Drexel Road

BRIDGE

Building Bridges and Empowering Communities: A Vision for Equity along Drexel Road

Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Discretionary Grant Program

CITY OF TUCSON

https://drexelroadbridge.com/

Project Description

The Santa Cruz River and its floodplain have been fundamental to the social and economic landscape of the Tucson Basin for more than 4,000 years. The Santa Cruz River spans approximately 184 miles from northern Sonora, Mexico, through Tucson and the Town of Marana.[1] Like all rivers, the Santa Cruz River supplied life-sustaining water for agricultural irrigation and drinking, but over the last century, the demand for water has dried up the natural resource. In some areas of southern Arizona, the river was once crucial to individuals looking for places to set down roots, but decades later, this natural resource leaves critical gaps in multimodal transportation infrastructure within south Tucson, particularly for individuals experiencing years of historical disinvestment who rely heavily on alternate modes of transportation to reach their daily destinations.

The City of Tucson ("The City") is requesting $20 million from the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Discretionary Grant Program to support capital investments in the Drexel Road Bridge, which will be constructed across the Santa Cruz River along Drexel Road on Tucson's south side. The project will reconnect communities experiencing historic disinvestment in south and west Tucson and address multiple transportation challenges in the area, including the lack of alternative modes of transportation, longer commutes for all including those using public transit, and traffic congestion. The project does so by providing more direct access to commercial and recreational opportunities through the construction of a **587-foot-long, three-lane bridge** (**two travel lanes and a two-way, left-turn lane**) over the Santa Cruz River, extending Drexel Road from Midvale Park Road to Calle Santa Cruz, and providing more direct access to The "Chuck Huckelberry" Loop – one of the most extensive and celebrated shared-use path systems in the country, recently recognized in ***USA Today's 2022 "10 Best Readers' Choice List" for Best Recreational Trail***.[2] The Loop has approximately 137 miles of paved, shared-use paths and segments of bicycle lanes connecting to trails and greenspaces throughout unincorporated Pima County, Marana, Oro Valley, Tucson and South Tucson. The Drexel Road Bridge project is located on the south side of Tucson within an urban area of Pima County, filling a gap in critical infrastructure over the Santa

Figure 1: Aerial view of the end of Drexel Road on the west side of the Santa Cruz River, with a view of The Loop's existing multimodal infrastructure.

[1] https://www.pima.gov/1494/Meet-the-Santa-Cruz-River
[2] https://10best.usatoday.com/awards/travel/best-recreational-trail-2022/

Cruz River, as shown in **Figure 1**. The project location is approximately 1-mile north of Valencia Road, 1-mile south of Irvington Road, and ¼-mile west of Interstate 19. The project will also support the installation of traffic signals at two intersections, including Midvale Park Road at Drexel Road and Calle Santa Cruz at Drexel Road. The total cost for the Drexel Road Bridge project is $39 million (see **Project Budget** for breakdown).

The project is identified as the Drexel Road Extension in the ***2045 Regional Mobility and Accessibility Plan***, published by the Pima Association of Governments (PAG)**,** a metropolitan planning organization serving southern Arizona. The Drexel Road Bridge project has been included in the **Regional Long-Range Transportation Plan** (RMAP, ID #6.03) since 2003, demonstrating the significance of the project to the region. Development of the plan extensively engaged policy makers, elected officials, stakeholders, and the public to build consensus to determine the region's needs.[3] The proposed bridge is a critical connection that will provide multimodal and climate change benefits to individuals experiencing historic disinvestment, offer better access to housing and economic opportunities, and maximize workforce development within the City. The bridge will not only benefit individuals who currently use circuitous alternate routes to continue traveling east or west on Drexel Road, it will enhance access to businesses and recreational areas, fostering economic growth and providing more convenient access for individuals traveling via alternative, low-cost modes of transportation such as walking, cycling, and using public transit. The project will include improvements to Drexel Road west of the proposed bridge, as well as upgrades to the intersections at Calle Santa Cruz and Midvale Park Road. The new bridge will address transportation challenges affecting access to daily destinations for individuals experiencing disinvestment, as shown in **Figure 2.**

Transportation Challenges

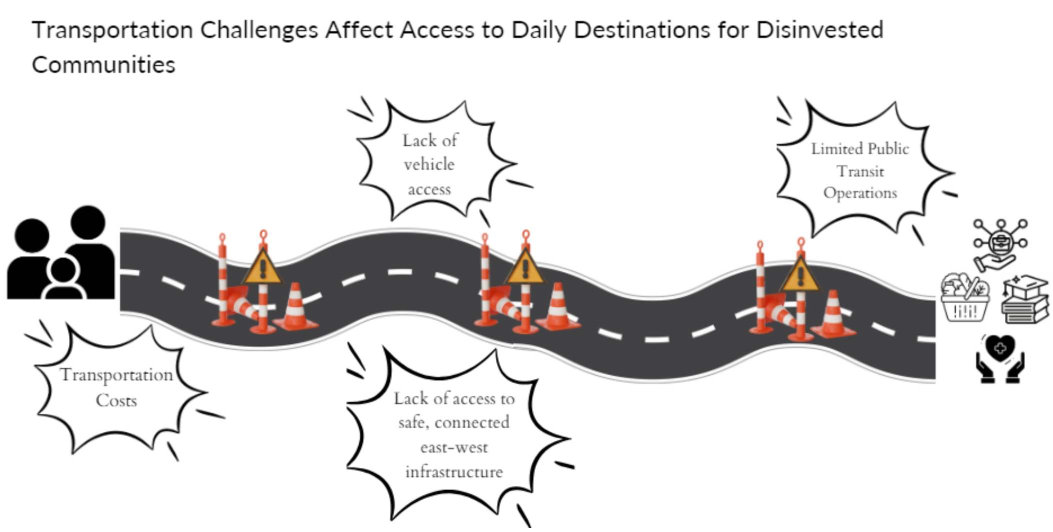

Figure 2*:* The project aims to address challenges related to transportation costs and lack of access to infrastructure, vehicles, and public transit.

[3] https://pagregion.com/wp-content/docs/pag/2020/08/2045RMAP.pdf

Challenge One: Lack of East-west Connectivity for All Modes of Transportation and Related Safety Concerns

The closest existing east-west street connections across the Santa Cruz River are Irvington Road, located one mile north of Drexel Road, and Valencia Road, located one mile to the south. The lack of connectivity and the density of the road network in the area, combined with the recent development and growth of Tucson Spectrum, an outdoor mall with over 70 shopping and entertainment businesses, has resulted in significant traffic congestion and safety concerns on both Valencia Road and Irvington Road as these corridors serve regional commercial destinations and are primary arterials providing access to fast-growing areas in south and west Tucson.

In compliance with the Federal Highway Administration (FHWA) requirements under 23 U.S.C 148(1), the Arizona Department of Transportation (ADOT) released an updated version of the ***Vulnerable Road User Safety Assessment*** (VRUSA) in November 2023. The VRUSA is a statewide initiative to improve safety for Vulnerable Road Users in Arizona. As shown in **Figure 3**, the 2023 VRUSA report ranked the area near I-19 and Irvington Road within the top 10 Bike Safety Concern Locations after approximately 16 serious injury and fatal bicyclist crashes occurred in the Irvington Road and I-19 area between 2013 and 2022.[4]

RANK	HEXTILE LOCATION	SERIOUS INJURY AND FATAL BICYCLIST CRASHES	BICYCLIST MILES TRAVELED	SERIOUS INJURY AND FATAL BICYCLIST CRASH RATE PER MILE
1	Prescott	5	557	0.009
2	Saddlebrooke/Catalina	4	451	0.009
3	Sedona	5	641	0.008
4	Scottsdale (Reata Pass)	6	810	0.007
5	Scottsdale (Pima Rd/Lone Mountain Rd)	4	582	0.007
6	Mesa (McKellips Rd/Mesa Dr)	8	1,430	0.006
7	Apache Junction	13	2,400	0.005
8	Oro Valley	7	1,640	0.004
9	Scottsdale/Phoenix (Hayden Rd/Pinnacle Peak Rd)	10	2,378	0.004
10	Tucson (I-19/Irvington Rd)	16	3,811	0.004
11	Phoenix (Cave Creek)	4	1,052	0.004
12	Kingman (New Kingman-Butler)	9	2,397	0.004
13	Lake Havasu City	11	2,951	0.004
14	Mesa/Gilbert (Power Rd)	6	1,746	0.003
15	Cottonwood	5	1,523	0.003
16	Mesa (Alma School Rd/Main St/University Dr)	45	13,901	0.003
17	Mesa (McKellips Rd/McDowell Rd)	4	1,240	0.003
18	Phoenix (Thomas Rd/I-10/I-17)	45	14,140	0.003
19	Mesa (Broadway Rd/ 4th Ave)/Apache Junction (Mountain Rd/110th St)	10	3,189	0.003
20	Goodyear/Litchfield Park/Avondale	22	7,124	0.003

Figure 3: Bike Safety Concern Locations were identified through the development of a bicyclist crash rate and dividing the number of bicyclist serious injury and fatal crashes by bicyclist miles traveled.

Solution #1

The Drexel Road Bridge project will address safety concerns of nonmotorized travelers along Irvington Road identified in Performance Reports prepared by **PAG.** Approximately 1.29 miles on Irvington Road from Mission Road to I-19 is rated in poor condition according to the **Level of Safety Service (LOSS),** a safety categorization system for roadway segments or intersections in reference to their expected performance. The LOSS is derived from Safety Performance Functions (SPFs) that reflect how a roadway or intersection is performing with regard to its expected crash frequency and severity at a specific annual average daily traffic (AADT). The Drexel Road Bridge project includes a new **587-foot-long, three-lane bridge over the Santa Cruz River** that will include Americans with Disabilities Act (ADA)-compliant sidewalks, enhanced bike lanes, multiuse paths, transit stops with bus shelters, drainage improvements and bank protection. Native landscaping and public art to beautify the corridor are included in the

[4] https://azdot.gov/sites/default/files/2023-11/ADOT-Vulnerable-Road-User-Safety-Assessment_Final-111523.pdf

project and will increase tree canopy cover and shade approaching the bridge to counteract heat impacts created by the urban heat island effect. The Drexel Road Bridge will provide a low-stress, low-speed solution, redistributing traffic from the overburdened Irvington and Valencia Roads, directing various modes of travel to local destinations for the historically disinvested communities in the project area. The proposed east-west connection across the Santa Cruz River will fill in gaps and create connections with existing bicycle and pedestrian infrastructure, including The Loop located on the west side of the Santa Cruz River, and will connect to the shorter Santa Cruz River Bikeway located on the east side of the river.

Challenge Two: Inadequate Access to Key Activity Centers for Disadvantaged Populations

The project and surrounding area are located within a large area of persistent poverty. The project area has a large Latinx population, a high concentration of limited English proficiency (LEP) households, and a relatively high number of people with ambulatory difficulties across four disadvantaged census tracts.

Solution #2

The new multimodal east-west connection across the river at Drexel Road will connect the neighborhoods of Sunnyside to the east and Midvale Park to the west, enhancing accessibility to shopping centers, employment opportunities, services, and other opportunities for individuals experiencing historic disinvestment. The Pima Community College Desert Vista Campus is located immediately adjacent to the project area, southeast of the intersection of Drexel Road and Calle Santa Cruz, providing residents with a new, convenient, and multimodal way to access educational and employment opportunities provided by the campus.

Challenge Three: Limited Efficiency and Flexibility for Transit Operations

Sun Tran serves the area with two east-west bus routes: Routes 27 and 29. Route 27, shown in **Figure 4**, must take a 2.6-mile detour from Drexel Road to Valencia Road between Midvale Park Road and Calle Santa Cruz due to the existing gap in infrastructure across the Santa Cruz River.

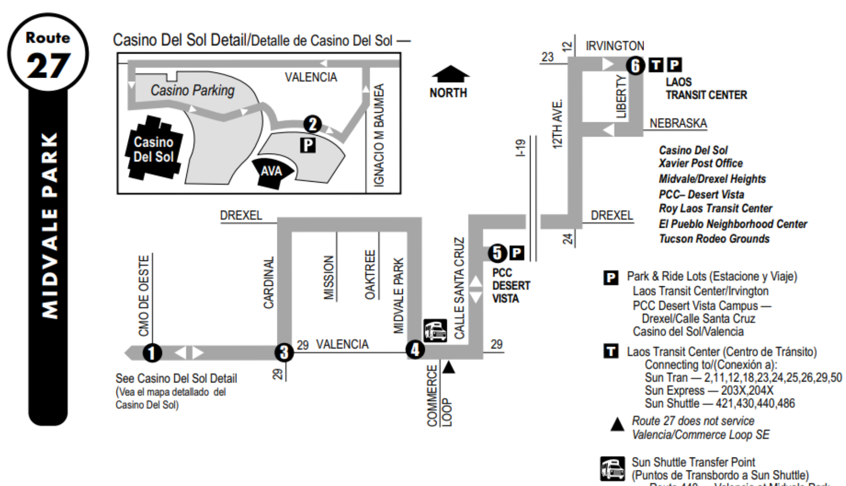

Figure 4: Map depicting existing Route 27 with detour south to Valencia Road due to the lack of a Drexel Road Bridge across the Santa Cruz River

Solution #3

The bridge will provide significant improvements in transit operations by eliminating a current route deviation that costs Sun Tran hundreds of thousands of dollars a year and makes transit less direct and convenient for residents. With the construction of the proposed bridge, the transportation network in this area will be able to accommodate higher volumes of traffic while reducing congestion and demand on the parallel east-west arterials, enabling commuters to choose from a wider range of routes, schedules, and modes of travel to reach their daily destinations.

