scenario) are included in the numerator along with other project benefits when calculating the benefit-cost ratio (BCR). As these O&M costs are higher in the Build scenario, these additional agency expenditures are considered a negative benefit to the project.

6.3 Transportation Impacts

6.3.1 Demand & Safety

As indicated in Section 3.0, parking demand was estimated based on data from the Missouri State Freight & Rail Plan. Although current demand was estimated using truck GPS data, the benefits and costs associated with each of the 18 sites were based on future or projected demand. Future demand was calculated using the Freight Analysis Framework (FAF), produced by the Bureau of Transportation Statistics (BTS) and Federal Highway Administration (FHWA). Consisting of data on freight movements by modes of transportation, the FAF provides a 2022 base year estimate and a 2050 projected estimate. The total number of truck trips in the base and projected scenarios was used to calculate a percentage change for each roadway segment. For each of the selected truck parking facilities, the percentage change for the nearest segment was applied directly to the number of spaces needed at each site, based on truck GPS data, to calculate the future demand or number of spaces needed at each site. Table 6.4 details current and proposed parking space inventory at each of the 18 sites compared to current and expected future demand.

Table 6.4 Current and Build future inventory compared to current and future demand

Site ID + Name	Current Inventory - # of Spaces (No Build)	Total # of Spaces Needed at Site (No Build Demand)	Total Gap (No Build Supply-Demand imbalance)	Future # of Spaces Needed at Site (No Build 2050 Demand)	Truck Spaces added	Inventory - # of Spaces (Build)
1 – Wright City (WB)	18	58	40	96	59	77
2 – Doolittle (EB)	14	56	42	101	93	107
3 – Doolittle (WB)	14	55	41	98	79	93
4 – Boonville (WB)	21	62	41	105	62	83
5 – Wright City (EB)	20	52	32	86	56	76
6 – Boonville (EB)	21	58	37	98	60	81
7 – St. Clair (EB) Weigh Station	10	53	43	96	13	36
8 – Halltown (EB)	17	48	31	85	39	56
9 – Lathrop (NB)	9	35	26	58	52	61

Site ID + Name	Current Inventory - # of Spaces (No Build)	Total # of Spaces Needed at Site (No Build Demand)	Total Gap (No Build Supply-Demand imbalance)	Future # of Spaces Needed at Site (No Build 2050 Demand)	Truck Spaces added	Inventory - # of Spaces (Build)
10 – Halltown (WB)	20	44	24	78	40	60
11 – Charleston (NB)	16	25	9	44	19	35
12 – Charleston (SB) Weigh Station (Proposed)	5	25	9	44	50	55
13 – Mineola (EB)	29	57	28	96	19	48
14 – Strafford (EB)	17	34	17	60	5	22
15 – Joplin (EB)	42	48	6	84	45	87
16 – Mineola (WB)	64	129	65	216	42	106
17 – St. Clair Alternative Location A (EB) (Proposed)	13	53	40	96	35	48
18 – St. Clair Alternative Location B (WB) (Proposed)	13	53	40	96	19	32

Source: WSP (2023).

Note: Demand data at the Mineola sites has been readjusted, given that existing demand during the study period was skewed by construction and closure conditions. For instance, WB Mineola location was impacted by bridge construction, bridge deck reconstruction and climbing lane work. The readjustments were estimated using supply-demand gap estimates at nearby locations such as Wright City.

6.3.2 Truck Vehicle Miles Traveled (VMT) Savings

Vehicle miles traveled (VMT) savings associated with meeting current and forecast demand with adding truck space capacity are currently calculated based on the distance that truck drivers would have to travel to go the next closest truck parking area with availability. In the No Build scenario, when drivers encounter a fully occupied truck parking facility (privately- or publicly-owned), they search for parking and attempt to go to the next location with availability. For the projects under consideration, the next available facility is generally a significant distance away, ranging from 70-150 miles. When distances are so far, it is unlikely that drivers travel the full distance required to go to the next location with availability. Prior surveys with multi-state drivers show that they typically spend anywhere from 15-60 minutes searching for parking. If they are unable to find parking at designated locations within this time, it is likely that truck drivers would park on the shoulder or in some undesignated area nearby, leading to potential safety concerns.

As such, daily VMT savings are calculated by determining the trips avoided searching for parking and the associated miles traveled. More specifically, all daily VMT savings included in the analysis are calculated using the methodology and assumptions detailed below.

- Assuming an average of 30 minutes spent looking for parking and an average speed of 60 mph, drivers would travel a maximum of 30 miles searching for parking.
- If the next parking facility with availability is less than 30 miles away:
- In the No Build scenario, the driver is assumed to simply travel to the next parking facility and rest there.
- In the Build scenario, drivers avoid that trip and simply park in the extra spaces provided by the project.
- The daily VMT savings are equal to the product of the distance between the two facilities and the total number of daily avoided trips.
- The total number of daily avoided trips is a factor based on the total current and future demand at the facility as well as the total number of truck spaces provided by the project. If the number of spaces provided is greater than the existing shortfall in spaces, then the full supply-demand gap is assumed to have been met. Otherwise, only demand up to the number of provided truck spaces is assumed to have been met.
- If the next parking facility with availability is more than 30 miles away:
- In the No Build scenario, it is assumed that the driver travels an average of 30 miles looking for parking and could park on the shoulder or in some undesignated area.
- In the Build scenario, drivers would avoid that trip and simply park in the extra spaces provided by the project.

- The daily VMT savings are equal to the product of 30 miles and the total number of daily avoided trips.
- The total number of daily avoided trips is a factor based on the total current and future demand at the facility as well as the total number of truck spaces provided by the project. If the number of spaces provided is greater than existing shortfall in spaces, then the full supply-demand gap is assumed to be met. Otherwise, only demand up to the number of provided truck spaces is assumed to have been met.
- As facility demand was determined using peak-hour weeknight demand, annual VMT savings are calculated by multiplying daily VMT savings calculated above with an annualization factor of 310.

Table 6.5 details the total current annual VMT savings for each of the facilities under proposed Build scenarios. As described above, these VMT savings increase in the future as facility demand is expected to increase and the added truck spaces will serve this increasing demand.

Table 6.5 Total annual VMT savings by facility, current year

Site ID + Name	Total Current Gap	Truck Spaces Added	Percent of Current Need Addressed	Total VMT Saved per Day, Current	Annual VMT Saved, Current
1 – Wright City (WB)	40	59	100%	1,154	357,844
2 – Doolittle (EB)	42	93	100%	1,268	392,936
3 – Doolittle (WB)	41	79	100%	1,216	376,874
4 – Boonville (WB)	41	62	100%	1,219	377,900
5 – Wright City (EB)	32	56	100%	918	284,479
6 – Boonville (EB)	37	60	100%	1,096	339,752
7 – St. Clair (EB) Weigh Station	43	13	30%	390	120,900
8 – Halltown (EB)	31	39	100%	916	283,830
9 – Lathrop (NB)	26	52	100%	537	166,423
10 – Halltown (WB)	24	40	100%	713	221,128
11 – Charleston (NB)	9	19	100%	256	79,496
12 – Charleston (SB) Weigh Station (Proposed)	9	50	100%	256	79,496
13 – Mineola (EB)	28	19	67%	82	25,327
14 – Strafford (EB)	17	5	30%	150	46,500

Site ID + Name	Total Current Gap	Truck Spaces Added	Percent of Current Need Addressed	Total VMT Saved per Day, Current	Annual VMT Saved, Current
15 – Joplin (EB)	6	45	100%	171	52,889
16 – Mineola (WB)	65	42	100%	1,260	390,600
17 – St. Clair Alternative Location A (EB) (Proposed)	40	35	87%	1,050	325,500
18 – St. Clair Alternative Location B (WB) (Proposed)	40	19	47%	570	176,700

Source: WSP (2023).

Note: The addition of truck spaces to meet demand is constrained by the size and geometry of the existing ROW at these locations. To fully meet the gap highlighted in the above table, additional capital expenditures are necessary to purchase ROW and complete additional grading and fill. In this analysis, only truck spaces that could be added within the existing ROW were considered. More broadly, this constraint applies to all prior analyses completed under this Research Project.

6.3.3 Safety – Undesignated Parking

Improving the availability of truck parking has a significant positive impact on safety. It decreases the temptation for trucks to park in undesignated or prohibited locations, such as highway shoulders, thereby reducing the risk of crashes associated with incursion into through lanes, blocking of shoulders and/or ramps, and obstruction of sight lines. Parking in locations that are not designed to accommodate large vehicles poses safety risks to the driver of the truck and the occupants of other vehicles.

In addition, difficulties finding parking leads truck drivers to rush to reach available parking within the federally regulated hours of service (HOS), or opt to violate HOS rest regulations altogether, which poses a clear safety risk to them and to other travelers. Making it easier for truck drivers to get needed rest in safe locations is critical to improve highway safety.

To estimate safety incidents that could potentially be caused by undesignated parking due to truck parking shortages, truck crash data for the National Highway System (NHS) was obtained and crash data associated with parked trucks within 20 miles of the parking sites was isolated for years 2017-2021 (see Table 6.6). Only crash data associated with the study network were included in the analysis.

Table 6.6 Crash statistics by severity (2017-2021)

Site ID + Name	Total # of Crashes	Fatal Crashes	Disabling Injury Crashes	Serious Injury Crashes	Minor Injury Crashes	Property Damage Only Crashes
1 – Wright City (WB)	12	3	0	1	2	6
2 – Doolittle (EB)	10	0	0	0	2	8
3 – Doolittle (WB)	10	0	0	0	2	8
4 – Boonville (WB)	11	0	0	1	1	9
5 – Wright City (EB)	12	3	0	1	2	6
6 – Boonville (EB)	11	0	0	1	1	9
7 – St. Clair (EB) Weigh Station	11	1	1	0	1	8
8 – Halltown (EB)	7	0	1	0	0	6
9 – Lathrop (NB)	7	0	0	0	1	6
10 – Halltown (WB)	7	0	1	0	0	6
11 – Charleston (NB)	2	0	0	0	0	2
12 – Charleston (SB) Weigh Station (Proposed)	2	0	0	0	0	2
13 – Mineola (EB)	7	0	0	0	2	5
14 – Strafford (EB)	7	0	0	0	1	6
15 – Joplin (EB)	1	0	0	0	0	1
16 – Mineola (WB)	8	0	0	0	3	5
17 – St. Clair Alternative Location A (EB) (Proposed)	11	1	1	0	1	8
18 – St. Clair Alternative Location B (WB) (Proposed)	11	1	1	0	1	8

Source: MoDOT, 2023; analysis by Cambridge Systematics and WSP.

It was not possible to ascertain from the data how many of these crashes were caused by undesignated parking associated with a lack of spaces in the nearby parking facility. As such, crashes associated with parked trucks were monetized with some conservative assumptions. In the Build scenario, meeting parking demand would cut the number of crashes associated with parked trucks within the 20-mile radius by 50 percent.

This safety benefit is only included in the analysis if the next nearby designated location with availability is more than 30 miles away. As described in Section 6.3.2, if the next facility with availability is less than 30 miles away, drivers would simply park at that facility and avoid the safety risks associated with undesignated parking along the highway. However, if the next facility with availability also does not have enough capacity to meet the full demand associated with additional trucks, some drivers would again be forced to park along the highway. In such a case, safety benefits are only apportioned up to the amount of demand that the next facility is not able to serve.

Finally, if there is another parking facility without availability within 30 miles (generally a corresponding facility on the other side of the highway that is also being analyzed as part of this study), then the safety benefit is halved again. This adjustment is made because safety benefits are calculated based on analyzing incidents within a 20-mile radius of a facility, and parking shortages at northbound/southbound or eastbound/ westbound pairs of facilities in close proximity to each other may both be contributing to incidents involving parked trucks at the same time. Assuming that both locations achieve a similar safety benefit given concurrent investment in capacity expansion, the calculated safety benefit is evenly apportioned to both facilities (i.e. 50 percent each).

Table 6.7 details the average number of crashes that could be expected to be avoided in the Build scenario, based on current VMT and crash data. These safety benefits are expected to increase in the future as safety incidents are expected to scale with increased expected VMT. Similar to the analysis of VMT savings, if the number of spaces added by the project is lower than the supply-demand gap at the facility either now or in the future, the project is not assumed to solve the full extent of safety concerns in the Build scenario. Instead, safety benefits are only apportioned in proportion to the number of spaces added, and not the total supply-demand gap every year.

Table 6.7 Average crashes avoided per year, based on current VMT, crash statistics and percent of need addressed by added truck spaces

Site ID + Name	Fatal Crashes (K) Avoided per year	Disabling Injury Crashes (A) Avoided per year	Suspected Serious Injury Crashes (B) Avoided per year	Minor Injury Crashes (C) Avoided per year	Property Damage Only Crashes (O) Avoided per year
1 – Wright City (WB)	0.061	0.000	0.020	0.040	0.121
2 – Doolittle (EB)	0.000	0.000	0.000	0.100	0.400
3 – Doolittle (WB)	0.000	0.000	0.000	0.100	0.400

Site ID + Name	Fatal Crashes (K) Avoided per year	Disabling Injury Crashes (A) Avoided per year	Suspected Serious Injury Crashes (B) Avoided per year	Minor Injury Crashes (C) Avoided per year	Property Damage Only Crashes (O) Avoided per year
4 – Boonville (WB)	0.000	0.000	0.050	0.050	0.450
5 – Wright City (EB)	0.038	0.000	0.013	0.025	0.075
6 – Boonville (EB)	0.000	0.000	0.050	0.050	0.450
7 – St. Clair (EB) Weigh Station	0.015	0.015	0.000	0.015	0.121
8 – Halltown (EB)	0.000	0.050	0.000	0.000	0.300
9 – Lathrop (NB)	0.000	0.000	0.000	0.000	0.000
10 – Halltown (WB)	0.000	0.050	0.000	0.000	0.300
11 – Charleston (NB)	0.000	0.000	0.000	0.000	0.100
12 – Charleston (SB) Weigh Station (Proposed)	0.000	0.000	0.000	0.000	0.100
13 – Mineola (EB)	0.000	0.000	0.000	0.010	0.025
14 – Strafford (EB)	0.000	0.000	0.000	0.015	0.091
15 – Joplin (EB)	0.000	0.000	0.000	0.000	0.050
16 – Mineola (WB)	0.000	0.000	0.000	0.097	0.162
17 – St. Clair Alternative Location A (EB) (Proposed)	0.044	0.044	0.000	0.044	0.349

Site ID + Name	Fatal Crashes (K) Avoided per year	Disabling Injury Crashes (A) Avoided per year	Suspected Serious Injury Crashes (B) Avoided per year	Minor Injury Crashes (C) Avoided per year	Property Damage Only Crashes (O) Avoided per year
18 – St. Clair Alternative Location B (WB) (Proposed)	0.024	0.024	0.000	0.024	0.189

Source: WSP (2023).

6.4 Project Benefits

6.4.1 Truck Vehicle Hours Traveled (VHT) Savings

The annual VMT savings calculated using the methodology described in Section 6.3.2 have associated driver travel time savings, as these avoided trips searching for parking or traveling to the next parking facility with availability have an associated trucker productivity benefit. These travel time savings are calculated by dividing the annual VMT savings by an average assumed speed of 60 mph to yield annual vehicle hours traveled (VHT) savings. These VHT savings are monetized using USDOT-provided factors referenced in Table 6.8.

Table 6.8 Travel time monetization factor

Variable	Unit	Value	Source
Value of Travel Time Savings – Trucks	2021$ per person-hour	$32.40	USDOT BCA Guidance January 2023[5] Table A-3

Source: USDOT.

The final monetized values of truck driver travel time savings for all projects is shown in Table 6.9.

[5] https://www.transportation.gov/sites/dot.gov/files/2023-01/Benefit%20Cost%20Analysis%20Guidance%202023%20Update.pdf

Table 6.9 Monetized travel time savings for year 5, year 10, year 15, year 20, and total across analysis period (undiscounted 2021 dollars)

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
1 – Wright City (WB)	$230,026	$260,519	$280,723	$280,723	$5,121,721
2 – Doolittle (EB)	$256,040	$292,811	$334,864	$382,956	$6,006,680
3 – Doolittle (WB)	$245,921	$281,523	$322,280	$368,937	$5,776,743
4 – Boonville (WB)	$246,215	$281,553	$305,146	$305,146	$5,530,248
5 – Wright City (EB)	$185,671	$212,583	$243,395	$263,988	$4,340,360
6 – Boonville (EB)	$222,483	$255,336	$293,041	$301,225	$5,156,600
7 – St. Clair (EB) Weigh Station	$65,286	$65,286	$65,286	$65,286	$1,305,720
8 – Halltown (EB)	$188,412	$194,052	$194,052	$194,052	$3,799,649
9 – Lathrop (NB)	$106,470	$120,175	$135,643	$153,103	$2,456,557
10 – Halltown (WB)	$150,468	$177,486	$195,972	$195,972	$3,477,459
11 – Charleston (NB)	$58,133	$72,191	$89,648	$93,617	$1,478,568
12 – Charleston (SB) Weigh Station (Proposed)	$58,133	$72,191	$89,648	$111,327	$1,521,885
13 – Mineola (EB)	$13,677	$13,677	$13,677	$13,677	$273,532
14 – Strafford (EB)	$25,110	$25,110	$25,110	$25,110	$502,200
15 – Joplin (EB)	$47,830	$69,128	$99,910	$144,400	$1,567,369
16 – Mineola (WB)	$114,729	$81,800	$58,322	$41,583	$1,704,714
17 – St. Clair Alternative Location A (EB) (Proposed)	$175,770	$175,770	$175,770	$175,770	$3,515,400
18 – St. Clair Alternative Location B (WB) (Proposed)	$95,418	$95,418	$95,418	$95,418	$1,908,360

Source: WSP (2023).

6.4.2 Safety – Parked Trucks

The safety benefits assessed in this analysis include a reduction in fatalities and injuries, as well as a reduction in other property damage crash costs resulting from the additional truck spaces provided by each of the projects under consideration. Crash categories are denoted by the

KABCO scale[6], which detail the severity of the crash and the safety impact associated with it. Annual safety benefits calculated using the methodology described in Section 6.3.3 are then monetized using USDOT-provided monetization factors, provided in Table 6.10.

Table 6.10 Safety benefit monetization factors

Variable	Unit	Value
Fatal Crash - K	2021$	$13,046,800
Injury Crash - A	2021$	$307,800
Non-Incapacitating - B	2021$	$153,700
Possible Injury - C	2021$	$78,500
No Injury/Property Damage Only - O	2021$	$4,000

Source: USDOT BCA Guidance January 2023.

The final monetized values of safety benefits for all projects are shown in Table 6.11.

Table 6.11 Monetized safety benefits for year 5, year 10, year 15, year 20, and total across analysis period (undiscounted 2021 dollars)

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
1 – Wright City (WB)	$859,573	$973,523	$1,049,022	$1,049,022	$20,638,399
2 – Doolittle (EB)	$11,403	$13,041	$14,914	$17,056	$287,195
3 – Doolittle (WB)	$11,419	$13,072	$14,965	$17,131	$287,925
4 – Boonville (WB)	$16,180	$18,502	$20,052	$20,052	$391,339
5 – Wright City (EB)	$540,908	$619,310	$709,077	$769,067	$13,576,882
6 – Boonville (EB)	$16,262	$18,663	$21,419	$22,017	$404,863
7 – St. Clair (EB) Weigh Station	$188,110	$188,110	$188,110	$188,110	$4,138,409
8 – Halltown (EB)	$36,160	$37,242	$37,242	$37,242	$790,721
9 – Lathrop (NB)	$–	$–	$–	$–	$–
10 – Halltown (WB)	$37,066	$43,721	$48,275	$48,275	$918,457
11 – Charleston (NB)	$542	$673	$835	$872	$14,631

[6] Established by FHWA: K=Killed, A=Incapacitating injuries, B=Non-Incapacitating, C=Possible Injury, O=Property Damage

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
12 – Charleston (SB) Weigh Station (Proposed)	$542	$673	$835	$1,037	$15,035
13 – Mineola (EB)	$900	$900	$900	$900	$19,798
14 – Strafford (EB)	$1,548	$1,548	$1,548	$1,548	$34,057
15 – Joplin (EB)	$335	$484	$700	$1,011	$11,423
16 – Mineola (WB)	$4,505	$3,212	$2,290	$1,633	$80,018
17 – St. Clair Alternative Location A (EB) (Proposed)	$544,332	$544,332	$544,332	$544,332	$11,975,305
18 – St. Clair Alternative Location B (WB) (Proposed)	$295,495	$295,495	$295,495	$295,495	$6,500,880

Source: WSP (2023).

6.4.3 VMT-Associated Savings

Emissions Savings

All projects under review are expected to create environmental and sustainability benefits relating to reduction in air pollution associated with decreased commercial truck travel. Four forms of emissions were identified, measured and monetized, including: carbon dioxide, nitrous oxide, sulfur dioxide, and particulate matter.

Estimates of emissions reductions were calculated by applying a per VMT rate of emissions, adjusted for average speed, to expected changes in VMT, as detailed in Section 6.3.2. Per ton monetized estimates for each pollutant type were then applied to the estimates of emissions reductions. USDOT's 2023 Benefit Cost Analysis Guidance for Discretionary Grant Programs was used to obtain the recommended per ton monetization values. The assumptions used are presented in Table 6.12.

Table 6.12 Assumptions and monetization factors for emissions savings

Variable	Unit	Value
Cost of CO2 emissions	2021$ per metric ton	$56 (in 2022) - $88 (in 2050)
Cost of NOx emissions	2021$ per metric ton	$16,600 (in 2022) - $18,900 (in 2050)
Cost of PM2.5 emissions	2021$ per metric ton	$796,700 (in 2022) - $907,600 (in 2050)

Variable	Unit	Value
Cost of SOx emissions	2021$ per metric ton	$44,300 (in 2022) - $51,300 (in 2050)
Emissions per VMT	Grams per VMT	Varies by year, vehicle type, speed, and emission type

Source: USDOT BCA Guidance January 2023 for cost of emissions, and California Air Resources Board EMFAC Database (2021) for Emissions per VMT.

The final monetized values of emissions reductions for all projects can be seen in Table 6.13.