The Drexel Road Bridge project will deliver significant economic benefits through:

- **Travel time savings**: The project will result in a more efficient and connected street network, decreased congestion, and decreased network vehicle hours traveled.
- **Vehicle emissions reductions**: The project team estimates a decrease in greenhouse gas (GHG) emissions of nearly 105.2 metric tons annually over a 20-year period.
- **Public transit improvements**: The more efficient street network will enable a re-routing of Sun Tran Route 27 over the new bridge, decreasing passenger travel times and vehicle operating expenses.
- **Increased safety**: By reducing congestion on the alternate routes, thereby reducing vehicle miles traveled on parallel major roadways, the project will result in reduced fatal, injury, and other crashes.
- **Housing and economic opportunities**: The project will improve access to housing, reducing sprawl, associated traffic congestion, and GHG emissions through efficient access to multimodal transportation infrastructure with the construction of the proposed bridge.
- **Workforce development**: Through the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA), federal funds are supporting projects like the City's infrastructure projects that identify strategic approaches for recruiting, training, and retaining workers. A more connected transportation network will support those goals.
- **Combating the urban heat island effect**: Access to new infrastructure can significantly reduce the impact of the urban heat island by promoting sustainable transportation that includes native vegetation and landscaping in and around the project area.

Tucson Fire Department will benefit from improved emergency response times, as explained in more detail in the **Merit Criteria Narrative**. The project will provide additional unquantifiable benefits, such as improving the quality of life through improved connections to educational facilities and housing opportunities, recreational and key activity centers, and improves economic competitiveness by reducing congestion on parallel major roadways, particularly for individuals experiencing historic disinvestment and/or persistent poverty.

Merit Criteria Narrative

The City of Tucson ("the City") is preparing for a future in a rapidly changing world by making economically and environmentally resilient transportation investments. The City's transportation master plan, ***Move Tucson***, is a direct result of Tucson's Complete Streets Policy adopted in 2019. Grounded in analysis and community input, ***Move Tucson outlines*** six guiding principles to create a mobility future that reduces barriers and enables opportunities for all individuals by increasing transportation choices, improving multimodal safety, and investing in existing infrastructure. The guiding principles of the ***Move Tucson*** plan in **Figure 1**, include:

Connected	***Move Tucson*** investments will remove physical barriers to movement, such as unsafe intersections or network gaps, and find new ways to provide cultural and technological connections that improve residents' access to opportunity.
Optimized	***Move Tucson*** will make the roadway network available to more people regardless of mode of travel and will leverage new technology and tools to make the current system more efficient and effective.
Safe	***Move Tucson*** will advance safety by focusing on policies and programs to eliminate traffic fatalities and serious injuries and by developing continuous networks that serve all ages and abilities.
Equitable	***Move Tucson*** will expand and improve practical mobility options for Tucsonans who face the greatest barriers to access and opportunity by increasing investments in the highest-need communities while being sensitive to processes of gentrification and displacement.
Resilient	***Move Tucson*** project apply sustainability best practices and increase the resilience of the city's transportation infrastructure and systems, enabling Tucson to be more responsive to its natural context and to be nimble in the face of climate change.
Authentic	***Move Tucson*** projects are context-sensitive, reflecting a neighborhood or district's character andt the preference of community members who live there, and support community and cultural attractions and events.

Figure 1: The six guiding principles in the City of Tucson's transportation master plan, Move Tucson, adopted in 2019.

The Drexel Road Bridge project was identified as a high-priority project in the ***Move Tucson*** transportation plan because it addresses the guiding principles by closing a critical transportation gap, benefits a historically underserved area of the city, and expands safe transportation options for people walking, biking, and using public transportation.[1]

The Drexel Road Bridge project will improve transportation infrastructure and connectivity in four census tracts (25.05, 25.08, 39.01, and 39.02), through the construction of a 587-foot-long, three-lane bridge (two travel lanes and a two-way, left-turn lane) and the installation of traffic signals at two intersections at Midvale Park Road and Calle Santa Cruz along Drexel Road. The project is located in a Historically Disadvantaged Community (HDC) within Pima County, as verified by the **Climate and Economic Justice Screening Tool (CEJST)**. The **USDOT Equitable Transportation Community (ETC) Explorer** shows that nearly 68% of residents in the project area reside in Disadvantaged Census tracts – a share significantly higher than both the City of Tucson (56%) and Pima County (44%) as a whole.[2] The Drexel Road Bridge project aims to provide more direct access to commercial, residential, and recreational opportunities and

[1] https://assets.tucsonaz.gov/share/transportation/movetucson/Plan_Fall2021.pdf, page 260.
[2] https://experience.arcgis.com/experience/0920984aa80a4362b8778d779b090723/page/ETC-Explorer---National-Results/ (selectors to produce results include Arizona; Pima County, Arizona; City of Tucson (AZ)).

alleviate longer commutes, traffic congestion and bottlenecks, supporting the priorities of the City of Tucson's Climate Action Plan, ***Tucson Resilient Together***, to reduce city emissions to net zero by 2030.[3] **The total cost of the Drexel Road Bridge project is $39 million**, which the City cannot address itself without external support. **For this reason, the City is requesting a $20 million RAISE grant** for the project to improve quality of life through improved connections to recreational and key activity centers and improve economic competitiveness by reducing congestion on parallel roadways. **Figure 2** shows how the project will benefit and enhance the area.

Figure 2: The Drexel Road Bridge project aims to provide more direct access to commercial and recreational opportunities within the project area, as identified on the Drexel Road Bridge Handout, located at drexelroadbridge.com/events.

Safety

Tucson is located within Pima County, one of the top 50 counties in the United States with the highest rates of traffic fatalities as of July 2023, as shown in **Figure 3**. The number of fatalities in Pima County was **11.3 times greater** than the county average of 61 total roadway fatalities since 2017, with **over 691 total fatalities reported between 2017 and 2021**.[4]

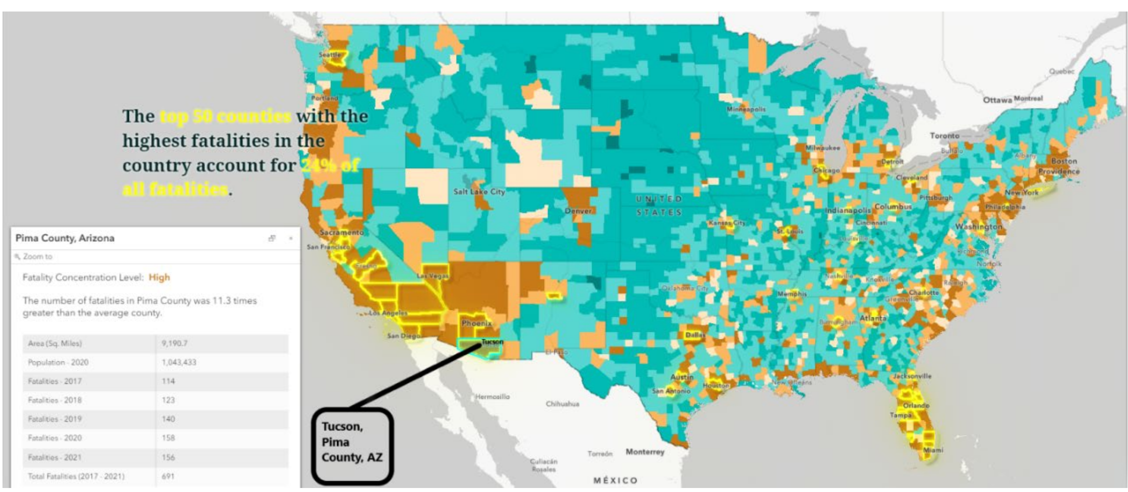

Figure 3: Concentration of Roadway Fatalities by the National Highway Traffic Safety Administration (NHTSA), updated in July 2023. Pima County is highlighted blue to show county statistics, with a black line and box identifying Tucson's location.

[3] https://assets.tucsonaz.gov/share/gis-docs/caap/TucsonResilientTogether_20230228.pdf
[4] https://storymaps.arcgis.com/stories/9e0e6b7397734c1387172bbc0001f29b, July 2023

Fatalities among nonmotorized travelers have been increasing faster than roadway fatalities in the past decade, reducing the number of individuals choosing climate friendly transportation to move around the City. The Smart Growth America ***Dangerous by Design 2022*** report ranked **Tucson as the 13th most dangerous metropolitan area in the United States** (U.S.) for people walking between 2016 and 2020.[5] The metropolitan areas were ranked by the number of deaths per 100,000 people in the population (rate), with the City serving 542,629 individuals, according to the 2020 Census. ***Dangerous by Design 2022*** reported that approximately 162 pedestrian deaths occurred between 2016 and 2020, which has only increased in subsequent years. Between 2018 and 2022, there were 172 pedestrian fatalities. Bicyclists and pedestrians represented nearly 48% of roadway deaths over the 5-year period. As of February 16, 2024, there have been 13 bicycle and pedestrian fatalities in the City, accounting for 72% of all roadway deaths with only 47 days into the year. In order to address the growing number of roadway fatalities, particularly amongst more vulnerable users, the City passed a Complete Streets policy in 2019, which prioritizes the safety, comfort, and connectivity to individuals of all ages and abilities. According to ***Smart Growth America***, the National Complete Streets Coalition evaluates and scores policies on a 100-point scale using a standardized set of ten elements. Based on this scoring system, the City of Tucson's Complete Streets policy scored 95 out of 100, classifying it as one of the strongest policies passed between 2019 and 2022.[6] Through the objectives corresponding to the Safe System Approach, as outlined in the **National Roadway Safety Strategy 2022**, the City will design roadway environments to anticipate human mistakes and lessen impact forces to reduce crash severity and save lives. As the City works toward a future with zero roadway fatalities and serious injuries, the City will ensure alignment with the principles that form the basis of the Safe System approach, shown in **Figure 4**, which aims to address and mitigate the risks of the transportation system to prevent crashes and minimize harm. Improving safety translates into economic benefits, in terms of lives saved and injuries prevented.

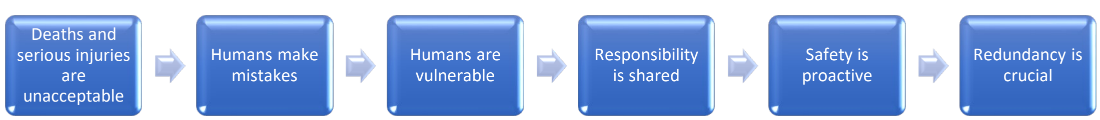

Figure 4: The Principles of The Safe System Approach, USDOT 2022.

Incorporate Actions and Activities in the National Roadway Safety Strategy Plan

According to the ETC Explorer, the project area is in the fifty-second percentile for traffic safety transportation insecurity, with impacted census tracts experiencing up to 9.68 traffic fatalities per 100,000 people. Most of the serious crashes occur on Irvington and Valencia Roads, the two closest east-west roads with Santa Cruz River bridge crossings. Between 2018 and 2022, there were a total of 858 vehicle crashes on both roadways, 28 of which resulted in severe injuries (See **PAG Performance Reports 4167** and **4168**). The project will fill a critical gap in transportation infrastructure along Drexel Road, reconnect communities, and provide an additional route that

[5] https://smartgrowthamerica.org/dangerous-by-design/
[6] https://smartgrowthamerica.org/best-complete-streets/

will reduce the frequency and severity of crashes in the project area, including along Irvington and Valencia Roads. As mentioned in the **Project Description**, the project was also identified in ADOT's Vulnerable Roadway Users Analysis (VRUSA) as one of the top 10 hot spots for bicycle crashes. With a goal of reducing the risk of accidents between vehicles, pedestrians and cyclists, the multimodal bridge will include separate accommodations for nonmotorized travelers in both directions, as shown in **Figure 5**.

Figure 5: The multimodal access will be improved through the construction of the proposed bridge project.

Reduce Safety Risks for Non-motorized and Motorized Travelers

The Drexel Road Bridge project, shown in **Figure 6,** will provide a new lower stress and safer connection across the Santa Cruz River for individuals walking and cycling, emphasizing the safety of the traveling public as a primary project purpose. The project will create a new connection for residents to access destinations via a new bridge and roadway that has **projected traffic volumes of around 10,000 vehicles per day** as opposed to the 40,000 to 50,000 vehicles per day traveling on the parallel river crossings along Irvington and Valencia Roads. The speed limit across the bridge will be **30 Miles Per Hour** (MPH). **As a way to reduce fatalities and/or serious injuries in an area experiencing historic disinvestment**, the decreased speed in miles per hour on Drexel Road addresses speeding as a contributor to deaths on our roadways and leads to a decrease in the risk of death of pedestrians and cyclists from 50% at speeds around 42 MPH to 25% for speeds around 32 MPH.[7] The fewer commercial driveways along Drexel Road means fewer conflict points for vulnerable users and will provide a lower-volume crossover to The Loop, a system of paved, shared-use paths and segments of protected bike lanes built on top of soil cement banks along metro waterways. Using best practices in complete street design, the new bridge will be designed to the highest safety standards by incorporating the safe systems approach to

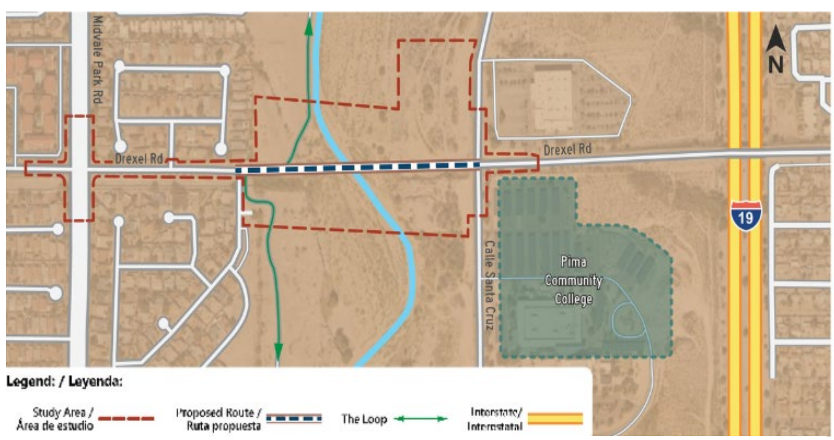

Figure 6: Map depicting the Drexel Road Bridge project area from Midvale Park Road to Calle Santa Cruz.

[7] https://www.transportation.gov/sites/dot.gov/files/2022-02/USDOT-National-Roadway-Safety-Strategy.pdf, page 27.

reduce fatalities and serious injuries in underserved communities. Safety elements will include but are not limited to:

- Dark-sky compliant LED street lighting linked to a 42% crash reduction
- Protected bicycle lanes anticipating a 43% to 52% bicycle and vehicle crash reduction
- Traffic signals anticipating 14% to 23% crash reduction
- Shared-use path grade-separated underpasses
- Roadway design to encourage slower speeds
- Smaller curb radii for pedestrian safety

Figure 7: Graphic depicting two alternatives for the Drexel Road Bridge with two buffer variations for bicycle and pedestrians.

The City of Tucson is considering two bridge alternatives, as shown in **Figure 7.** Bridge section **Alternative 1** includes one 11-foot-wide travel lane in each direction, a 12-foot-wide two-way center turning lane, 6-foot-wide shoulders, and a 12-foot-wide multi-use path in each direction, for an approximate bridge width of 75 feet.

Alternative 2 includes one 11-foot-wide travel lane in each direction, a 12-foot-wide, two-way center left turning lane, a 3-foot buffer with a curb or other device between the travel lanes and bike lanes in each direction, a 6-foot-wide bike lane in each direction, and a 6-foot-wide raised sidewalk in each direction on the bridge, for an approximate bridge width of 67 feet. Both alternatives were presented to the public for feedback via an in-person meeting on December 5, 2023, and a virtual meeting on December 6, 2023. **The City is evaluating narrowing the travel lanes from 11 to 10 feet to further reduce speeds along Drexel Road.**

As a result of shifting traffic to the new facility, which will be designed and delivered in accordance with the City of Tucson's Complete Streets policy, incorporating the Safe Systems Approach, **the new bridge is estimated to result in the reduction of one traffic fatality and 46 serious injuries over 20 years in the project impact area.**

Environmental Sustainability

The transportation sector is the largest source of greenhouse gas (GHG) emissions in the United States (U.S.) contributing to the climate crisis, affecting quality of life and air quality across communities like Tucson, one of the fastest warming cities in the nation. The City, situated in the Sonoran Desert, has experienced climatic extremes of multiannual drought and seasonal dryness. Each year between June 15 and September 30, the city experiences the annual U.S. Southwest monsoon season often called the "North American monsoon." In 2023, Tucson experienced the hottest July on record, with every day reaching 100 degrees Fahrenheit or hotter.[8] Access to effective multimodal transportation is becoming more and more vital as the degree of heat increases as rising temperatures can be dangerous to vulnerable populations, including elderly individuals and children, low-income, and minority populations. Through the Drexel Road Bridge project, the City will focus on environmental sustainability as a primary project objective of promoting low carbon transportation options while improving air quality, mobility and combating the urban heat island effect.

Align With a Local Greenhouse Gas Reduction Plan – Tucson Resilient Together

Mayor Regina Romero and the Tucson City Council declared a climate emergency in 2020 and committed the City to achieving carbon neutrality by 2030. The Tucson Climate Action and Adaptation Plan, ***Tucson Resilient Together***, was released in 2023 as a roadmap for how the city will prioritize its commitment to significant and lasting carbon emissions reductions. Community outreach was completed through climate listening sessions during the development of ***Tucson Resilient Together***, presenting the public with an opportunity to complete surveys to express any climate related concerns. As temperatures in Tucson continue to rise and affect the region for a longer period of time than in the past, residents are concerned about the effects of urban heat islands.

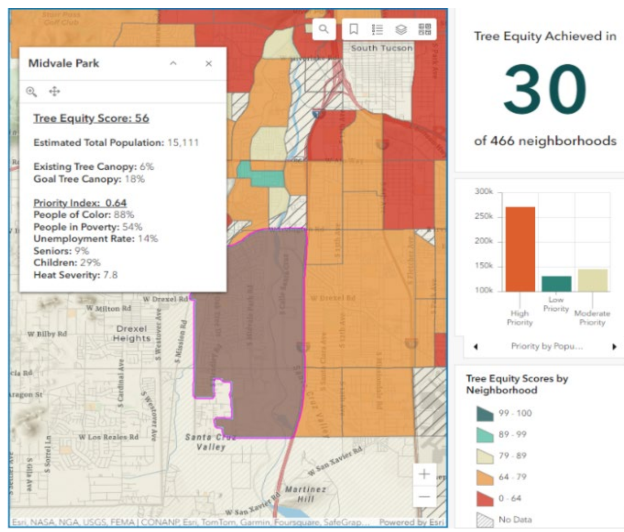

Figure 8: Tree Equity Dashboard for the project area shows low tree canopy compared to the City's goal for the area.

The City developed a **Tree Equity Dashboard**, shown in **Figure 8**, to inform the city on how well it is delivering equitable tree cover to all residents, providing shade, and promoting air quality. The score combines tree canopy cover, climate, demographic and socioeconomic data. The Tree Equity Score for Midvale Park which encompasses the project area is equal to 56, which is in the lowest range based on all factors, calling for more trees to be planted.[9] Compared to the mean surface temperatures in other parts of Tucson, individuals near the project area may experience a temperature differential of almost **7 degrees Fahrenheit**. Corridor enhancements along the roadway supports Mayor Romero's ***Tucson Million Trees Initiative*** that incorporates nature-based solutions using native vegetation to help mitigate the impacts of climate change in heat-vulnerable neighborhoods and to combat the negative effects of the urban heat island effect. The City has identified types of native vegetation that will provide shade to individuals using Americans with Disabilities Act (ADA)-compliant sidewalks, and that captures carbon dioxide. For example, full-grown desert willow trees can absorb as much as 48 pounds of carbon dioxide

[8] https://www.weather.gov/twc/2023MonthlyClimateReports
[9] https://climateaction.tucsonaz.gov/pages/milliontrees-tree-equity

a year. The same tree could also produce enough oxygen in a day for two people, positively improving air quality for individuals in the project area.

The Drexel Road Bridge **aligns with *Tucson Resilient Together* solutions for decarbonization** to encourage mode shift to more sustainable forms of transportation, enhancing corridors with shaded pedestrian areas, addressing negative environmental impacts such as air and noise pollution, and expanding options for public transit access in disinvested communities. Public transportation is a lifeline for people around the world as it provides mobility options, spurs economic growth, and promotes social connectivity. The City and Sun Tran are addressing GHG Emissions contributing to poor air quality and are engaging in efforts to reduce the exposure of the public to these pollutants in and outside the buses by switching to low- and zero-emission buses, which will operate in the project area. In June 2023, the City and Sun Tran received an award from the Federal Transit Administration (FTA) Low or No Emission Grant Program to replace the remaining 39 high-polluting diesel buses in the fleet with compressed natural gas (CNG) buses, supporting the transition to all low- or no-emission vehicles to improve air quality in the Tucson region.[10] The incorporation of broadband into the construction of the bridge will further improve connectivity of smart technologies in the project area promoting advancements of electrification and-/-or zero emission vehicle infrastructure.

Vehicle hours traveled (VHT) and emissions will also decrease from access to a more direct route compared to the two alternate routes along Irvington and Valencia Roads that experience higher traffic volumes. The VHT reduction is a result of faster travel times from more direct travel routes for some travelers, and less congestion and idling times on the alternate routes for others. Based on results from the PAG regional travel demand model, the project is anticipated to reduce carbon dioxide emissions by approximately 950 metric tons over 23 years of operations. Following the U.S. Environmental Protection Agency and Bureau of Transportation Statistics (BTS), **the benefit-cost analysis (BCA) for this project estimates decreases in GHG emissions of approximately 105.2 metric tons annually, as quantified over a 20-year period, and approximately 40,000 hours of person travel time per year.**

Planning and design for the Drexel Road Bridge project followed the federal design process, including conformance to the National Environmental Policy Act (NEPA) and other relevant environmental laws and regulations. **To address the disproportionately negative environmental impacts of transportation on local communities**, a noise study will be conducted as part of this project. A measurement was completed in November 2023 to measure the existing noise levels in the project area, where the result was 51 decibels (dBA). A dBA is a weighted scale for judging loudness that corresponds to the hearing threshold of the human ear. A noise model will be built based on the proposed design, which will incorporate the geometry of the new roadway and bridge, including elevation. The 20-year future projected traffic levels will then be input into the model and will predict noise levels with the future 20-year traffic data. A comparison will be made between the existing monitored noise levels (51 dBA) and the future projected noise levels, and if the noise levels are predicted to be at or above the ADOT threshold

[10] https://www.transit.dot.gov/funding/grants/fy23-fta-bus-and-low-and-no-emission-grant-awards

of 66 dBA, noise barriers will be evaluated. Results from the noise study will be available in March 2024.

In support of the City's objective of becoming a 15-minute city, a concept of urban planning in which residents are provided with basic services within a 15-minute radius by alternate modes of transportation, the bridge project will expand connections for all modes of transportation. The bridge has been designed to minimize its impact on the surrounding ecosystem, preserving natural habitats and allowing for the free movement of wildlife. Native vegetation and wildlife corridors can be preserved, ensuring minimal disruption to local ecosystems. The end result is a sustainable crossing that connects communities while protecting precious natural resources. Though a complex undertaking, this bridge over the Santa Cruz River represents a commitment to balancing development and conservation, progression, and preservation in Tucson.

Quality of Life

The City supports the Biden Administration's Justice40 Initiative to create a more sustainable and livable city. Census Tract breakdown below uses the CEJST and the ETC Transportation Insecurity Analysis Tool to describe the four census tracts in the project area (**25.05, 25.08, 39.01, and 39.02**) in Figure 9. **Census Tract 25.05 (04019002505)** has an estimated population of 6,608 people. Nearly 43.3% of the tract population live in poverty. The tract is low income, with a median household income around $51,483. Approximately 3% of households in this tract do not own a personal vehicle, and people spend nearly $12,731 (20.4% of their household income) on transportation. The tract also scored disadvantaged for the percent of people ages 25 years or older whose **high school education** is less than a high school diploma. **Census Tract 25.08 is part of Disadvantaged tract 04019002506 on CEJST,** which has an estimated population of 8,274. Nearly 43.9% of Census Tract 25.08 live in poverty. The tract is designated low income, with a median household income of $56,964. Approximately 7% of households in this tract do not own a personal vehicle, and people spend nearly $13,414 (18.3% of their household income) on transportation. The tract also scored disadvantaged for the percent of people ages 25 years or older whose **high school education** is less than a high school diploma. **Census Tract 39.01 (04019003901)** has an estimated population of 2,041. Nearly 56.1% of the tract population live in poverty. The tract is designated low income, with a median household income of $35,650. Approximately 6% of households in this tract do not own a personal vehicle, and people spend nearly $11,913 (29.45% of their household income) on transportation. The tract also scored disadvantaged for the percent of people ages 25 years or older whose **high school education** is less than a high school diploma, and for a high **unemployment** rate, based on the number of

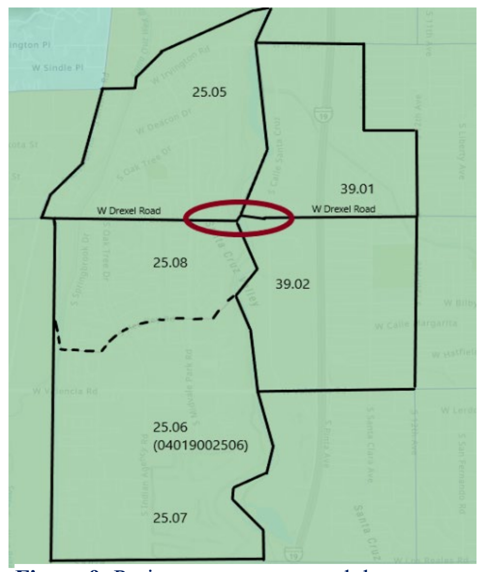

Figure 9: Project census tracts and the estimated project location circled in red using the USDOT Equitable Transportation Community (ETC) Explorer Transportation Insecurity Tool.

unemployed people as part of the labor force living in the area. **Census Tract 39.02 (04019003902)** has an estimated population of 2,843. Nearly 49.5% of Census Tract 39.02 live in poverty. The tract is designated low income, with a median household income of $43,088. Approximately 7% of households in this tract do not own a personal vehicle, and people spend nearly $12,305 (24.56% of their household income) on transportation. The tract also scored disadvantaged for the percent of people ages 25 years or older whose **high school education** is less than a high school diploma, and for a high **unemployment** rate, based on the number of unemployed people as part of the labor force living in the area). The tract also scored disadvantaged for **traffic proximity and volume** due to the count of vehicles at major roads within 500 meters, or approximately 1,640-ft, of households. The census tracts were verified as being in an Area of Persistent Poverty through the **Grant Project Location Verification Tool** (2020 Census).