Table 6.13 Monetized emissions reductions for year 5, year 10, year 15, year 20, and total across analysis period (undiscounted 2021 dollars)

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
1 – Wright City (WB)	$84,498	$80,912	$72,830	$58,256	$1,699,703
2 – Doolittle (EB)	$94,054	$90,941	$86,877	$79,472	$1,960,903
3 – Doolittle (WB)	$90,337	$87,436	$83,612	$76,563	$1,885,034
4 – Boonville (WB)	$90,445	$87,445	$79,167	$63,325	$1,829,586
5 – Wright City (EB)	$68,205	$66,024	$63,146	$54,783	$1,418,760
6 – Boonville (EB)	$81,727	$79,302	$76,026	$62,511	$1,690,230
7 – St. Clair (EB) Weigh Station	$23,982	$20,277	$16,938	$13,548	$452,136
8 – Halltown (EB)	$69,212	$60,269	$50,345	$40,270	$1,284,956
9 – Lathrop (NB)	$39,111	$37,324	$35,191	$31,772	$806,431
10 – Halltown (WB)	$55,273	$55,124	$50,843	$40,669	$1,139,207
11 – Charleston (NB)	$21,355	$22,421	$23,258	$19,428	$470,813
12 – Charleston (SB) Weigh Station (Proposed)	$21,355	$22,421	$23,258	$23,103	$480,247
13 – Mineola (EB)	$5,024	$4,248	$3,548	$2,838	$94,717
14 – Strafford (EB)	$9,224	$7,799	$6,515	$5,211	$173,899
15 – Joplin (EB)	$17,570	$21,470	$25,921	$29,966	$467,040
16 – Mineola (WB)	$43,862	$27,312	$16,973	$10,210	$730,862
17 – St. Clair Alternative Location A (EB) (Proposed)	$64,568	$54,591	$45,602	$36,476	$1,217,290
18 – St. Clair Alternative Location B (WB) (Proposed)	$35,051	$29,635	$24,755	$19,801	$660,815

Source: WSP.

Vehicle Operating Costs (Including Fuel)

The projects analyzed here would augment the economic competitiveness of freight providers and consumers in Missouri (and the nation more broadly) by generating improvements in the efficiency of freight operations in the state. Two types of benefits are measured in the assessment of economic competitiveness: travel time savings (highlighted in Section 6.4.1) and vehicle operating savings.

In calculating vehicle operating savings for this BCR analysis, two estimates were generated: one for savings resulting from decreased wear and tear on vehicles, and another from reduced fuel consumption. Both travel time savings and reduced vehicle operating costs were calculated using the results of the demand analysis described in Section 6.3 and are ultimately based on the reduction in truck VMT expected from each of the projects.

Vehicle operating cost savings includes the cost of fuel, as well as maintenance and repair, replacement of tires, and the depreciation of the vehicle over time. Fuel consumption rates per VMT are combined with per VMT rates of wear and tear and depreciation to calculate total vehicle operating cost savings. Estimates of VMT savings described in Section 6.3.2 and unit costs for each component of vehicle operating cost are applied to the consumption rates to calculate the total vehicle operating cost. The assumptions used in the estimation of vehicle operating costs are presented in Table 6.14.

Table 6.14 Vehicle operating costs monetization factor

Variable	Unit	Value
Vehicle Operating Costs - Commercial Trucks	2021$ / VMT	$1.01

Source: USDOT BCA Guidance January 2023 Table A-5.

The final monetized values of vehicle operation cost savings for all projects is shown in Table 6.15.

Table 6.15 Monetized vehicle operating cost Savings for year 5, year 10, year 15, year 20, and total across analysis period (undiscounted 2021 dollars)

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
1 – Wright City (WB)	$430,233	$487,267	$525,056	$525,056	$9,579,515
2 – Doolittle (EB)	$478,890	$547,666	$626,319	$716,269	$11,234,717
3 – Doolittle (WB)	$459,963	$526,553	$602,783	$690,049	$10,804,649
4 – Boonville (WB)	$460,513	$526,608	$570,735	$570,735	$10,343,611
5 – Wright City (EB)	$347,273	$397,608	$455,240	$493,754	$8,118,081
6 – Boonville (EB)	$416,126	$477,574	$548,095	$563,403	$9,644,751

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
7 – St. Clair (EB) Weigh Station	$122,109	$122,109	$122,109	$122,109	$2,442,180
8 – Halltown (EB)	$352,401	$362,948	$362,948	$362,948	$7,106,750
9 – Lathrop (NB)	$199,138	$224,771	$253,703	$286,359	$4,594,671
10 – Halltown (WB)	$281,431	$331,964	$366,541	$366,541	$6,504,135
11 – Charleston (NB)	$108,731	$135,024	$167,675	$175,098	$2,765,469
12 – Charleston (SB) Weigh Station (Proposed)	$108,731	$135,024	$167,675	$208,223	$2,846,489
13 – Mineola (EB)	$25,580	$25,580	$25,580	$25,580	$511,605
14 – Strafford (EB)	$46,965	$46,965	$46,965	$46,965	$939,300
15 – Joplin (EB)	$89,460	$129,295	$186,870	$270,081	$2,931,561
16 – Mineola (WB)	$214,585	$152,996	$109,084	$77,776	$3,188,446
17 – St. Clair Alternative Location A (EB) (Proposed)	$328,755	$328,755	$328,755	$328,755	$6,575,100
18 – St. Clair Alternative Location B (WB) (Proposed)	$178,467	$178,467	$178,467	$178,467	$3,569,340

Source: WSP (2023).

State of Good Repair

The primary benefit related to state of good repair assessed in this analysis is the decrease in road and pavement damage caused by a reduction in VMT among truck users. To calculate the monetized value for decrease in road damage, per VMT costs for pavement damage from FHWA were applied to estimates of the expected change in truck VMT, as described in Section 6.3.2.

The assumptions and sources used in this calculation are presented in Table 6.16.

Table 6.16 State of good repair monetization factor

Variable	Unit	Value
Truck Average Pavement Cost	2021$ / VMT	$0.1057

Source: Derived from FHWA, Cost Allocation Study[7], 2000, adjusted for 2021$

[7] https://www.fhwa.dot.gov/policy/hcas/addendum.cfm.

The final monetized values of state of good repair savings for all projects can be seen in Table 6.17.

Table 6.17 Monetized state of good repair savings for year 5, year 10, year 15, year 20, and total across analysis period (undiscounted 2021 dollars)

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
1 – Wright City (WB)	$45,004	$50,970	$54,923	$54,923	$1,002,061
2 – Doolittle (EB)	$50,094	$57,288	$65,516	$74,925	$1,175,202
3 – Doolittle (WB)	$48,114	$55,080	$63,054	$72,182	$1,130,215
4 – Boonville (WB)	$48,172	$55,086	$59,702	$59,702	$1,081,989
5 – Wright City (EB)	$36,326	$41,592	$47,620	$51,649	$849,188
6 – Boonville (EB)	$43,529	$49,956	$57,333	$58,935	$1,008,885
7 – St. Clair (EB) Weigh Station	$12,773	$12,773	$12,773	$12,773	$255,463
8 – Halltown (EB)	$36,863	$37,966	$37,966	$37,966	$743,398
9 – Lathrop (NB)	$20,831	$23,512	$26,538	$29,954	$480,623
10 – Halltown (WB)	$29,439	$34,725	$38,342	$38,342	$680,362
11 – Charleston (NB)	$11,374	$14,124	$17,540	$18,316	$289,281
12 – Charleston (SB) Weigh Station (Proposed)	$11,374	$14,124	$17,540	$21,781	$297,756
13 – Mineola (EB)	$2,676	$2,676	$2,676	$2,676	$53,516
14 – Strafford (EB)	$4,913	$4,913	$4,913	$4,913	$98,255
15 – Joplin (EB)	$9,358	$13,525	$19,547	$28,252	$306,655
16 – Mineola (WB)	$22,447	$16,004	$11,411	$8,136	$333,526
17 – St. Clair Alternative Location A (EB) (Proposed)	$34,389	$34,389	$34,389	$34,389	$687,785
18 – St. Clair Alternative Location B (WB) (Proposed)	$18,668	$18,668	$18,668	$18,668	$373,369

Source: WSP (2023).

Congestion Costs

When trucks searching for parking are taken off the road with the provision of adequate spaces in designated parking facilities, there may be resultant congestion improvements to traffic around the facility and beyond. Precisely estimating reductions in congestion caused by this diversion of freight traffic can be challenging and usually requires a traffic speed and volume analysis that is beyond the scope of this prioritization assessment. However, USDOT's 2023 Benefit Cost Analysis Guidance for Discretionary Grant Programs provides per-VMT figures for approximate monetized congestion costs (Table 6.18), and these are applied to VMT savings for each of the projects to develop a final monetized congestion cost value for all facilities (Table 6.19).

Table 6.18 Congestion cost monetization factor

Variable	Unit	Value
Truck Average Congestion Cost	2021$ / VMT	0.1970

Source: Derived from USDOT BCA Guidance January 2023 Table A-14.

Table 6.19 Monetized congestion cost savings for year 5, year 10, year 15, year 20, and total across analysis period (undiscounted 2021 dollars)

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
1 – Wright City (WB)	$83,917	$95,041	$102,412	$102,412	$1,868,480
2 – Doolittle (EB)	$93,407	$106,822	$122,163	$139,708	$2,191,326
3 – Doolittle (WB)	$89,716	$102,704	$117,573	$134,594	$2,107,441
4 – Boonville (WB)	$89,823	$102,715	$111,322	$111,322	$2,017,516
5 – Wright City (EB)	$67,735	$77,553	$88,794	$96,307	$1,583,428
6 – Boonville (EB)	$81,165	$93,151	$106,906	$109,891	$1,881,204
7 – St. Clair (EB) Weigh Station	$23,817	$23,817	$23,817	$23,817	$476,346
8 – Halltown (EB)	$68,736	$70,793	$70,793	$70,793	$1,386,168
9 – Lathrop (NB)	$38,842	$43,841	$49,485	$55,854	$896,188
10 – Halltown (WB)	$54,893	$64,749	$71,494	$71,494	$1,268,628
11 – Charleston (NB)	$21,208	$26,336	$32,705	$34,153	$539,403
12 – Charleston (SB) Weigh Station (Proposed)	$21,208	$26,336	$32,705	$40,614	$555,206
13 – Mineola (EB)	$4,989	$4,989	$4,989	$4,989	$99,788
14 – Strafford (EB)	$9,161	$9,161	$9,161	$9,161	$183,210
15 – Joplin (EB)	$17,449	$25,219	$36,449	$52,679	$571,799
16 – Mineola (WB)	$41,855	$29,842	$21,277	$15,170	$621,905
17 – St. Clair Alternative Location A (EB) (Proposed)	$64,124	$64,124	$64,124	$64,124	$1,282,470
18 – St. Clair Alternative Location B (WB) (Proposed)	$34,810	$34,810	$34,810	$34,810	$696,198

Source: WSP (2023).

Noise Pollution

A minor benefit of VMT savings and the associated reduction in truck traffic is a reduction in levels of noise generated by transportation activity, particularly at nighttime when truck drivers are often looking for parking. Per USDOT guidance, projects involving a reduction in truck VMT may apply the monetization values shown in Table 6.20.

This monetization factor is then applied to the VMT savings (see Section 6.4.3) to develop the final monetized values of noise pollution savings for all projects (Table 6.21).

Table 6.20 Noise pollution monetization factor

Variable	Unit	Value
Truck Average Noise Cost	2021$ / VMT	0.0223

Source: Derived from USDOT BCA Guidance January 2023 Table A-14.