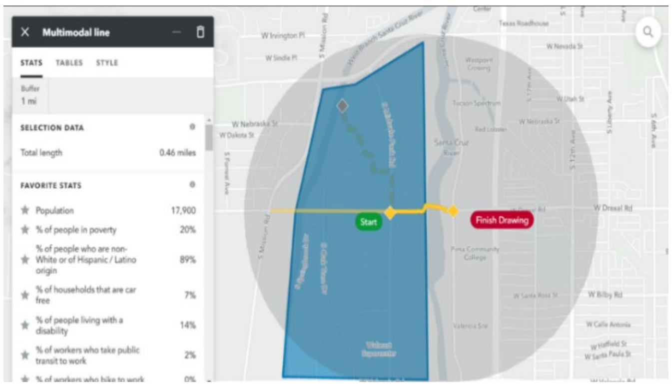

Figure 10: Data from Remix depicting the project area with 1-mile buffers (the circumference of the circle).

The population in the project area depicted in **Figure 10,** is approximately 18,000 individuals, but does not span the entirety of the census tracts leaving a population gap compared to the data above estimating 20,000 individuals across all four census tracts. Approximately 3,600 individuals, or 20 percent of the area population in **Figure 10** is living in poverty, and 90% identify as Latinx. Approximately 1,260 individuals, or 7 percent of the residents in the area, live in a car-free household and nearly 360 people use public transit to reach their place of work.[11] Additionally, the average daily bicycle count shows that approximately 221 people used The Loop between January and November 2023, while the average daily pedestrian count shows approximately 134 persons accessing The Loop at Irvington Road, north of Drexel Road.[12] Access to The Loop would significantly expand the option of active transportation in the project area.

The Drexel Road Bridge project will redress past and present inequities for those segregated by the lack of east-west access over the Santa Cruz River and will improve quality of life for residents and visitors in the area by **increasing affordable transportation choices**, expanding access to goods and services, and improving connectivity to jobs and other critical destinations, particularly for individuals in recognized areas of persistent poverty and historically disinvested communities. In addition, improved connectivity can also attract businesses and investors with a view to creating jobs and economic growth. By providing more opportunities for employment, increased income, and access to a wider range of goods, services, and green space, this growth in economic activity could further improve the quality of life enjoyed by citizens. The bridge will allow individuals to choose between modes of transportation that will **significantly reduce**

[11] https://platform.remix.com/project/0e815e8b?latlng=32.14846,-110.99387,17
[12] https://www.pima.gov/248/Loop-Usage-Reports

vehicle dependence in an area experiencing historical disinvestment by providing access to a **new facility that promotes active transportation and public transit along Route 27, which will no longer require a route deviation south to Valencia Road.**

The existing no-build scenario, shown in **Figure 11**, where the bridge would not be built, requires a 2.3-mile deviation equivalent to a 14-minute detour for someone using public transit from the Midvale Park/Drexel (SW) bus stop to Pima Community College Desert Vista campus. An individual walking the same route would spend approximately 52 minutes walking the 2.3 miles, where a bicyclist would take 12 minutes, and individuals using a personal vehicle would take 6 minutes to reach the campus from the bus stop location. With the proposed bridge, it would take a vehicle traveling at 30 MPH about one minute to travel across the bridge from Midvale Park Road to Calle Santa Cruz if the traffic signal is green at Calle Santa Cruz.

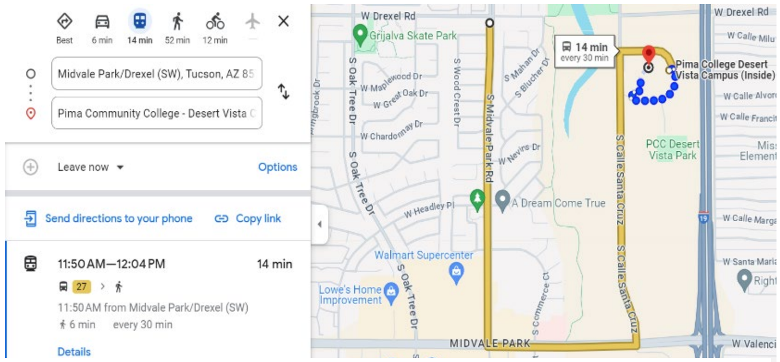

Figure 11: Google Maps of transit route from Midvale Park / Drexel (SW) bus stop to Pima Community College Desert Vista Campus, showing a 14-minute commute along a 2.3-mile route.

Without using the high traffic routes of Irvington and Valencia Roads, the construction of the bridge will make it easier for individuals to reach various services and areas not only in the project area but throughout the city at reduced travel times. This project will not only lead to a stronger sense of community but reduces the stress and fatigue one may experience from an extended commute. This is a significant benefit to the individuals within the average sixty-fifth percentile for low life expectancy across the four census tracts experiencing historical disinvestment. **The Drexel Road Bridge will actively address the urban heat island effect to protect the health of at-risk residents, outdoor workers, and others by installing native vegetation and trees throughout the project area**.

Art will be incorporated to aesthetically enhance the project. This enhancement is anticipated to provide the community with a sense of pride for the Drexel Road Bridge project, which contributes to improving the quality of life. One percent of the estimated construction cost of the project will be allocated for public art, and the City has begun the process of selecting an artist to become part of the design team. Potential artwork and locations include decorative metal railings, rustication on retaining walls, bridge abutments, columns, and wingwalls. Additionally, stand-alone art sculptures or other artistic features can be included at various locations along the project limits. Artistic elements will be developed during the final design of the project.

Emergency Response Times

Tucson Fire Department (TFD) responded to approximately 280 calls per day, or nearly 102,000 incidents, in 2022. Response times vary depending on traffic volume and where units are located when the calls come in, but typically are responded to within five to six minutes. Tucson Fire Station 14, built in 1968, is located 1-mile east of the proposed bridge, and Fire Station 18, built in 2000, is located ½-mile to the west and serves the community of Midvale Park. **Figure 12** models Paramedic coverage in the region surrounding **Station 14**. Based on the top model showing no-build results for Station 14, the lighter green lines depict 5-minute coverage areas. The bottom model in **Figure 12** show the results based on the construction of Drexel Road Bridge. Similar model results can be seen in **Figure 13** depicting the no build versus project construction for **Station 18**. The top of **Figure 13** shows the modeled drive time, and what areas are within 5-minute coverage. The bottom model depicts revised response times for Station 18 with the addition of the bridge across the Santa Cruz River. The TFD's Fire and emergency medical services (EMS) response in these areas have extensive response times above the national standard (5 minutes and 20 seconds) due to heavy traffic flow and limited ingress and egress from Stations 14 and 18 without the proposed connection across the Santa Cruz River. Adding a bridge across the Santa Cruz River along Drexel Road will improve transport-capable unit response times between two and four minutes for these units responding in-house between stations. The Drexel Road Bridge will allow TFD's Fire and EMS to operate more efficiently and safely to establish patient care more rapidly through the reduction in response times.

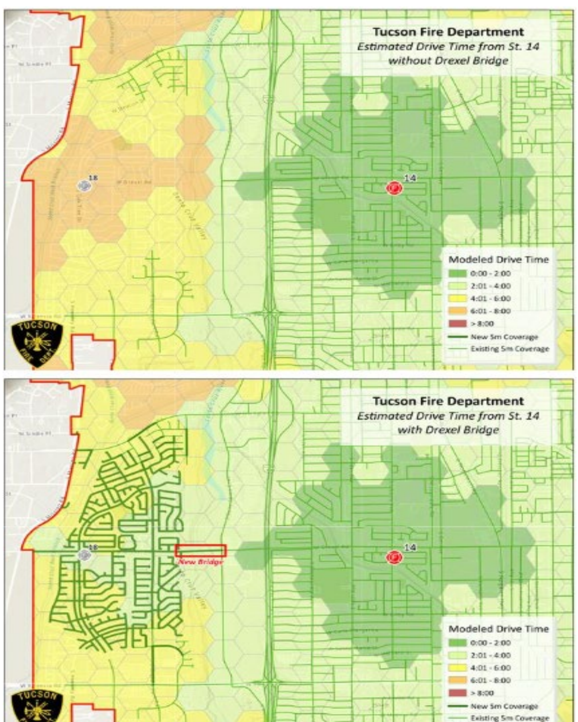

Figure 12: Model at the top depicts the existing no-build Paramedic coverage versus the Paramedic coverage using the bridge connection from Station 14 on the east side of the Drexel Road Bridge project.

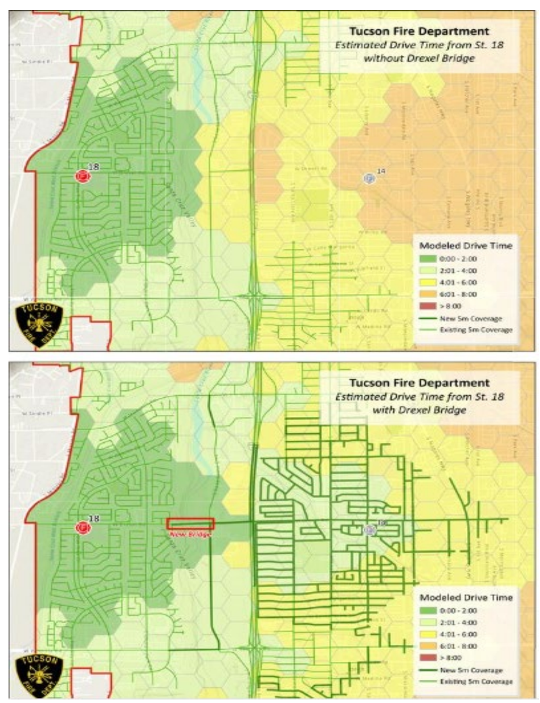

Figure 13: Model at the top of the image depicts the existing no-build connection for Tucson Fire Department Paramedic coverage from Station 18 to travel times based on the construction of the Drexel Road Bridge in the second model.

Improved Mobility and Community Connectivity

The social and economic health of south Tucson neighborhoods has been significantly affected by the lack of physical connectivity caused by the Santa Cruz River. Mobility and connectivity are primary purposes of the project and **will remove physical barriers for individuals by reconnecting communities** located east and west of the Santa Cruz River **by access to direct, affordable transportation** through a new facility that promotes walking and cycling. The project will include fully accessible sidewalks, enhanced bicycle lanes, transit stops with bus shelters to promote the use of public transit, drainage improvements and bank protection, as well as native landscaping and public art to beautify the corridor. Local roads and neighborhood streets make up most of the streets in Tucson, covering more than 1,700 miles of road centerline. The bridge will improve the flow of traffic in the area and reduce the risks of accidents that result from gridlock and bottlenecks by reducing systemic congestion on Irvington Road and Valencia Road.

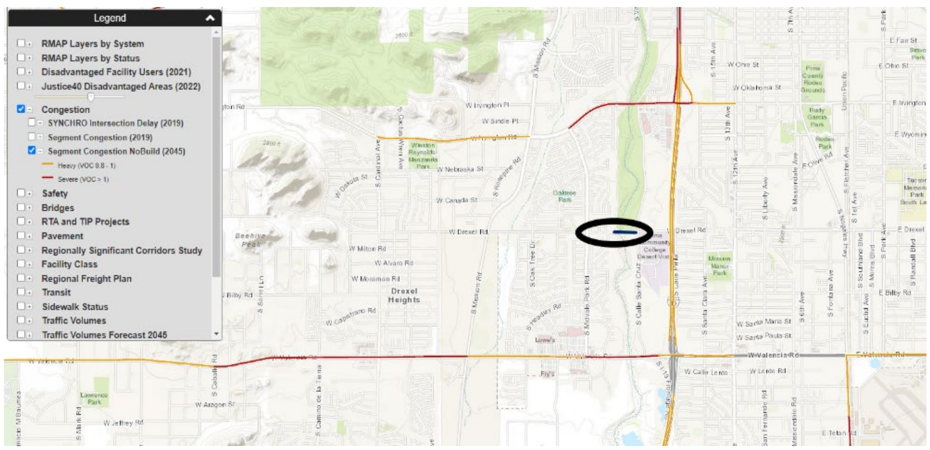

Figure 14: Projections for 2045 show heavy and severe congestion along Irvington and Valencia Roads, the routes parallel to the Drexel Road Bridge project, highlighted in a black oval with a navy-blue line depicting the bridge location.

Gridlock is a traffic jam where a grid of streets is congested to a point that no motorized vehicle is able to move. Projections of future congestion on Tucson's roadways, as identified in **Figure 14**, anticipate nearly 21% of major roadways will be heavily congested in 2045 under a "no-build" scenario, including Irvington and Valencia Roads (**Figure 14**). For motorized travelers along the 1.29 miles from Mission Road toward I-19 on Irvington Road, congestion is a common barrier. The Drexel Road Bridge project will remove vehicles from both routes, clearing congestion along important Freight Facilities and leading to a change in travel distance and travel time that improves GHG emissions. **Table 1** shows daily volume projections and daily travel time along the adjacent routes.

Table 1: Daily Volume Projections and Daily Travel Time along Irvington and Valencia Roads.

	Daily Volume Projections (vehicles per day)						Daily Travel Time (vehicle hours traveled per day)					
	Opening Year			Design Year			Opening Year			Design Year		
Street	No-Build	Build	% Difference	No-Build	Build	% Difference	No-Build	Build	% Difference	No-Build	Build	% Difference
Irvington Road	37,263	33,298	-11%	43,974	40,622	-8%	415	354	-15%	518	455	-12%
Drexel Road	0	10,889	-	0	10,943	-	0	185	-	0	197	-
Valencia Road	52,969	49,108	-7%	61,869	55,324	-11%	478	426	-11%	597	499	-16%

The Drexel Road Bridge is expected to decrease the traffic volumes on the adjacent arterials (Irvington and Valencia Roads) between 7% and 11%, and the travel time between 11% and 16%. The anticipated reduction in daily volume and daily travel time is significant considering the level of congestion along the adjacent arterials. To illustrate the benefit of the project, Valencia Road is a six-lane roadway and the expected volume in the design year of 61,869 vehicles per day (vpd) would require an additional lane in each direction of travel to accommodate the anticipated travel demand, creating additional safety challenges along the segment**.** However, the volume projection with the Drexel Road Bridge project constructed anticipates 55,324 **vpd** on Valencia Road, which can be accommodated with the current six-lane roadway configuration.

Economic Competitiveness and Opportunity

The project area is in the 88th percentile for the state of Arizona for Transportation Cost Burden, according to the ETC explorer state results, and a significant share of households have no access to an automobile. The Drexel Bridge project will improve freight performance within the project area. Both Irvington and Valencia Roads were identified as Regional Freight Corridors (RFC) in PAG's 2018 Regional Freight Plan[13] due to the high amount of non-interstate commercial vehicle traffic routing on the corridors and due to the proximity to major freight-generating businesses. By shifting more passenger trips onto Drexel Road, the new bridge will reduce delays for commercial vehicles and improve reliability of goods movement on these critical urban freight arterials for the region.

Improved crossings and high-quality bike and pedestrian networks can improve the experience of real and perceived safety for Tucsonans in high scoring equity zones that rely heavily on alternate modes of transportation to reach their daily destinations. The Drexel Road Bridge will benefit the economy by improving access to goods, services, and jobs. Educational facilities including Pima Community College Desert Vista Campus, Raúl M. Grijalva Elementary School and Mission Manor Elementary School will also benefit from the east-west connectivity provided by the construction of Drexel Road Bridge. The City works in close cooperation with Tucson Unified School District (TUSD) throughout the city to create safe access to schools through appropriate signage in and around school zones, crossing guard staffing, and working with local law enforcement. The City is pursuing additional project improvements along the entire extent of Drexel Road to evaluate interim safety improvements near Raúl M. Grijalva Elementary School **as a separate effort to provide students with safe routes to school.** Infrastructure projects benefit the economy through the monetary investments from the funding supporting the project. When funds are awarded with local matching funds to support capital projects, the impact of government support on worker salaries and the use of wages to purchase goods and services spurs economic growth.

Davis-Bacon and Related Acts

The project aligns with the City's organizational commitment to equity-focused data collection and analyses related to project delivery and implementation. In January 2024, Mayor Regina

[13] https://pagregion.com/wp-content/docs/pag/2020/09/PAGRegionalFreightPlan2018.pdf

Romero and the City Council passed a Prevailing Wage Ordinance. The City remains in compliance with Davis-Bacon and Related Act requirements, and in good standing with all Federal Civil Rights programs, including the ADA, Title VI, and Disadvantaged Business Enterprise.[14] The City has staff tasked with ensuring compliance with Davis-Bacon Act across all federal grants to prevent potential violations and guarantee contractors adhere to prevailing wage laws. The City has established the vision, policies, and priorities to promote an economy of equal opportunities for individuals of all skill levels, provides equal access for individuals of all abilities and backgrounds, and emphasizes participation in the workforce with local partnerships that support economic development, youth development, and job creation. As part of this commitment, the City recently updated its **Title VI Annual Report**[15] and **Title VI Non-Discrimination Plan**[16] in August 2023 to address discrimination and environmental justice in low-income communities.

In addition, by 2024, the City's Housing and Community Development (HCD) will commit funding towards the Arizona Department of Housing through awarded low-income housing tax credit for the Desert Dove Apartments, an affordable housing project. The housing project will be located 0.7 miles south of the Drexel Road Bridge project at 6163-6165 South Midvale Park Road and include 63 units of family housing. Increased access to public transportation and multimodal infrastructure offered by the construction of the Drexel Road Bridge will benefit those who will live in the low-income housing units. The City's transportation investments like the Drexel Road Bridge project create opportunities for new industries, tourism, and investment while stimulating economic development through the buildout in previously inaccessible or underdeveloped areas.

State of Good Repair

The project creates a direct link between multimodal transportation along Drexel Road to address current and projected traffic system vulnerabilities along Irvington and Valencia Roads. The City will be able to maintain an efficient transportation system with smooth traffic flow, reducing congestion and delays caused by the use of alternate routes along Irvington and Valencia Roads, while maintaining a new facility in good condition. It is vital to maintain infrastructure in a state of good repair so as to ensure security, connectivity, and the welfare of society. By regularly inspecting and repairing any damage or deterioration post-construction, the City will reduce the risk of accidents or structural failures, providing peace of mind to residents and visitors using the infrastructure. By addressing any maintenance needs, the City will minimize environmental hazards to preserve the surrounding ecosystems. This commitment to environmental stewardship aligns with sustainable development goals and demonstrates a responsible approach to infrastructure management. Investing in the state of good repair for the Drexel Road Bridge project goes beyond safety and economic considerations, extending to preserving and protecting the environment for future generations.

[14] https://www.tucsonaz.gov/Departments/Business-Services-Department/Procurement/Contract-Compliance-DBE-SBE-DBRA/Disadvantaged-Business-Enterprise
[15] https://www.tucsonaz.gov/files/sharedassets/public/v/1/dtm/documents/title-vi/2023-title-vi-non-discrimination-plan.pdf
[16] https://www.tucsonaz.gov/files/sharedassets/public/v/1/dtm/documents/title-vi/7-19-23-dtm-policy-title-vi-non-discrimination-policy-statement.pdf

Partnership and Collaboration

The City is committed to the USDOT's priorities to reduce inequities across our transportation systems to ensure that communities benefit from the safe, efficient, and sustainable movement of people and goods. The City works to engage individuals within the community to provide input based on their lived experiences and areas of expertise related to projects and programs to better understand concerns, identify new opportunities, explore alternatives, and collaboratively create a vision for the future of Tucson. In early 2023, the Pima County Department of Transportation (PCDOT) in partnership with the City of Tucson Department of Transportation and Mobility (DTM) and other local government entities, received $1.5 million in planning funds from the ***Safe Streets and Roads for All Discretionary Grant Program*** to develop a multijurisdictional Action Plan focused on creating a culture of safety for all and reduce traffic-related injuries and fatalities within Pima County. The City works vigorously to establish and maintain multifaceted partnerships with organizations like the Arizona Department of Transportation (ADOT), Pima County, PAG, the Regional Transit Authority (RTA), and other local stakeholders based on the project type and scale. During the planning and design phase of the Drexel Road Bridge project, the City partnered with the PAG and RTA, Sun Tran, and Pima County. The work done through this project aligns with forecasted work of the **Pima County Flood Control District (PCFCD). PCFCD** has completed plans for improvements to the Loop from Irvington to Drexel along the east bank of the Santa Cruz River, anticipated to begin construction in fiscal year 2027/2028. With future improvements planned for The Loop, individuals will have direct access to this urban recreational path system to travel throughout Tucson. Work done through the Drexel Road Bridge project will assist PCFCD in its efforts to reopen this area of the recreational path system to all individuals accessing The Loop. The proximity to Interstate 19 makes ADOT a valuable stakeholder for the Drexel Road Bridge project, as they are under active design at the Irvington Traffic Interchange (TI). ADOT supports the construction of the Drexel Road Bridge across the Santa Cruz River (see **Letters of Support**).

Innovation

During the project's planning and design phase, the City completed a traffic signal warrant analysis regarding the potential conversion of Drexel Road and Calle Santa Cruz from a three-legged intersection to a four-legged intersection while exploring advanced traffic signal control and detection technology, including adaptive signal control. Adaptive signal control technology optimizes red, yellow, and green lights based on real-time traffic trends to reduce congestion and emissions to improve travel time reliability. The addition of broadband and adaptive signalization supports the new safety road actions in the Safe System Approach, which aims to advance the use and deployment of technologies enhancing safety for all roadway users. Including broadband infrastructure in the bridge design, in coordination with private fiber providers, connects existing infrastructure on either side of the Santa Cruz River and incorporates smart technologies into the project area. The fiber will interconnect the adjacent traffic signals and allows for video monitoring, adaptive technologies, street light monitoring and control, emergency pre-emption, transit priority, connected vehicles and other future Intelligent Transportation Systems technologies such as connected and automated vehicles. The project will include other technologies like dark-sky compliant LED lighting to improve the safety of the public during inclement weather and while traveling at night.

Project Budget

The City of Tucson seeks **$20 million** from the U.S. Department of Transportation through the RAISE Discretionary Grant Program for the construction of the Drexel Road Bridge project.

The project proposes:

- The installation of a 587-foot-long, three-lane bridge (two travel lanes and a two-way, left-turn lane) over the Santa Cruz River
    - Continuous ADA-compliant walkways, enhanced bicycle lanes and multiuse paths
    - Dark-sky compliant and energy-efficient LED lighting
- Two new signalized intersections along Drexel Road: one at the intersection of Midvale Park Road at Drexel Road, and the other at the intersection of Calle Santa Cruz at Drexel Road
- Transit bus stops with shelters
- Fiber/broadband connections
- Public art
- Native vegetation and landscaping

Figure 1: An aerial image taken from the west of the Santa Cruz River showing where the bridge will connect to Calle Santa Cruz.

The Drexel Road Bridge preliminary total project cost is **$39 million**, as shown in **Table 1**. The design and construction budget has been developed based on a **February 2024** estimate of costs using the 15% design plans. The estimate is based on the construction of the bridge, with the proposed bicycle and pedestrian improvements, the addition of a center-turn lane on the western bridge approach, and the installation of traffic signals at two intersections.

Table 1: Preliminary total project cost breakdown for the Drexel Road Bridge project as of February 2024.

Description	**Cost Estimate**
Construction Subtotal	$21,955,627.00
Inflation Allowance (6% for three years - 19.1%)	$4,193,877.00
Design Costs	$2,600,000.00
Public Art	$219,556.00
Right-of-Way Allowance	$100,000.00
Environmental Mitigation	$50,000.00
Post-Design / As-Builts	$219,556.00
Construction Engineering	$3,073,788.00
Contingency (30%)	$6,586,688.00
Total Cost	$38,999,092.00

The budget reflects estimated expenses plus a 30% construction contingency, an approximately 7% design allowance, and a 19% inflation factor to account for increases in material and labor costs that may arise between now and construction based on the 15% design completion.

The Drexel Road Bridge is a unique opportunity to leverage multiple funding sources, given the City's recent success in securing **$15 million in State of Arizona funds** during the 2023 legislative session, specifically for the project. The City's work to obtain state funding illustrates its commitment to the project as well as the importance of the Drexel Bridge to the State of Arizona. A federal grant through the RAISE Discretionary Grant Program will allow the City to proceed without delay in bridging a critical gap in its infrastructure while benefitting residents living in the surrounding Areas of Persistent Poverty (APPs) and Historically Disadvantaged Communities (HDCs). Federal funding will allow the City to proceed with construction of this much-needed project to redress the harm to the neighborhoods on the east and west side of the Santa Cruz River to benefit the community, particularly individuals experiencing historic disinvestment. Without the RAISE grant, the delivery timeline would be uncertain as the City assesses other funding strategies. The project is located in an urbanized area with census tracts that meet the definition of APP and HDC census tracts.

If the City is successful in securing RAISE funding, construction is anticipated to begin as early as **January 2026**, with construction activities lasting approximately 12 to 18 months. Once the grant agreement has been executed and funding has been obligated, the City will be well-positioned to start the project and maintain the timeline (see **Project Readiness**) to ensure all funds are obligated at least six months before the obligation deadline of September 30, 2028, and expended by the expenditure deadline of September 30, 2033.

The Drexel Road Bridge project will be funded from three sources:

- The **RAISE Grant** Program will provide **$20 million**, or approximately **51%** of the total project costs. The RAISE grant will be used for the construction of the Drexel Road Bridge, which will provide major enhancements to connectivity and accessibility in an area experiencing historic disinvestment through the construction of a 587-foot, three-lane bridge over the Santa Cruz River along Drexel Road.
- The **2023 State of Arizona funding** will provide **$15 million**, or approximately **38%** of the total project costs.
- The remaining **$4 million**, or approximately **11%** of the total project cost, is supported by City of Tucson local funds, consisting of $2 million from local allocation of the Arizona Highway User Revenue Fund (HURF) and $2 million from City of Tucson Development Impact fees. (See **Funding Commitments**).

Table 2 shows the distribution of funding across the three funding sources (RAISE funds, Other Non-Federal Funds from the State of Arizona, and Local funds to support the $39 million total project cost based on the components listed in **Table 1**.

Table 2: Budget and Funding Source

	RAISE Funds (51%)	Other Non-Federal Funds (38%)	Local Funds (11%)	Total Funding (100%)
Construction Subtotal	$11,197,370.00	$8,343,138.00	$2,415,119.00	$21,955,627.00
Inflation Allowance	$2,138,878.00	$1,593,672.00	$461,327.00	$4,193,877.00
Design Costs	$0.00	$2,600,000.00	$0.00	$2,600,000.00
Public Art	$111,974.00	$83,432.00	$24,150.00	$219,556.00
Right-of-Way Allowance	$51,000.00	$38,000.00	$11,000.00	$100,000.00
Environmental Mitigation	$25,500.00	$19,000.00	$5,500.00	$50,000.00
Post-Design / As-Builts	$111,973.00	$83,432.00	$24,151.00	$219,556.00
Construction Engineering	$1,567,632.00	$1,168,039.00	$338,117.00	$3,073,788.00
Contingency (30%)	$3,359,211.00	$2,502,941.00	$724,536.00	$6,586,688.00
Total Funding	$18,563,538.00	$16,431,654.00	$4,003,900.00	$38,999,092.00

Area of Persistent Poverty

Tract 25.05
- 23.3% of people in this tract live in poverty

Tract 25.08
- 22.4% of people in this tract live in poverty

Tract 39.01
- 22.9% of people in this tract live in poverty

Tract 39.02
- 14.5% of people in this tract live in poverty

Figure 2: The percentage of individuals living in poverty per census tract, according to 2022 American Community Survey 5-Year Estimates.