Table 6.21 Monetized noise pollution savings for year 5, year 10, year 15, year 20, and total across analysis period (undiscounted 2021 dollars)

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
1 – Wright City (WB)	$9,478	$10,734	$11,567	$11,567	$211,034
2 – Doolittle (EB)	$10,550	$12,065	$13,798	$15,779	$247,497
3 – Doolittle (WB)	$10,133	$11,600	$13,279	$15,202	$238,023
4 – Boonville (WB)	$10,145	$11,601	$12,573	$12,573	$227,867
5 – Wright City (EB)	$7,650	$8,759	$10,029	$10,877	$178,839
6 – Boonville (EB)	$9,167	$10,521	$12,074	$12,412	$212,471
7 – St. Clair (EB) Weigh Station	$2,690	$2,690	$2,690	$2,690	$53,801
8 – Halltown (EB)	$7,763	$7,996	$7,996	$7,996	$156,560
9 – Lathrop (NB)	$4,387	$4,952	$5,589	$6,308	$101,219
10 – Halltown (WB)	$6,200	$7,313	$8,075	$8,075	$143,284
11 – Charleston (NB)	$2,395	$2,975	$3,694	$3,857	$60,922
12 – Charleston (SB) Weigh Station (Proposed)	$2,395	$2,975	$3,694	$4,587	$62,707
13 – Mineola (EB)	$564	$564	$564	$564	$11,271
14 – Strafford (EB)	$1,035	$1,035	$1,035	$1,035	$20,693
15 – Joplin (EB)	$1,971	$2,848	$4,117	$5,950	$64,581

Site ID + Name	Year 5 (2030)	Year 10 (2035)	Year 15 (2040)	Year 20 (2045)	Total
16 – Mineola (WB)	$4,727	$3,370	$2,403	$1,713	$70,241
17 – St. Clair Alternative Location A (EB) (Proposed)	$7,242	$7,242	$7,242	$7,242	$144,848
18 – St. Clair Alternative Location B (WB) (Proposed)	$3,932	$3,932	$3,932	$3,932	$78,632

Source: WSP (2023).

6.5 Residual Value

Residual value (at the end of a study analysis period) of infrastructure components that are built or developed as part of a project often are included as a minor benefit in benefit-cost analyses. Estimates for the useful life of parking spaces vary, with 15-25 years the most common range. Assuming an average 20-year useful life with only routine operations and maintenance performed on these parking spaces, the residual value of facility improvements generated by all projects is expected to be negligible at the end of the analysis period (which is 20 years of operations). As such, residual value has not been included in the BCR analysis for project prioritization.

6.6 Prioritization Results

The BCR analysis converts potential gains (benefits) and losses (costs) from the projects into monetary units and compares them. The following common benefit-cost evaluation measures are included in this BCR analysis for all projects under consideration:

- Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.

- Benefit-Cost Ratio (BCR): The evaluation also estimates the benefit-cost ratio; the present value of incremental benefits is divided by the present value of incremental costs to yield the benefit-cost ratio. The BCR expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of the costs.

All costs provided in 2023 dollars were converted to 2021 dollars to directly compare to project transportation impact benefits (which were monetized in 2021 dollars using USDOT recommended parameters). Table 6.22 lists the results of the BCR analysis for each of the facilities, providing results for discounted total benefits (2021$) and discounted total costs (2021$). Changes in O&M expenditures attributed to MoDOT are included as a negative disbenefit rather than a cost, per USDOT guidance.

When total benefits are seen to be negative, it is because the anticipated safety, VHT and VMT-associated savings are not significant enough to outweigh the expected increase in O&M costs that result from the specific project. For example, the Charleston SB Weigh Station projects adds 55 spaces (and significant associated O&M cost increases), even though the expected gap in supply-demand is only expected to be nine spaces, rising to 28 by 2050.

Table 6.22 BCR results by facility—Discounted total benefits and total Costs, net present value and BCR

Site ID + Name	Total Benefits (Discounted 2021$)	Total Costs (Discounted 2021$)	Net Present Value (Discounted 2021$)	Benefit-Cost Ratio	BCR Effectiveness Category
1 – Wright City (WB)	$14,899,717	$3,946,229	$10,953,488	3.78	High
2 – Doolittle (EB)	$6,595,211	$5,234,651	$1,360,560	1.26	Medium
3 – Doolittle (WB)	$6,687,840	$4,528,744	$2,159,096	1.48	Medium
4 – Boonville (WB)	$6,080,436	$4,174,545	$1,905,891	1.46	Medium
5 – Wright City (EB)	$11,200,334	$3,566,823	$7,633,511	3.14	High
6 – Boonville (EB)	$5,444,107	$4,631,538	$812,570	1.18	Medium
7 – St. Clair (EB) Weigh Station	$3,389,609	$1,727,845	$1,661,764	1.96	Medium
8 – Halltown (EB)	$5,472,380	$2,918,697	$2,553,683	1.87	Medium
9 – Lathrop (NB)	$1,758,164	$5,381,457	$(3,623,293)	0.33	Low
10 – Halltown (WB)	$4,754,349	$3,425,131	$1,329,218	1.39	Medium
11 – Charleston (NB)	$1,125,922	$2,106,795	$(980,873)	0.53	Low
12 – Charleston (SB) Weigh Station (Proposed)	$243,252	$3,081,213	$(2,837,961)	0.08	Low
13 – Mineola (EB)	$(162,399)	$2,603,676	$(2,766,075)	(0.06)	Low
14 – Strafford (EB)	$528,713	$2,003,889	$(1,475,176)	0.26	Low
15 – Joplin (EB)	$837,368	$4,934,563	$(4,097,195)	0.17	Low
16 – Mineola (WB)	$5,976,019	$4,099,811	$1,876,208	1.46	Medium
17 – St. Clair Alternative Location A (EB) (Proposed)	$9,414,968	$1,852,232	$7,562,737	5.08	High
18 – St. Clair Alternative Location B (WB) (Proposed)	$5,123,837	$1,337,401	$3,786,437	3.83	High

Source: WSP (2023).

These projects were then placed into three categories of effectiveness based on their BCR:

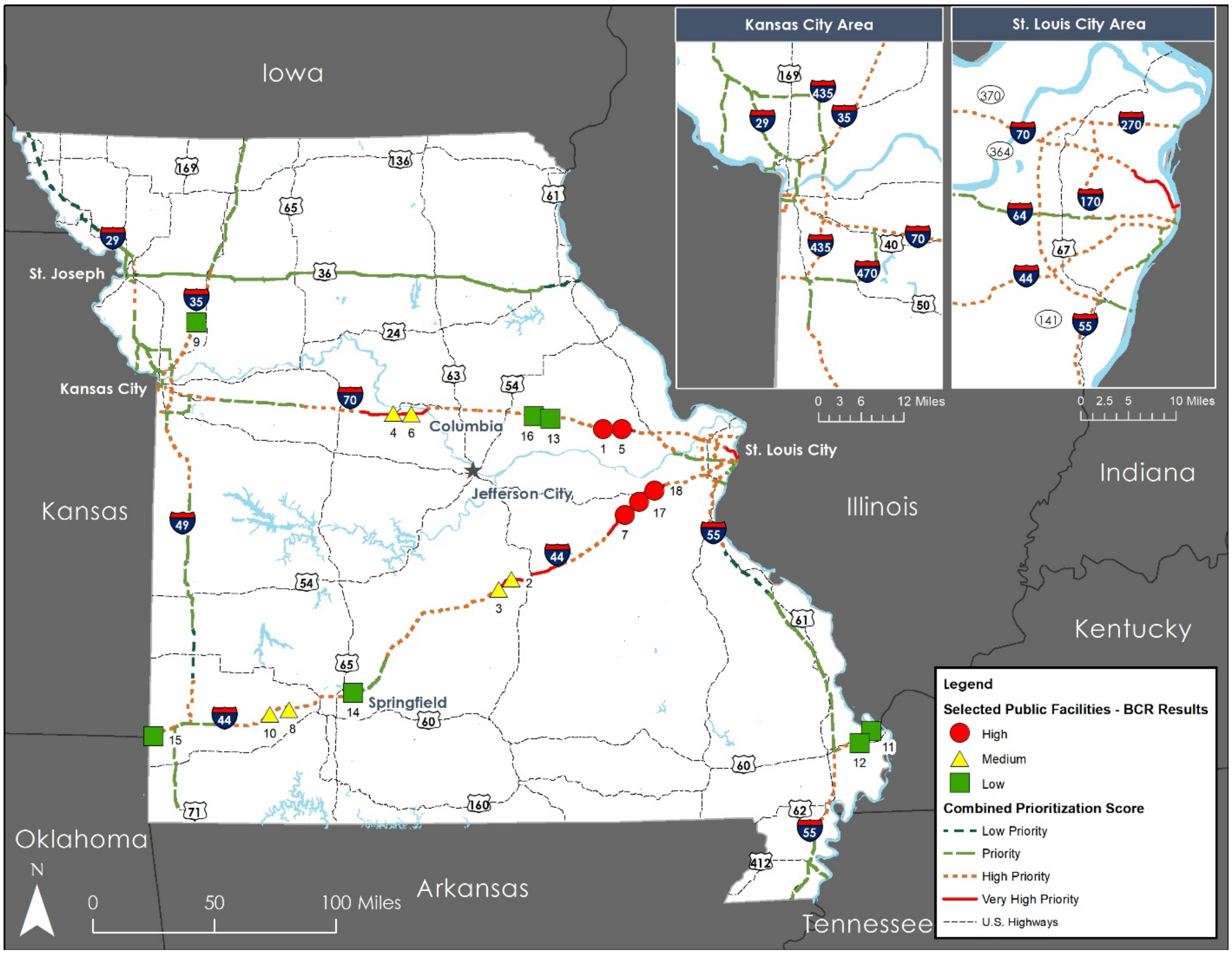
- High – if the BCR was greater than 3.0
- Medium – if the BCR was equal or greater than 1.0 but less than 3.0
- Low – if the BCR was less than 1.0

Projects effectively addressing parking demand in high incident locations score the highest in the analysis. In fact, for projects in the High effectiveness category, total benefits tend to be more sensitive to expected improvements in safety benefits over any other category. Projects with High effectiveness include proposed improvements at Wright City (WB), Wright City (EB), and the two St. Clair alternate locations (St. Clair Alternative Location A (EB) and St. Clair Alternative Location B (WB)).

Projects with Low effectiveness either:

- Do not have a large enough supply-demand gap currently (relative to expected costs), and as such see limited benefits (such as Joplin EB) - While current supply-demand gap at these facilities is currently low relative to other sites, total demand is expected to rise significantly in the future. As such, truck spaces are being added at these facilities keeping forecast (2050) demand in mind, which will provide excess capacity for most of the analysis period.
- (Or) Do not add enough parking spaces to address expected demand, and as such do not experience the full extent of benefits possible (such as Mineola EB and Strafford EB) – Mineola EB project adds only 19 spaces while current gap is 28 and forecasted to rise to 67. Similarly, Strafford EB project adds 5 spaces while current gap is 17 and forecasted to rise to 43.
- (Or) Have expected O&M costs that outstrip transportation benefits (such as Charleston NB and Charleston SB Weigh Station) – Incremental O&M costs are higher due to the addition of truck spaces as well as structures for vault toilets.
- (Or) a combination of the above (such as Mineola EB).