The project area for the Drexel Road Bridge is composed of four census tracts located within Tucson, an urban area of Pima County, with a population greater than 200,000 (2020 Census). The project area is located in an area of persistent poverty in tracts 25.05, 25.08, 39.01 and 39.02 (CEJST, 2020 Census). Similarly, the project was located in four disadvantaged census tracts in 2010 (25.05, 25.06, 39.01, and 39.02; CEJST). The project meets the definition of being located in an area of persistent poverty as three of the four census tracts in the project area, as shown in

Figure 2, have a poverty rate of at least 20% as measured by the ***2022 American Community Survey 5-Year Estimates***.

Table 3 lists the four surrounding APP and HDC census tracts and the corresponding project cost. The City estimates the project investment per census tract is equal to one-quarter of the total project cost, or $9.75 million per census tract for a total project cost of $39 million for the Drexel Road Bridge project.

Table 3: APP and HDC Census Tracts and Project Costs

Census Tract(s)	Project Cost per Census Tract	Project Investment per Census Tract
[25.05] - 04019002505 (CEJST)	**$9,750,000**	**25%**
[25.08] - 04019002506 (CEJST)	**$9,750,000**	**25%**
[39.01] - 04019003901 (CEJST)	**$9,750,000**	**25%**
[39.02] - 04019003902 (CEJST)	**$9,750,000**	**25%**
	Total Project Cost: $39,000,000	**100%**

Table 4: Tucson, Arizona, meets the definition of an **urban area**, as verified by the *Census Designated Urban Areas with Population Greater Than 200,000 (2020 Census)* layer in the Grant Project Location Verification mapping tool, as Tucson has a population of 542,629 (2020 Census).[1] The total project cost will be expended in an urban area with a population greater than 200,000.

Table 4: Census Designated Urban Areas and Funding Justification

Urban/ Rural	Project Cost
Urban (2020 Census-designated urban area with a population greater than 200,000)	$39,000,000
Rural (Located outside of a 2020 Census-designated urban area with a population greater than 200,000)	$0
	Total Project Cost: $39,000,000

[1] https://www.census.gov/quickfacts/fact/table/tucsoncityarizona/PST045223

Project Readiness

Design on the Drexel Road Bridge project began in summer 2023 with data collection, survey, traffic analysis, and right-of-way. The City anticipates completing the initial Design Concept Report, marking 15% design, in March 2024. The project was able to advance as a result of a $15 million set-aside from the State of Arizona, demonstrating the importance of the project to the residents of the state and region. Although the project is not currently federally funded, the City began environmental activities consistent with the requirements of a National Environmental Policy Act (NEPA) environmental assessment (EA) to allow the City to deliver the project following a more aggressive pre-grant agreement timeline in the event federal funding through the RAISE grant is secured. The City is actively working with partners at Pima Association of Governments (PAG) to include the Drexel Road Bridge in the Transportation Improvement Program (TIP), so that the City may enter into an agreement with the Arizona Department of Transportation to formalize the environmental process. **The project is listed under TIP ID #47.23 in the Administrative Amendment #2022.082 (**See **TIP Amendment #2022.082**).

The project team is actively working on the following **environmental documents**:

- cultural report
- biological report
- aquatic resources report and delineation
- visual resources analysis
- air quality analysis
- noise analysis
- hazardous materials assessment

These initial reports are anticipated in March 2024. The reports will inform the EA that will be completed for the bridge project and may require updating prior to completion of the EA.

Project Schedule

The City has a pre-grant agreement timeline to ensure the project begins construction in a timely manner, consistent with all applicable local, state and federal requirements. Once the grant agreement has been executed and funding has been obligated, the City will be well-positioned to start the project and maintain the timeline to ensure all funds are expended by the expenditure deadline of September 30, 2033. Construction is anticipated to begin in **January 2026**, with construction activities lasting approximately 12 to 18 months. The City will take the necessary steps to obligate funding at least six months prior to the obligation deadline of September 30, 2028, to allow sufficient time for unanticipated delays. The project schedule is shown in **Figure 1**.

Project Timeline

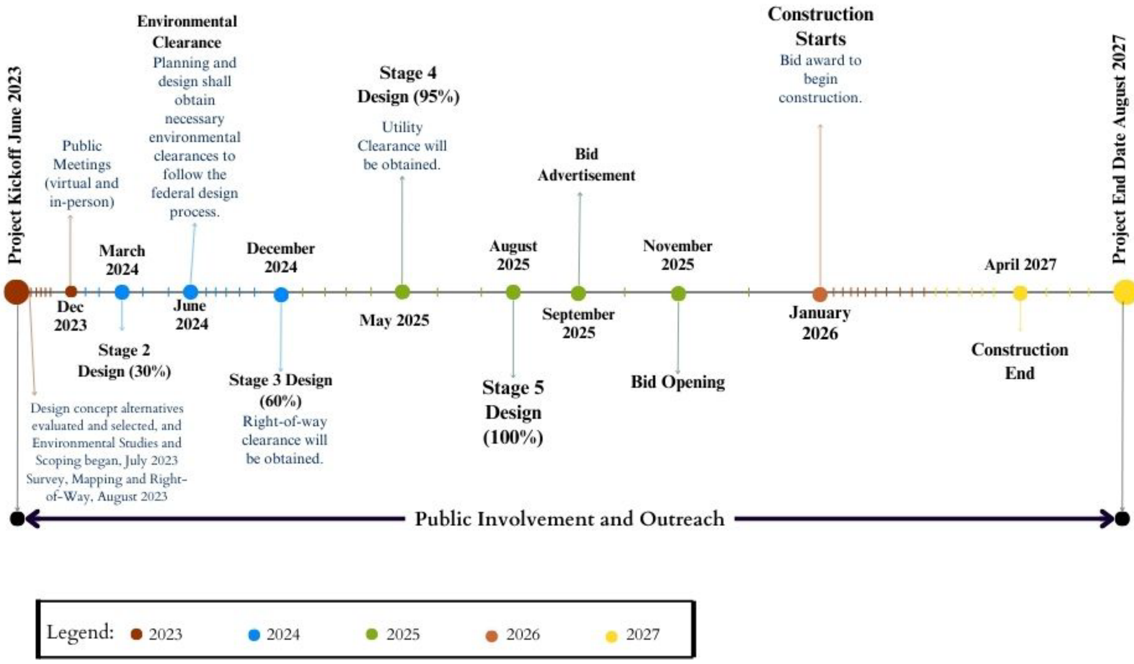

Figure 1: Project Schedule shows the timeline for the project, with construction activities anticipated to begin in January 2026.

Public Involvement and Outreach:

The City held public meetings in December 2023, both virtually and in-person, as shown in **Figure 2**, to provide options for residents who may have been unable to attend in person, All materials were provided in English and Spanish, and translation services were provided at both events. Recordings of the virtual meetings are available at https://drexelroadbridge.com/ under the **Events** page for anyone unable to attend the December 2023 meetings. The project team is

Figure 2: The City presented two design alternatives to the public at the in-person meeting held in December 2023.

meeting regularly with the most affected stakeholders, including the Midvale Park and Sunnyside Neighborhoods.

The in-person and virtual public meeting allowed the City staff to discuss the project with over 180 community members, present two design alternatives, and collect public input regarding the bridge design, including input on areas of opportunity and areas of concern related to the project, its location, and the quality of life of all individuals, particularly those experiencing historic disinvestment in and adjacent to south Tucson. The project team is committed to working closely with residents most directly affected by the project to develop any necessary mitigation strategies as a result of increased traffic, noise, and light closest to the project area. Additional in-person and virtual meetings will be held throughout the project's life cycle to allow for public involvement, allowing the City to directly address recommendations and issues identified through previous community engagement efforts.

All real property and Right-of-way acquisition

The City has determined existing right-of-way by checking existing plans, historic documents, property surveys, deeds, and existing property corners and right-of-way monumentation with assistance from the City's Department of Real Estate. The existing City right-of-way is 90 feet wide from Midvale Park Road to west of the Santa Cruz River and 150 feet wide from west of the Santa Cruz River to Calle Santa Cruz. Adjacent properties include private residences, private development, Pima Community College, Pima County Flood Control District, and the City. Minor acquisitions are anticipated but have not been delineated yet. Preliminary right-of-way delineation will occur prior to the 60% design plans. We anticipate most of the acquisitions to occur from Pima County Flood Control District parcels, however, there is a possibility that minor acquisitions from private property or Pima Community College would be needed at the intersection of Drexel Road and Calle Santa Cruz for turn-lane improvements.

Environmental Risk Assessment

The conceptual planning process and the City's past experience with similar projects have helped to identify potential risks that may arise during the life cycle of the Drexel Road Bridge project. The City has extensive experience complying with federal environmental requirements, including the National Environmental Policy Act (NEPA), and has worked with ADOT as a local public agency (LPA) partner to advance the environmental process for numerous City projects receiving federal funding. The City is currently establishing an intergovernmental agreement (IGA) with ADOT to allow ADOT to provide guidance and assistance with project delivery for the Drexel Road Bridge. ADOT's environmental planning department would also assist with reviewing environmental technical studies and ensure appropriate NEPA compliance. The City has completed field work and drafted environmental technical studies in the areas of cultural resources, biological resources, aquatic resources, visual resources, and hazardous materials. Existing conditions have been evaluated for the air quality and noise analyses, and those technical studies will be quickly completed when traffic data are available to complete the future conditions modeling. The EA is also being drafted in anticipation of federal funding. In addition to the City's collaboration with ADOT to advance the environmental documentation, coordination is expected with the U.S. Army Corps of Engineers for aquatic resources, with the U.S. Fish and Wildlife Service and Arizona Game and Fish Department for biological resources, and with the Arizona State Historic Preservation Office and other consulting parties, including local jurisdictions and tribes, for cultural resources. With the environmental studies well under way, the City has not identified any environmental issues that would delay the Drexel Road Bridge project's implementation.

State and Local Approvals

As mentioned above, the City received $15 million from the State of Arizona during the 2023 legislative session, demonstrating the significance of the project to the state and the region. The Drexel Road Bridge is included in PAG's 2022-2026 TIP Projects, with a TIP ID #47.23, approved under TIP Amendment #2022.082 on February 1, 2024. Given the proximity to Interstate 19 and an Arizona Department of Transportation (ADOT) project that is under active design at the Irvington Road traffic interchange, the City sought a Letter of Support from ADOT, and other organizations, for the Drexel Road Bridge project (see **Letters of Support**).

Assessment of Project Risks and Mitigation Strategies

Project risks, such as procurement delays, environmental uncertainties, increases in real estate acquisition costs, or any other issues can affect the likelihood of successful project start and completion. The following table identifies potential risks and mitigation strategies.

Risks	Impact	Likelihood	Mitigation Strategy
Obtaining Required Environmental Approvals	Moderate	Low	Environmental efforts for the Drexel Road Bridge project are well under way and most of the technical studies, along with the EA, have been drafted. No major issues have been identified that would delay environmental compliance approval.
Rising Cost of Construction	High	High	The City included a 30% construction contingency and a 19% inflation factor in the project budget to account for any unanticipated expenses that may arise during the project timeline.
Construction noise in a largely residential area	Moderate	Low	The City will ensure compliance with local noise ordinances and mitigate where warranted. The City will follow its public outreach procedures to inform and mitigate construction impacts for those living and traveling in the project area. Since a crossing of the Santa Cruz River is not in place now, construction impacts are anticipated to be minimal to local residents.
Transportation network impacts	Moderate	Low	Traffic volumes will increase on Drexel Road in the project vicinity but the benefits of increased mobility and connectivity for all modes of transportation will outweigh the disadvantages.

Technical Capacity

Federal Regulations: The Business Services Department provides financial and procurement services to the City, and the Shared Services Procurement Division is responsible for City contracting. The Business Services Department operates under the auspices of federal, state, and local law and regulations to ensure all public procurement practices follow the highest ethical standards, as described in the City Charter and the Tucson Procurement Code. Construction contracts for City projects are generally competitively bid through the Invitation for Bid (IFB) process and are awarded to the lowest responsive and responsible bidder but may also be competitively solicited through the Request for Qualification (RFQ) process and awarded to the most qualified offeror.[1] As mentioned in the **Merit Criteria Narrative**, the City recently passed a Prevailing Wage Ordinance to be applied to all City projects and will adhere to the federal standard for prevailing wages and will apply to trades that are subject to federal **Davis-Bacon Act and related** requirements. Through the procurement process, the City will be transparent about the conditions that must be met, including but not limited to fair employment practices, compliance with the Americans with Disabilities Act (ADA), compliance with the Civil Rights Act, certification regarding debarment from federal programs, and all requirements specific to USDOT projects including Build America, Buy America.

Project Planning: The Drexel Road Bridge project has been included in the Regional Mobility and Accessibility Plan published by PAG, the metropolitan planning organization serving southern Arizona, since 2003 (RMAP, ID# 6.03), demonstrating the project's significance to the region. The project has also been included in PAG's TIP, a five-year schedule and budget of proposed transportation improvements in eastern Pima County. The update process incorporates input from PAG member jurisdictions and other agencies that implement TIP projects to maximize the use of federal, state, and local funds and other resources to meet the region's multimodal needs. The Drexel Road Bridge project is included in TIP Amendment #2022.082, approved on February 1, 2024.

Federal Funding: Tucson Mayor Regina Romero has a vision of transforming Tucson into an equitable, sustainable, and thriving desert city, a goal made possible through leveraging multiple funding sources, including federal funding identified in the Inflation Reduction Act and the Bipartisan Infrastructure Law/Infrastructure Investment and Jobs Act. The City received $15 million from the State of Arizona during the 2023 legislative session for the Drexel Road Bridge project, has $2 million available from the Highway User Revenue Fund (HURF) and $2 million from City of Tucson Development Impact fees, for a total local match of $19 million (See **Funding Commitments**). With a total project cost of $39 million, the cost of the project is too great for the City to address the without external funding.