Figure 6.1 Benefit-cost ratio category for selected public facilities for prioritization



Source: Analysis by WSP and Cambridge Systematics (2023).

7.0 Conclusion and Next Steps

The Truck Parking Investments for Missouri study builds on the Missouri State Freight & Rail Plan Truck Parking Profile. Using the truck parking demand data from the plan, and including additional safety datasets from MoDOT, this study takes a comprehensive approach to analyze truck parking challenges. This study examined the magnitude of truck parking demand and safety challenges statewide, and with direct feedback from MoDOT, resulted in a list of 18 priority truck parking sites for possible investment. Through a comprehensive analysis of estimated development costs, impacts, and benefits the shortlist of 18 public truck parking facilities was prioritized by their benefit-cost ratio effectiveness.

As Missouri considers strategies and policies to produce a lasting impact in the availability of truck parking, investment in these identified facilities will yield the highest positive impact with the lowest cost. However, given limited funding to develop all the facilities, the 12 with a BCR effectiveness score greater than one should be considered first. For the development of these sites, next steps will involve more detailed engineering and design assessments to further understand the local costs and impacts. Overall, with a projected increase in truck traffic throughout Missouri, this study reaffirms the need for increased funding for truck parking investment and the increase of truck parking capacity.

Appendix A. Literature Review

This appendix includes more detailed information on the results of the literature review summarized in Section 2.0, which reviewed prioritization methods used by 10 U.S. states departments of transportation, including Arizona, California, Florida, Georgia, Maryland, Nevada, Ohio, Oregon, South Carolina, and Texas.

A.1 Arizona DOT (ADOT) Truck Parking Study

Working Paper 4: Truck Parking Needs and Solutions (2019)

Chapter 3 of this working paper summarizes a prioritization exercise undertaken by ADOT to rank undesignated parking locations. The prioritization process relied on three data sources: truck driver surveys, industry consultations, and GPS data obtained through the American Transportation Research Institute (ATRI). From these sources, 15 clusters of significant undesignated parking were identified and compared against the following eight criteria, grouped into three categories, to assign a prioritization score to each project.

- Location of undesignated truck parking
  - The undesignated parking occurs at an ADOT rest area (5 points).
  - The undesignated parking location was mentioned in ADOT district outreach either specifically or obliquely by area, corridor, or infrastructure type. The more direct the mention, the higher the score (maximum 10 points).
  - A scaled value based on the weighted average parking demand at public/ private truck parking facilities within 25 miles of the undesignated parking location (maximum 20 points).
- Undesignated trucks
  - For rest area locations, a scaled value based on the average number of trucks parked along the shoulders of the rest area in ADOT's March 2017 survey (maximum 10 points).
  - A scaled value based on the count of undesignated truck parked less than eight hours at the undesignated parking location (maximum 10 points).
  - A scaled value based on the count of undesignated truck parked eight hours or more at the undesignated parking location (maximum 20 points).
- Truck traffic
  - A scaled value based on the 2016 AADTT for the nearest major roadway adjacent to the undesignated parking location (10 points).

- A scaled value based on the projected growth in truck traffic for 2016–2040 near the undesignated parking location (15 points).

A.2 California Department of Transportation (Caltrans)

California Statewide Truck Parking Study (2022)

Chapter 4 of this study, "Where are California's Truck Parking Needs Greatest?", describes an extensive prioritization process. The process identifies roadway segments one to 10 miles in length and scores them according to three factors – demand (60 percent), safety (30 percent), and stakeholder feedback (10 percent) – are summarized and combined in a weighted scheme to determine a final prioritization score.

- The **demand factor** is the total number of trucks parking in designated and undesignated locations for a segment at the statewide peak hour (12 am – 1 am) subtracted from the total number of designated truck parking spaces normalized by the segment length.
- The **safety factor** is the total number of crashes on the segment, which are weighted by severity, normalized by segment length. This particular study used five years of crash data involving parked trucks for the analysis.
- The **stakeholder feedback factor** combines three datasets – the Social Pinpoint Stakeholder survey, 2019 California Highway Patrol (CHP) truck parking citations, and an informal 2018 CHP survey of officers. The CHP data sources in this study were aggregated at the county level, making this factor less granular than the other factors. The total number of survey pinpoints and CHP mentions/citation are combined and reported per mile for each segment.

These three factors are weighted to determine the order of priority. Additional analysis was done to compare these prioritized segments with other needs criteria such as equity and environmentally sensitive areas. While the prioritization process does not incorporate the equity/environmental analysis into its scoring criteria, it shows how the two types of needs – truck parking and equity – overlap in certain parts of the state.

Finally, the segments were grouped into corridors/regions in a sensible, non-quantitative manner to show priority areas for truck parking interventions, which were typically located near interstate corridors or larger urban areas.

A.3 Florida Department of Transportation (FDOT)

Statewide Truck Parking Study (2020)

Compared to the studies conducted in Arizona and California, this study uses fewer criteria in its prioritization process to identify "areas of concern." The process begins by clustering areas of high truck parking utilization combining designated and undesignated truck parking into 20 specific areas. The overall truck park demand (volume or V) is compared to the available truck parking supply (capacity C), and areas are ranked by their V/C ratio. In order to focus on areas of concern that have both a high V/C index and high excess truck parking demand, a threshold of

25,000 was established for excess truck parking demand. The areas of concern with an excess truck parking demand over 25,000 were ranked according to their V/C index.

The results of this prioritization process were then compared to stakeholder feedback both within FDOT and external, as well as through a survey aimed at soliciting input from shippers, receivers, carriers, and truck stop operators. The study does not utilize a specific process to compare survey results with the V/C prioritization scores, but finds that the feedback generally aligns with the analysis findings.

A.4 Georgia Department of Transportation (GDOT)

Georgia Statewide Freight and Logistics Plan: Truck Modal Profile

This study uses a similar method to the FDOT study to prioritize corridors based on the deficit/surplus of truck parking spots during peak demand. Unlike most other truck parking studies, this GDOT study does not utilize truck GPS data to estimate the overall demand; rather, it uses the AADTT and origin-destination (OD) trip data for trucks in the area gathered by the Federal Highway Administration. The findings included a statewide map showing truck parking adequacy for corridors in Georgia, ranked on a scale from 1-9. The study only considered long-haul trucks.

A.5 Maryland Department of Transportation (MDOT)

Maryland Truck Parking Study Final Report (2020)

Chapter 6 in this study included a prioritization effort that focused specifically on undesignated parking locations. The methodology using truck GPS data from INRIX to identify truck stop events as designated or undesignated. After determining where the undesignated stops were occurring, MDOT identified and prioritized clusters of undesignated truck parking (clusters on heavy use corridors or clusters on last-mile corridors) to focus the analysis and solutions on the most severely impacted areas. These clusters were assigned a prioritization score based on three criteria:

- **Safety** (30 points) – unlike other studies this safety category focuses on the location of the parked truck instead of the number of crashes involving trucks.
  - Location along last-mile connectors to freight generators – 0 points
  - Location along heavy use corridor – 10 points
  - Location along roadside facilities developed for emergency use – 15 points
  - Location is an on/off ramp – 30 points
- **Duration Parked** – this assigns a scaled-value based on the number of undesignated stops of the duration range below. Locations with more long duration stops are given more points.
  - Duration of 0.5 to 3 hours – 10 points

  - Duration of 3 to 8 hours – 15 points
  - Duration of 8+ hours – 25 points
- **Total Number of Trucks Parked** – Assigns a maximum of 20 points scaled based on the total number of undesignated stop events at each location.

Clusters that were within the top 10 percent, as measured by density, were then used to count the total number of undesignated trucks parked within them, regardless of the stop's distance from the NHS. The top 20 polygons with the highest number of undesignated trucks for each type of cluster were advanced for prioritization.

A.6 Nevada Department of Transportation (NDOT)

Nevada Truck Parking Implementation Plan (2019)

Compared to many of the other plans reviewed in this summary, this plan is extremely thorough and more granular in its analysis of truck parking supply and demand. Its prioritization process followed a multi-objective decision-making process, which was applied to truck parking projects that expand supply as opposed to comparing sites, corridors, etc. Projects are scored across seven criteria as follows:

- Improves Emergency Parking (0-6 points) – either improves the "county" gap (0-3 points) or "site" gap (0-3 points) in parking
- Safety (0-3 points) – reduces distance between sites with truck parking, with larger gaps giving more points
- Economy (0-3 points) – points awarded based on AADTT near the project site
- Connect Communities (0-3 points) – scoring criteria described as "landscaping and aesthetics", without much clarification on how projects are compared
- Foster Sustainability (0-3 points) – includes environmental sustainability (0-1 points) and fiscal sustainability (0-2 points)
- Preservation (0-3 points) – projects that reuse existing facilities score higher than new construction
- Project Readiness (0-3 points) – up to one point awarded for each of the following: within NDOT ROW, can be obligated within two years, consistent with other plans

A.7 Ohio Department of Transportation (ODOT)

Transport Ohio: Ohio Truck Parking Study

This ODOT study implements a more commonly used prioritization process specifically focused on clusters of undesignated truck parking. The process includes three steps:

- Step 1: Identify clusters of undesignated truck parking using GPS data and an inventory of designated truck parking locations.
- Step 2: Apply three criteria to score the undesignated truck parking locations.
  - Safety Impacts – measured by multiplying the crash frequency by a monetization rate based on crash severity which is then compared to the property damage only crash cost. These costs are based on AASHTO guidance.
  - Capacity Shortage – based on the number of trucks and the duration of their stay at undesignated parking locations.
  - Supporting Ohio's Economy – based on whether an undesignated truck parking cluster location is located on or adjacent to a freight corridor or National Highway System intermodal connector.
- Step 3: Identify clusters that are close enough to one another so that improvements in one cluster would improve conditions in another. These interdependent clusters are grouped together to form mega-clusters that highlight corridor/regional truck parking issues.

A.8 Oregon Department of Transportation (ODOT)

Oregon Commercial Truck Parking Study (2020)

The prioritization process used by ODOT is unique. The process began with a series of strategies that were identified to address truck parking challenges and needs. The strategies were first categorized as either "site-specific" solutions or "statewide" solutions. The final report gives a high-level description of the prioritization methodology as well as some result, while the technical memorandum gives a more detailed description of the specific criteria for calculating scores. The following references the technical memorandum.

Projects are assessed according to 4 criteria receiving a low, medium or high score in each. For low scores in a criteria the project receives 3 points, medium receives 6 points, and high receives 9 points. Note that projects given a "low" score in the cost criteria are contradictorily given 9 points. These criteria are more qualitative than other studies.

- **Effectiveness in achieving goal –** strategies are given a higher score based on the degree to which the strategy accurately addresses a specific goal outlined in other portions of the report, is applicable across many sites, and is easy to use/implement.
- **Cost –** projects <$500k receive a low score, <$2M receive a medium score, and >$2M receive a high score. However, if costs are unknown it is left to the scorer's judgement as to whether the anticipated costs are low, medium, or high.
- **Private resource utilization –** strategies that utilize private partners or are completely controlled and implemented by private partners receive higher scores.

- **Ease of implementation –** fewer phases of implement, less resources utilized, and previous successful examples states lead to higher scores.

A.9 South Carolina Department of Transportation (SCDOT)

South Carolina Statewide Truck Parking Assessment Study: Final Report (2022)

This report prioritizes truck parking needs at the corridor level based on two criteria, safety and demand.

- Demand – corridors are scored based on the deficit of truck parking per mile on the corridor. Deficit is defined as the number of trucks parking in designated locations minus the supply of parking spaces plus the number of trucks parking in undesignated locations. Corridors with a surplus are given a low priority, 0 –1 truck per mile deficits are given a score of priority, 1 – 3 trucks high priority, and more than 3 trucks very high priority.

- Safety – corridors are scored based on the number and severity of crashes along the corridor per mile. Fatal crashes received 5 points, injury crashes 3 points, and all other crashes 1 point. The points for each corridor are summed, divided by the length of the corridor, and multiplied by 100. Low Priority corridors have a safety score of 0, Priority have a score <25, High Priority, 25 – 50, Very High Priority is greater than 50.

These categories were combined by assigning point values to each category as follows low priority 0 points, priority 33 points, high priority 67 points, and very high priority 100 points. They are then combined with a weighting factor of 70 percent for demand scores and 30 percent for safety scores.

A.10 Texas Department of Transportation (TxDOT)

Texas Statewide Truck Parking Study (2020)

This TxDOT study prioritizes truck parking needs on the priorly identified freight network. Three criteria are implemented to prioritize needs by corridor:

- Capacity Needs – truck parking shortage during peak hours (1 a.m. – 2 a.m.) per mile.

- Safety Needs – the count and severity of crashes involving parked trucks using data from 2013-2017 per mile.

- Freight Network Significance – this criteria is based on another plan in which TxDOT gave corridors in the Texas freight network a Freight System Designation score based on goods movements criteria (e.g. AADTT), market access criteria (e.g. proximity to ports), supply chain criteria (e.g. freight movement in target industries), and economic competitiveness criteria (e.g. workforce readiness).

Corridors were given a high, medium, or low score in each criteria and then a combined score where each are summed with a 25 percent, 50 percent, and 25 percent weighting scheme, respectively.

Appendix B. Conceptual Site Layouts

This appendix contains the conceptual site layouts for each of the 18 truck parking facilities described in this memorandum.

Figure B.1 Conceptual site layout - I-70 Wright City (WB)

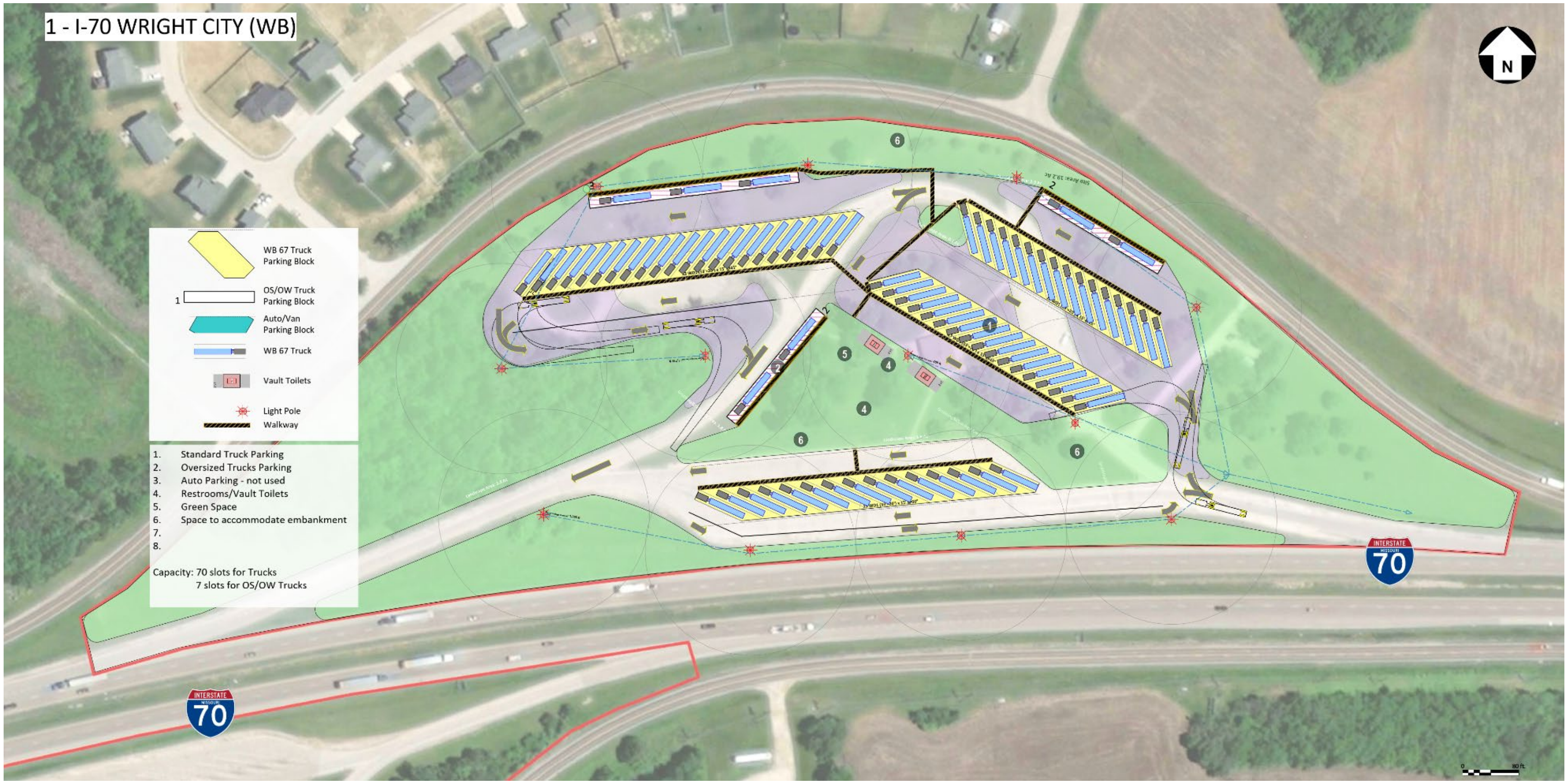


Figure B.2 Conceptual site layout - I-44 Doolittle (EB)

Figure B.3 Conceptual site layout - I-44 Doolittle (WB)

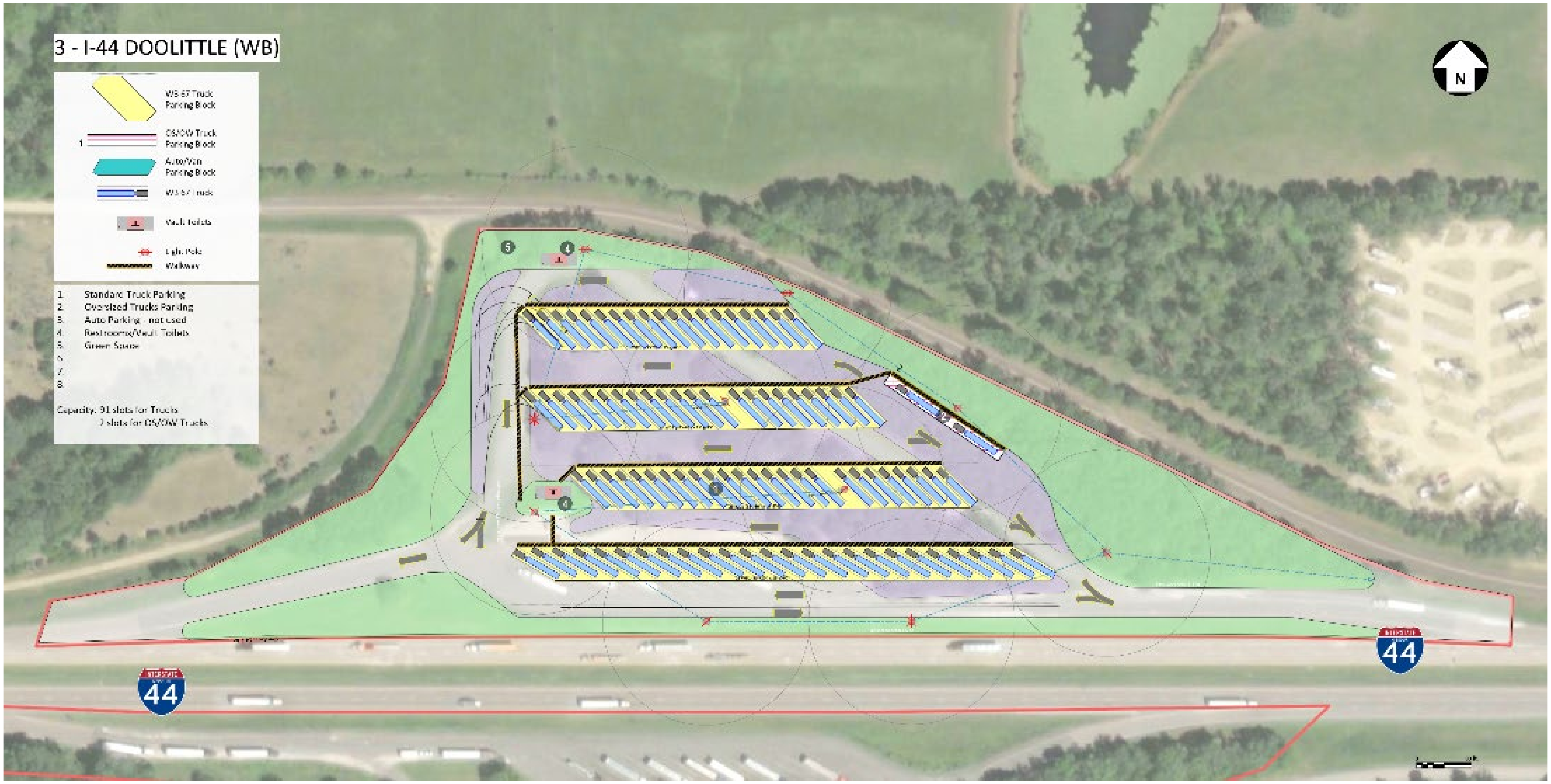


Figure B.4 Conceptual site layout - I-70 Boonville (WB)