Project Delivery: The City will follow the timeline above to ensure the project begins construction in a timely manner, consistent with all applicable local, state and federal requirements. The design standards, financing structure and partnerships support a project that will reconnect two areas of south and west Tucson and expand multimodal access in an area with a high population of individuals experiencing historic disinvestment.

Benefit-Cost Analysis Technical Memorandum
RAISE Discretionary Grant Program

Drexel Road Bridge Project

City of Tucson

February 28th, 2024

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1 Executive Summary

The Drexel Road Bridge Project (the Project) seeks to fill a critical gap in the multimodal transportation system in Tucson, Arizona. This much needed infrastructure upgrade will reconnect communities experiencing historic disinvestment in south and west Tucson and address multiple transportation challenges in the area, including the lack of alternative modes of transportation, longer commutes for all including those using public transit due to traffic congestion, and safety concerns. The Project does so by providing more direct access to commercial and recreational opportunities through the construction of a two-lane bridge over the Santa Cruz River, extending Drexel Road from Midvale Park Road to Calle Santa Cruz, and providing more direct access to The “Chuck Huckelberry” Loop – one of the most extensive and celebrated shared-use path systems in the country.

The Drexel Road Bridge Project, shown in **Figure 1**, is located on the south side of Tucson, within an urban area of Pima County. The project location is approximately 1 mile north of Valencia Road, 1 mile south of Irvington Road, and ¼ mile west of Interstate 19 (I-19). The proposed bridge is a critical connection that will provide multimodal and climate change benefits to individuals experiencing historic disinvestment, offer better access to housing and economic opportunities, and maximize workforce development within the city. The additional connection will greatly enhance community safety, both by providing a safer alternative for pedestrians and cyclists to cross the Santa Cruz River, and by reducing vehicle miles traveled in Pima County, one of the top 50 counties in the United States with the highest rates of traffic fatalities as of 2023. The bridge will not only benefit individuals who currently use circuitous alternate routes to continue traveling east or west on Drexel Road, it will enhance access to businesses and recreational areas, fostering economic growth and providing more convenient access for individuals traveling via alternative, low-cost modes of transportation such as walking, cycling, and public transit. The project will include improvements to Drexel Road west of the proposed bridge, as well as upgrades to the intersections at Calle Santa Cruz and Midvale Park Road.

Figure 1: Drexel Road Bridge project area

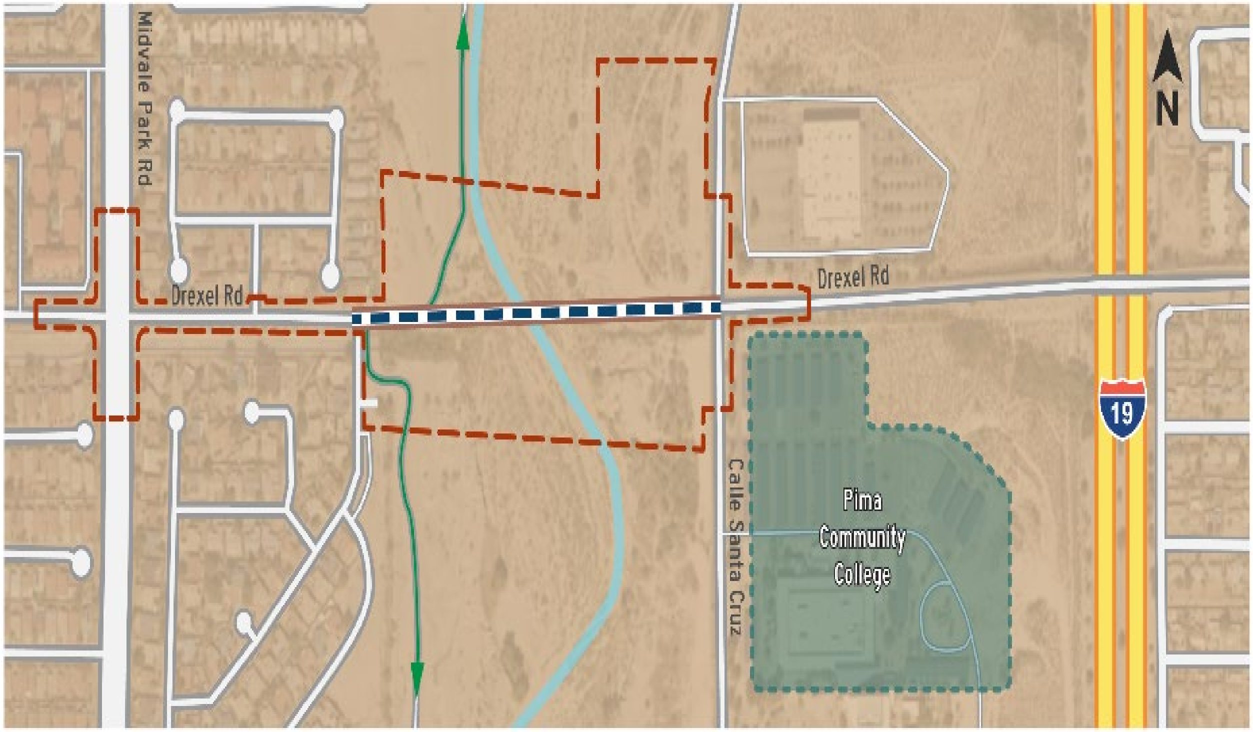


Table ES-1 summarizes the impacts and associated monetary benefits expected from the project through Benefit Cost Analysis (BCA).

Table ES-1: Summary of Infrastructure Improvements and Associated Benefits

Current Status (Base Scenario) & Problems to be Addressed	Changes to Baseline (Alternative Scenario)	Types of Impact	Population Affected by Impacts	Economic Benefits	Summary of Results (2022$, Discounted)
The closest existing east-west street connections across the Santa Cruz River are Irvington Road, located one mile north of Drexel Road, and Valencia Road, located one mile to the south. The lack of connectivity in combination with a growing population has resulted in excess congestion in the Project area. Additionally, the Project is located in an area with some of the highest accident rates in the United States. Currently, to cross the Santa Cruz River, pedestrians and cyclists must travel along either Valencia or Irvington Road, both of which are primary arterial roadways not well suited for active transportation.	Constructing the Drexel Road Bridge would solve a critical gap in the multimodal transportation system in Tucson, addressing multiple transportation challenges in the area. The Drexel Road Bridge project will alleviate congestion along these primary arterial roadways and provide a more direct route for local traffic and transit. As a result of these improvements, the Project is expected to generate significant societal benefits in the forms of reduced congestion, accidents, emissions, roadway wear-and-tear, and travel times for all roadway users. In addition, the Project is expected to reduce vehicle operating costs for roadway users, as well as operating costs for local transit agencies.	Reduction in accidents as result of fewer vehicle miles traveled in a region with a high historic collision rate. Also providing a route that is safer for pedestrians and cyclists.	Motorists	Avoided Accident Costs	**$18.6 M**
		Reduced travel time as a result of mitigated congestion and shorter travel distances.	Motorists, shippers, and local businesses and residents	Travel Time Savings	**$13.2 M**
		Avoided emissions from additional travel distance and idling vehicles.	Local residents and residents across the country	Avoided CAC Emissions	**$0.04 M**
		Avoided emissions from additional travel distance and idling vehicles.	Local residents and residents across the country	Avoided GHG Emissions	**$0.7 M**
		Reduction in vehicle operations costs from additional travel distances and vehicular idling.	Motorists, shippers, and local businesses and residents	Vehicle Operating Cost Savings	**$3.3 M**
		Shorter transit travel times as a result of a more efficient route.	Motorists	Transit Travel Time Savings	**$2.9 M**
		Reduced transit operating costs as a result of a more efficient route and less bus-miles traveled.	Local and state government, and project sponsors	Transit Operating Cost Savings	**$2.6 M**
		Reduced damage to roadway infrastructure associated with additional vehicle miles traveled, particularly by heavy vehicles such as trucks and buses.	Local and state government	Avoided Pavement Damage Costs	**$0.04 M**
		Alleviated congestion due to a third roadway in the Project area across the Santa Cruz River.	Motorists, shippers, and local businesses and residents	Avoided Congestion Costs	**$1.0 M**
		Reduce noise pollution associated with additional vehicle volumes	Local residents	Avoided Noise Costs	**$0.0 M**
		Residual value of capital assets	Project Sponsors	Residual Value of Assets	**$2.3 M**
		Maintenance costs associated with keeping new infrastructure assets in a state of good repair.	Project Sponsors	Incremental O&M Costs	**($1.1 M)**

**CO_2-related impacts are discounted at a real discount rate of 2 percent and all other impacts are discounted at a real discount rate of 3.1 percent per U.S. DOT BCA Guidance.*

The period of analysis used in the estimation of benefits and costs is 24 years, including 4 years of construction and planning and 20 years of operation beginning in 2028. The total project costs amount to $33.6 million dollars (2022$) in capital costs as shown in **Table ES-2** and **Table ES-3**.

Table ES-2: Annual Capital Expenditure, 2022 Dollars

Year	Capital Expenditure
2025	$4.1 M
2026	$14.7 M
2027	$14.7 M
Total	**$33.6 M**

The total project cost of $33.6 million used in the benefit-cost analysis differs from the $39.0 million presented in the project narrative for two reasons. Firstly, the BCA excludes the $4.2 million included in the cost estimate for inflation, and secondly, values are adjusted from 2023 to 2022 dollars using GDP deflators to ensure a meaningful comparison between monetized costs and benefits.

Table ES-3: Capital Expenditure by Project Component[1], 2022 Dollars

Component	Cost	Percentage of Cost
Construction Costs	$13.0 M	38.7%
Construction Costs - Bridge Structure	$8.2 M	24.4%
Right-of-Way	$0.1 M	0.3%
Public Art	$0.2 M	0.6%
Contingency & Soft Costs	$12.1 M	36.0%
Total	**$33.6 M**	**100%**

Based on the analysis presented in this document, the project is expected to generate **$43.7 million** in discounted benefits and **$29.4 million** in discounted costs, using a 2 percent real discount rate for CO_2-related impacts and a 3.1 percent real discount rate for all other impacts. Therefore, the project is expected to generate a Net Present Value of **$14.3 million** and a Benefit/Cost Ratio of **1.5[2].** Additional details, including the various assumptions and methodologies, are presented in the balance of this document.

Table ES-4: Overall Results of the Benefit Cost Analysis, 2022 Dollars

Evaluation Metrics	Undiscounted	Discounted
Total Benefits	$73.6 M	$43.7 M
Total Costs	$33.6 M	$29.4 M
Net Present Value (NPV)	$40.0 M	$14.3 M
Return on Investment (ROI)	119.2%	48.5%
Benefit-Cost Ratio (BCR)	2.2	1.5
Payback Period (years)	12.1 years	14.9 years
Internal Rate of Return (IRR)	6.6%	

[1] The benefit-cost analysis does not incorporate any escalation built into the cost estimate.

[2] When adjusted for equity considerations, the Project's BCR is increased to 2.1. See section 10 for full details.

The Drexel Road Bridge Project will alleviate congestion along primary arterial roadways and provide a more direct route for local traffic and transit. As a result of these improvements, the Project is expected to generate significant societal benefits in the forms of reduced congestion, accidents, emissions, roadway wear-and-tear, and travel times for all roadway users. In addition, the Project is expected to reduce vehicle operating costs for roadway users, as well as operating costs for local transit agencies. The monetized benefits are presented in **Table ES-5** below.

Table ES-5: Summary of Benefits

Impact Categories	NPV Over 20 Years of Operations	
	Undiscounted	Discounted
Benefits		
Avoided Accident Costs	$31.2 M	$18.6 M
Travel Time Savings	$22.1 M	$13.2 M
Avoided CAC Emissions	$0.07 M	$0.04 M
Avoided GHG Emissions	$0.9 M	$0.7 M
Vehicle Operating Cost Savings	$5.6 M	$3.3 M
Transit Travel Time Savings	$4.6 M	$2.9 M
Transit Operating Cost Savings	$4.1 M	$2.6 M
Avoided Pavement Damage Costs	$0.07 M	$0.04 M
Avoided Congestion Costs	$1.6 M	$1.0 M
Avoided Noise Costs	$0.03 M	$0.02 M
Residual Value of Assets	$5.0 M	$2.3 M
Incremental O&M Costs	($1.7 M)	($1.1 M)
PV Benefits	**$73.6 M**	**$43.7 M**
Costs		
Capital Cost	$33.6 M	$29.4 M
PV Costs	**$33.6 M**	**$29.4 M**
NPV	**$40.0 M**	**$14.3 M**
BCR	**2.2**	**1.5**

**GHG impacts are discounted at a 2% discount rate per US DOT BCA Requirements.*

2 Introduction

The balance of this document provides detailed technical information on the economic analyses conducted in support of the RAISE Grant Application for the Drexel Road Bridge Project.

Section 2 – Introduction: Outlines the BCA document layout and structure to assist USDOT reviewers.

Section 3 - Methodological Framework: Introduces the conceptual framework used in the Benefit-Cost Analysis (BCA).

Section 4 - Project Overview: Provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the Project is expected to generate.

Section 5 - General Assumptions: Discusses the general assumptions used in the estimation of project costs and benefits.

Section 6 – Demand Projections: Estimates of travel demand and traffic volumes.

Section 7 – Benefits Measurement, Data and Assumptions: Details the specific data elements and assumptions used to address the goals of the project and to comply with program requirements.

Section 8 – Summary of Findings and Benefit-Cost Outcomes: Estimates the Project's net present value (NPV), its benefit-cost ratio (BCR), and other project evaluation metrics.