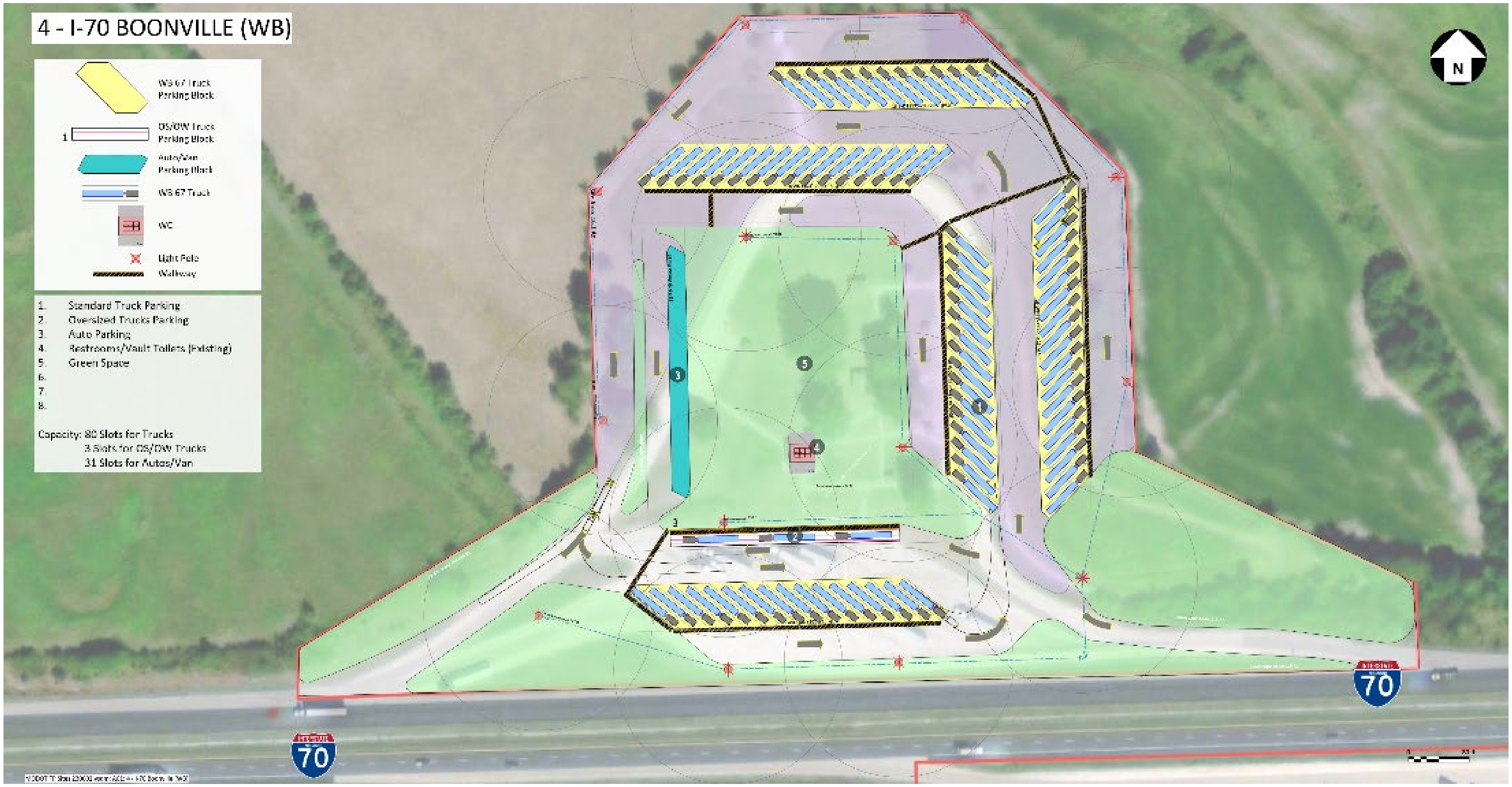


Figure B.5 Conceptual site layout - I-70 Wright City (EB)

Figure B.6 Conceptual site layout - I-70 Boonville (EB)

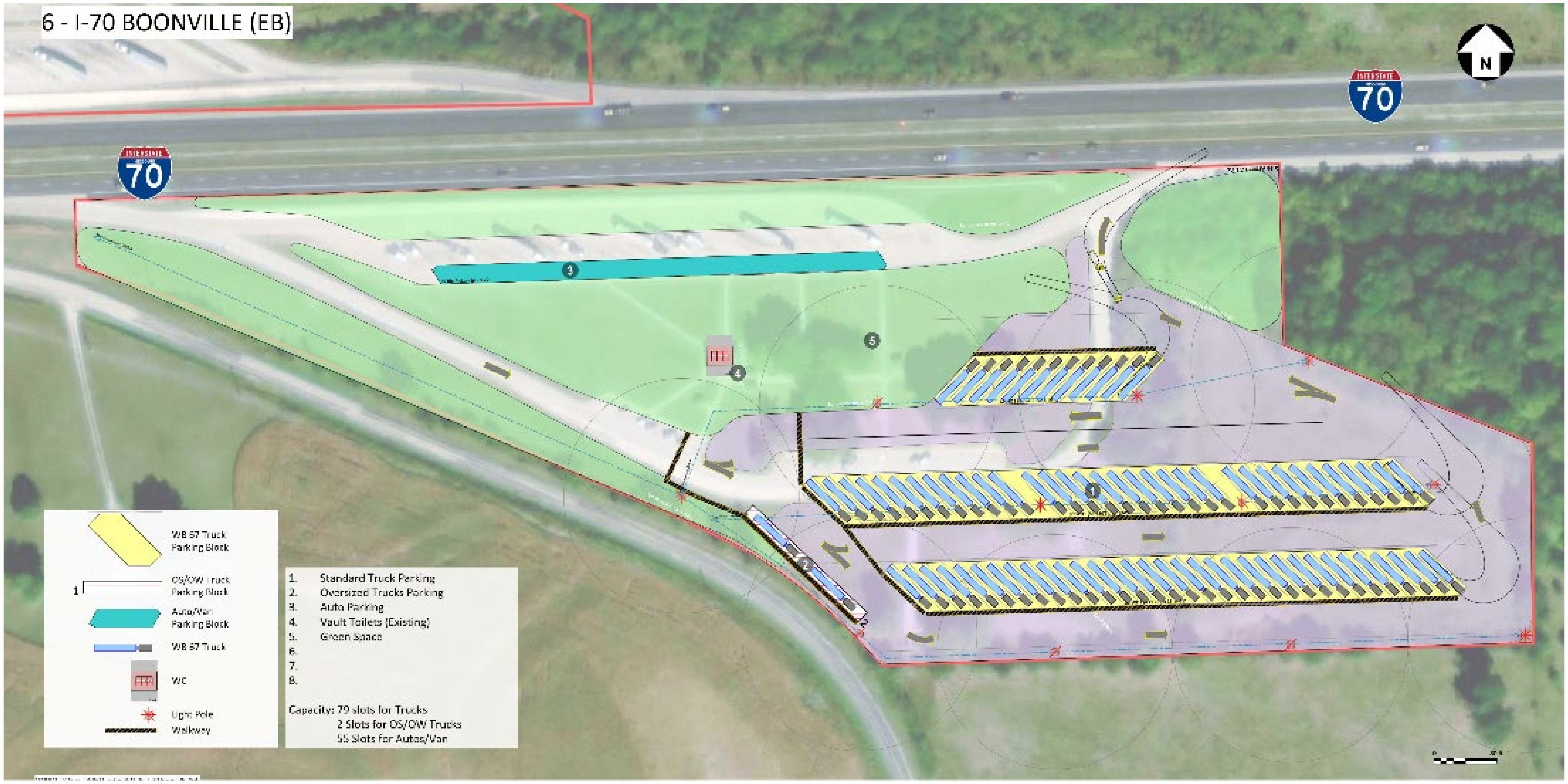


Figure B.7 Conceptual site layout - I-44 St. Clair (EB)

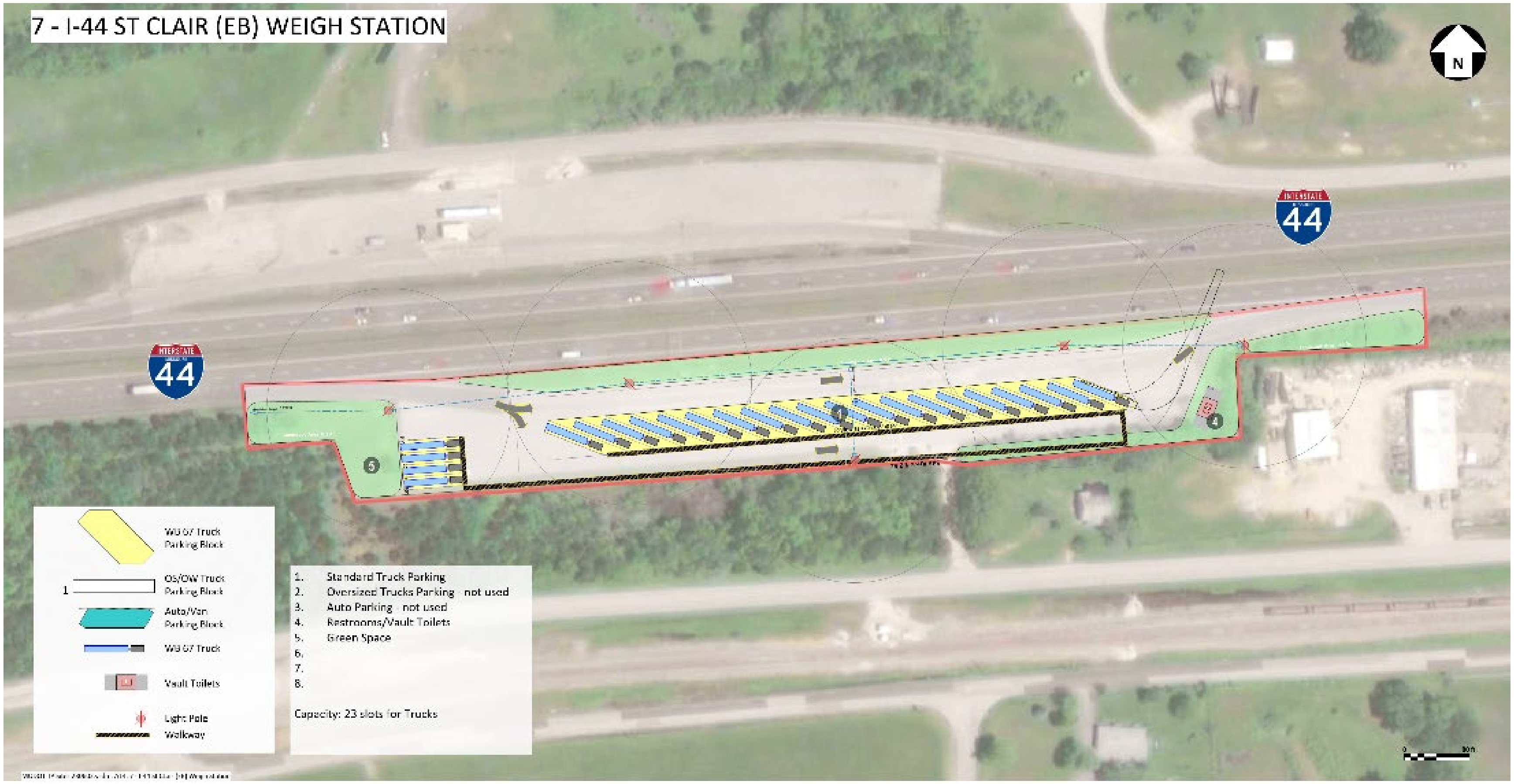


Figure B.8 Conceptual site layout - I-44 Halltown (EB)

Figure B.9 Conceptual site layout - I-35 Lathrop (NB)

Figure B.10 Conceptual site layout - I-44 Halltown (WB)

Figure B.11 Conceptual site layout - I-57 Charleston (NB)

Figure B.12 Conceptual site layout – I-57 Charleston (SB)

Figure B.13 Conceptual site layout - I-70 Mineola (EB)

Figure B.14 Conceptual site layout - I-44 Strafford (EB)

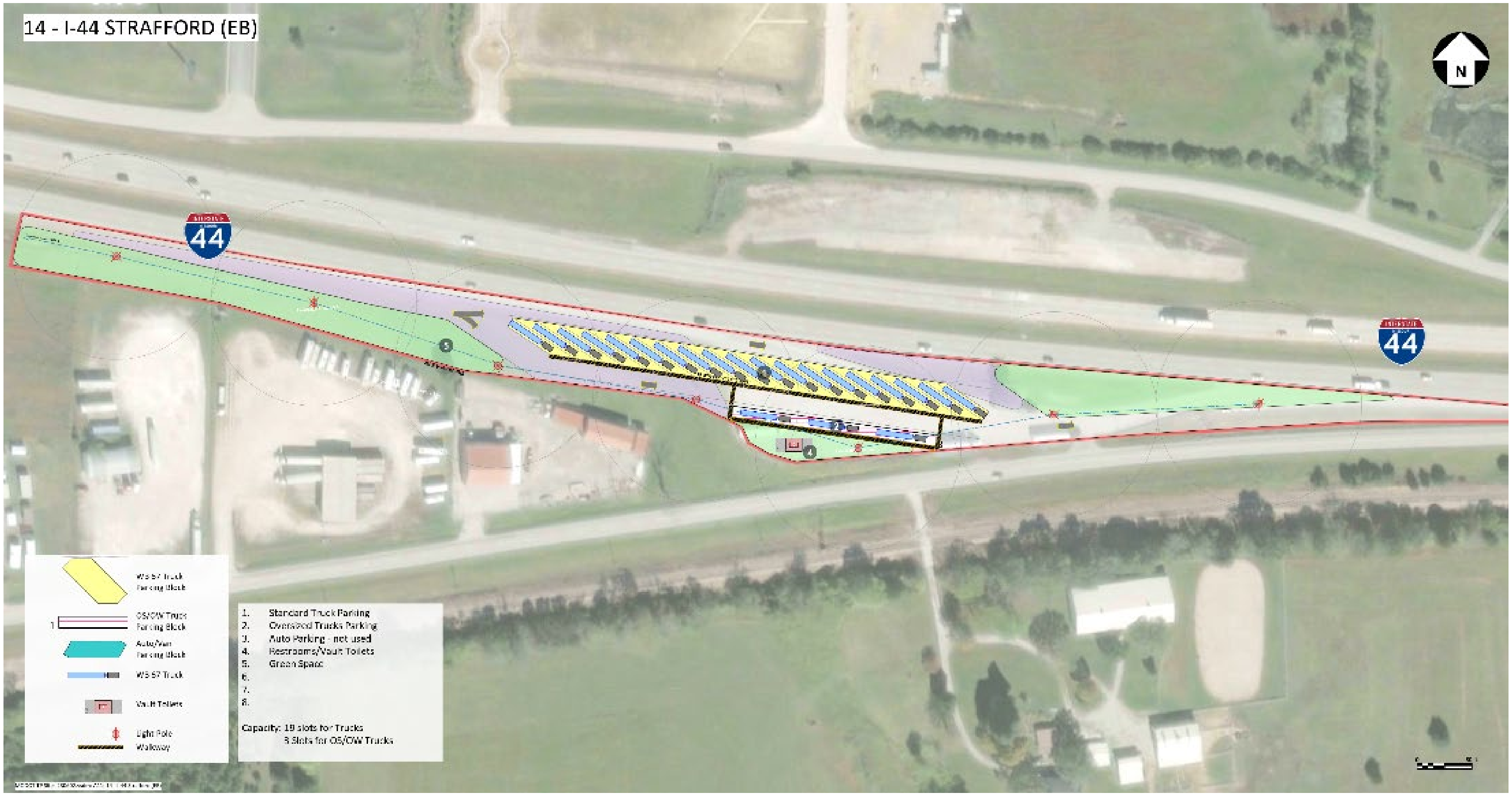


Figure B.15 Conceptual site layout - I-44 Joplin (EB)

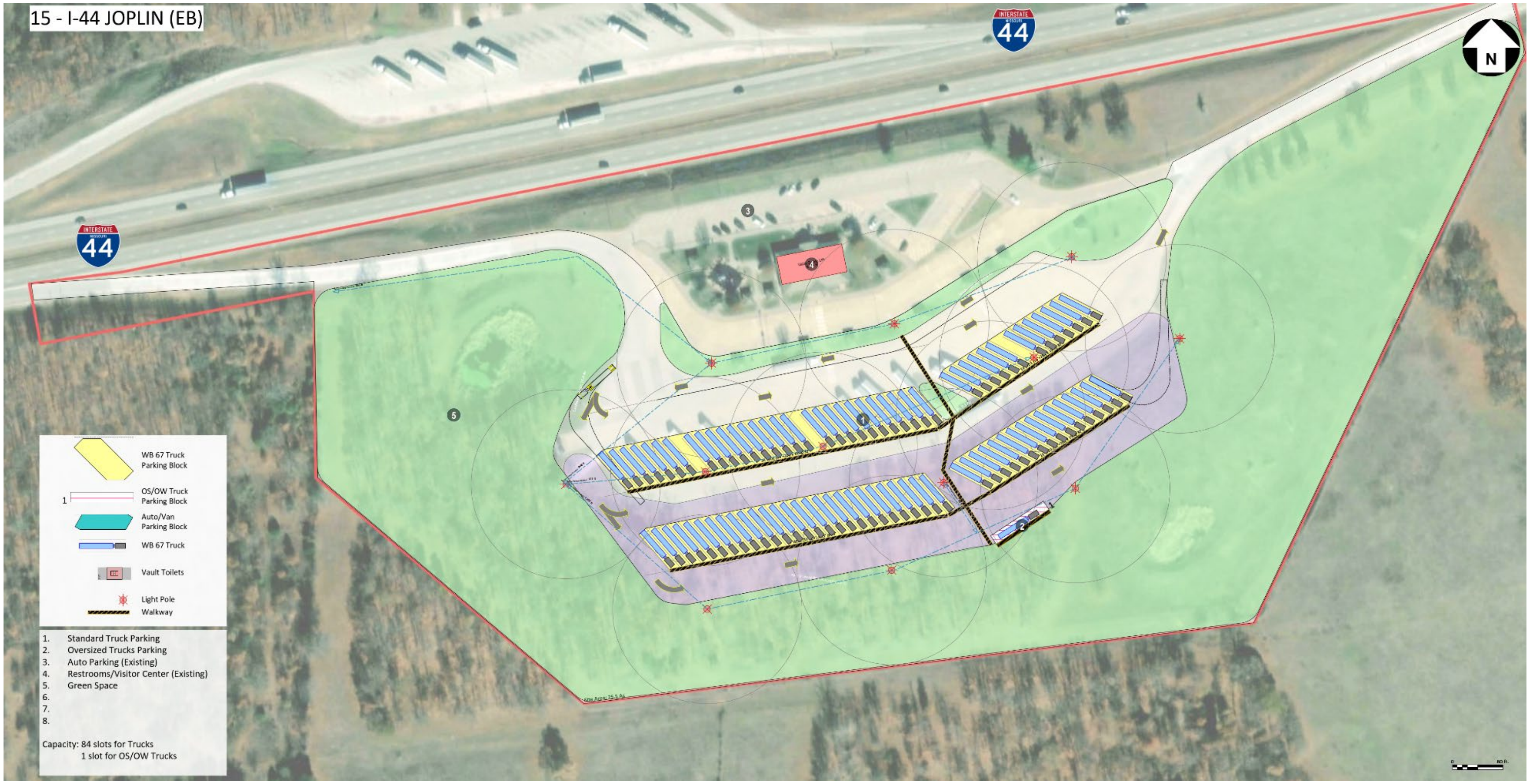


Figure B.16 Conceptual site layout - I-70 Mineola (WB)

Figure B.17 Conceptual site layout - I-44 St. Clair alternative location A (EB)

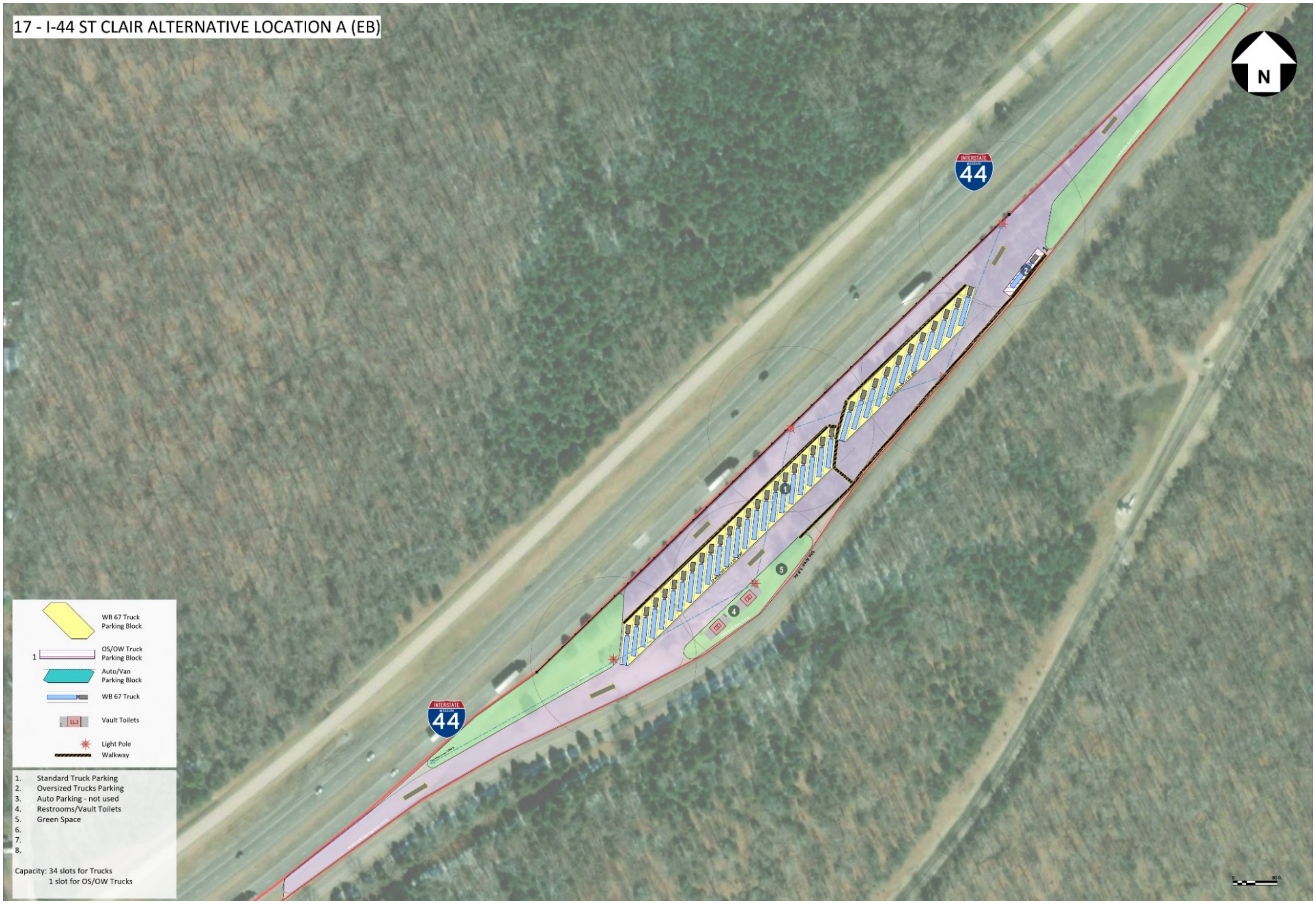


Figure B.18 Conceptual site layout - I-44 St. Clair alternative location B (EB)