Section 9 – Benefit Cost Sensitivity Analysis: Provides the outcomes of the sensitivity analysis that evaluates the different assumptions made by the City and the impact that the variability of those assumptions may have on the overall project.

Section 9 – Social Equity Value Analysis: Estimates the project's weighted net present value and (wNPV), weighted benefit-cost ratio (wBCR) to account for equity adjustments to the Project's benefits and costs to reflect how they are distributed among individuals in different income quintiles.

3 Methodological Framework

The Benefit Cost Analysis (BCA) conducted for this Project includes monetized benefits and costs measured using U.S. Department of Transportation (U.S. DOT) guidance, *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, as well as the quantitative and qualitative merits of the Project. A BCA provides estimates of the benefits expected to accrue over a specified period and compares them to the anticipated costs. Costs include both the resources required to develop the Project and the costs of maintaining the new or improved asset over time. Estimated benefits are based on the projected impacts of the Project on both users and non-users of the facility, valued in monetary terms.[3]

While a BCA is just one of the tools that can be used in making decisions about infrastructure investments, U.S. DOT believes that it provides a useful benchmark from which to evaluate and compare potential transportation investments.[4]

The specific methodology employed for this application is developed using the BCA guidance developed by U.S. DOT and is consistent with the RAISE program guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the Base Case (No Build) and Alternative Case (Build) scenarios;
- Assessing benefits with respect to each of the merit criteria identified in the Notice of Funding Opportunity (NOFO);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using U.S. DOT guidance for the valuation of safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by the U.S. DOT (3.1 percent); and,
- Conducting a sensitivity analysis to assess the impacts of changes in key assumptions.

[3] *U.S. DOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, December 2023.*

[4] Ibid.

4 Project Overview

The Drexel Road Bridge Project (the Project) seeks to fill a critical gap in the multimodal transportation system in Tucson, Arizona. This much needed infrastructure upgrade will reconnect communities experiencing historic disinvestment in south and west Tucson and address multiple transportation challenges in the area, including the lack of alternative modes of transportation, longer commutes for all including those using public transit due to traffic congestion, and safety concerns. The Project does so by providing more direct access to commercial and recreational opportunities through the construction of a two-lane bridge over the Santa Cruz River, extending Drexel Road from Midvale Park Road to Calle Santa Cruz, and providing more direct access to The “Chuck Huckelberry” Loop – one of the most extensive and celebrated shared-use path systems in the country.

The Drexel Road Bridge Project is located on the south side of Tucson, within an urban area of Pima County. The project location is approximately 1 mile north of Valencia Road, 1 mile south of Irvington Road, and ¼ mile west of Interstate 19 (I-19). The proposed bridge is a critical connection that will provide multimodal and climate change benefits to individuals experiencing historic disinvestment, offer better access to housing and economic opportunities, and maximize workforce development within the city. The additional connection will greatly enhance community safety, both by providing a safer alternative for pedestrians and cyclists to cross the Santa Cruz River, and by reducing vehicle miles traveled in Pima County, one of the top 50 counties in the United States with the highest rates of traffic fatalities as of 2023. The bridge will not only benefit individuals who currently use circuitous alternate routes to continue traveling east or west on Drexel Road, it will enhance access to businesses and recreational areas, fostering economic growth and providing more convenient access for individuals traveling via alternative, low-cost modes of transportation such as walking, cycling, and public transit. The project will include improvements to Drexel Road west of the proposed bridge, as well as upgrades to the intersections at Calle Santa Cruz and Midvale Park Road.

4.1 Base Case and Alternative Case

4.1.1 Base Case

The Base Case for Drexel Road Bridge Project is defined as the No Build scenario. In the Base Case, the Drexel Road Bridge is not constructed, and the gap in the multimodal transportation system remains unfilled. As population in Tucson continues to grow, Irvington and Valencia Roads become increasingly congested, resulting in additional vehicle hours and miles traveled by local residents, generating more emissions, accidents, and out-of-pocket expenses related to vehicle maintenance. Furthermore, the immediate Project area, comprised of four historically disadvantaged census tracts continue to be underserved by public transportation, and must continue to travel further distances to complete essential trips.

4.1.2 Alternative Case

The Alternative Case is defined as the Build scenario. In the Build case, the Drexel Road Bridge is constructed. A critical gap in the multimodal transportation system in Tucson is filled, addressing multiple transportation challenges in the area. The Drexel Road Bridge project will alleviate congestion along these primary arterial roadways and provide a more direct route for local traffic and transit. As a result of these improvements, the Project is expected to generate significant societal benefits in the forms of reduced congestion, accidents, emissions, roadway wear-and-tear, and travel times for all roadway users. In addition, the Project is expected to reduce vehicle operating costs for roadway users, as well as operating costs for local transit agencies.

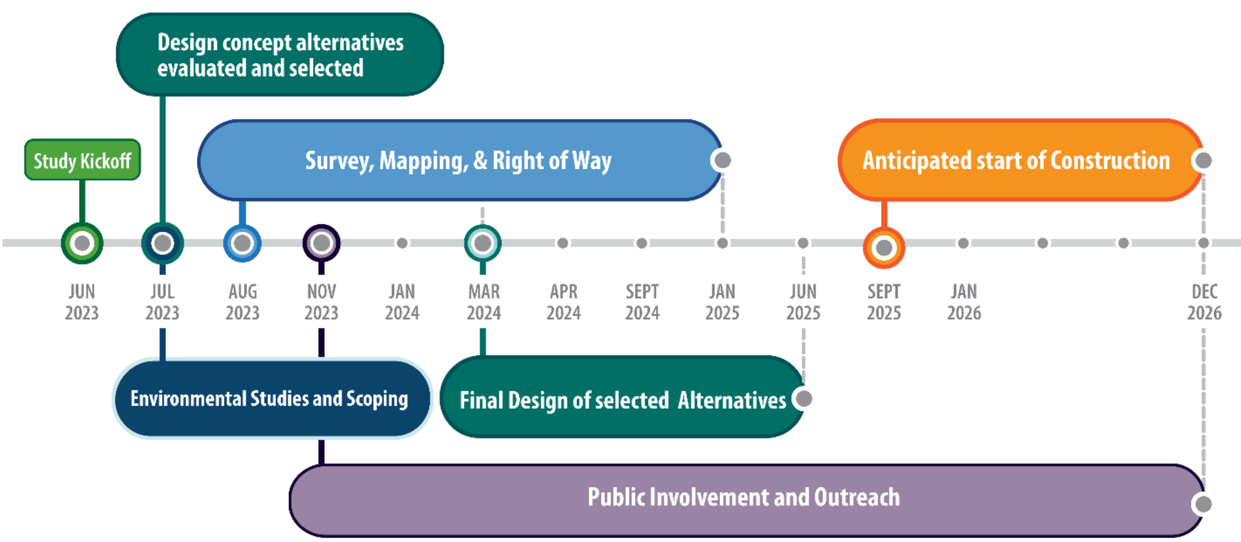
4.2 Project Cost and Schedule

Table 1 summarizes the total project cost including previously incurred costs and **Figure 2** shows the project schedule with substantial completion expected at the end of 2027, and the first full year of benefits occurring in 2028.

Table 1: Total Project Cost Components, 2022 Dollars

Component	Cost	Percentage of Cost
Construction Costs	$13.0 M	38.7%
Construction Costs - Bridge Structure	$8.2 M	24.4%
Right-of-Way	$0.1 M	0.3%
Public Art	$0.2 M	0.6%
Contingency & Soft Costs	$12.1 M	36.0%
Total	**$33.6 M**	**100%**

Figure 2: Project Schedule



4.3 Merit Criteria

The main benefit categories associated with the project are mapped into the merit criteria set forth by U.S. DOT in **Table 2**.

Table 2: Expected Effects on Merit Criteria Outcomes and Benefit Categories

Merit Criteria	Benefit Category	Description	Monetized	Qualitative
Economic Competitiveness	Travel Time Savings	Reduced travel time as a result of mitigated congestion and shorter travel distances.	Yes	-
	Vehicle Operating Cost Savings	Reduction in vehicle operations costs from additional travel distances and vehicular idling.	Yes	-
	Transit Travel Time Savings	Shorter transit travel times as a result of a more efficient route.	Yes	-
	Transit Operating Cost Savings	Reduced transit operating costs as a result of a more efficient route and less bus-miles traveled.	Yes	-
	Avoided Congestion Costs	Alleviated congestion due to a third roadway in the Project area across the Santa Cruz River.	Yes	-
	Avoided Noise Costs	Reduce noise pollution associated with additional vehicle volumes.	Yes	-
Safety	Avoided Accident Costs	Reduction in accidents as result of fewer vehicle miles traveled in a region with a high historic collision rate. Also providing a route that is safer for pedestrians and cyclists.	Yes	-
Environmental Sustainability	Avoided CAC Emissions	Avoided emissions from additional travel distance and idling vehicles.	Yes	-
	Avoided GHG Emissions	Avoided emissions from additional travel distance and idling vehicles.	Yes	-
State of Good Repair	Incremental O&M Costs	Maintenance costs associated with keeping new infrastructure assets in a state of good repair.	Yes	-
	Residual Value of Assets	Residual value of capital assets	Yes	-
	Avoided Pavement Damage Costs	Reduced damage to roadway infrastructure associated with additional vehicle miles traveled, particularly by heavy vehicles such as trucks and buses.	Yes	-
Mobility and Community Connectivity	Increase Connectivity Between Communities	Improve Connectivity of Communities with Improved Transit Infrastructure.	-	Yes

5 General Assumptions

The BCA measures benefits against costs throughout a period of analysis, beginning at the start of construction and 4 years of construction activity, and including 20 full years of operations.

The monetized benefits and costs are estimated in 2022 dollars, with future dollars discounted in compliance with U.S. DOT RAISE requirements.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2022 dollars;
- The period of analysis begins in 2024 and ends in 2047; it includes project development and construction years (2024–2027) and 20 full years of operations (2028–2047); and,
- A constant 2 percent real discount rate for carbon dioxide (CO_2)-related benefits and 3.1 percent real discount rate for all other benefits are assumed throughout the period of analysis.

6 Demand Projections

Accurate demand projections are important to effectively estimate the benefits in a BCA. Demand projections for this project are estimated based on traffic demand modeling completed by Kittelson & Associates. Transit ridership is provided directly by the City of Tucson.

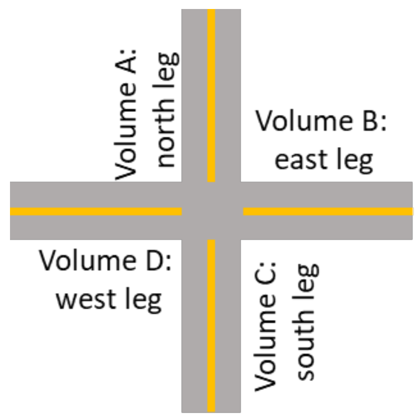
6.1 Methodology

6.1.1 Yearly Volumes for Drexel Road, Irvington, and Valencia Road

To perform the safety and travel analysis, volumes for the relevant roadways are gathered for the base year (2019) and for a future year (2045) for two conditions: No Build (roadway network without Drexel Road Bridge) and Build (roadway network with Drexel Road Bridge). The 2019 and 2045 No-Build and Build volumes are obtained from the regional travel demand model prepared by the Pima Association of Governments (PAG).

Roadway Segment and Intersection Volumes

Roadway segment volumes are obtained directly from the PAG travel demand model. Estimating intersection volumes requires an additional analysis step: two-way volumes from segments immediately north and south of each intersection are averaged together to determine an average two-way volume. This same method is used to determine the west-east average two-way volume. The average two-way north-south and west-east volumes from 2019 and 2045 are then interpolated to estimate 2030 volumes.



(Volume A + Volume C) / 2 = average two-way north-south volume.
(Volume B + Volume D) / 2 = average two-way west-east volume.

6.1.2 Vehicle Hours Traveled

To perform the travel time analysis, vehicle hours traveled (VHT) data is gathered for the south-west and south- central areas of the city of Tucson. VHT data is obtained from the PAG travel demand model. The collected data includes the base year (2019) and a future boundary year (2045) for two conditions: No-Build (roadway network without Drexel Road Bridge) and Build (roadway network with Drexel Road Bridge). The study area utilized for the travel time analysis is defined as follows:

- Irvington Road to the North (Irvington Road is included in the analysis)
- Mission Road to the West (Mission Road is not included in the analysis)
- Valencia Road to the South (Valencia Road is Included in the analysis)
- I-19 to the East (I-19 is not included in the analysis)

This area represents the roadways primarily impacted by the proposed bridge project. This area includes west-east and north-south roadways within 1-mile of the proposed bridge site.

Within the study roadway area outlined previously, the sum of the segment VHT for the 2019 base, 2045 No-Build and 2045 Build scenarios is calculated using the PAG travel demand model outputs. The VHT outputs from the model in 2019 and 2045 are provided in **Table 3.**

Table 3: PAG Travel Demand Model Outputs for Study Area

PAG Travel Demand Model Scenario	VHT (Daily)
Base Year 2019	4,981
No-Build 2045	6,370
Build 2045	6,188

Utilizing the model outputs, the yearly (Annual Weekday) VHT is calculated accounting for 261 annual weekdays. The annual weekday VHT for each year between 2019 and 2045 is linearly interpolated to determine each year's annual VHT. The Annual (weekday) VHT is then converted into passenger vehicle and truck totals. The 2019 and 2045 PAG travel demand models are used to determine a truck percentage of approximately 4% across the roadway network.

6.2 Demand Projections

The resulting projections for vehicle miles traveled, vehicle hours traveled and transit ridership volumes in both the Build and No-Build scenarios are summarized in **Table 4**, and all assumptions used to calculate transit benefits are found in **Table 5**.

Table 4: Demand Projections

Category	Units	2028 (first year of benefits)	2037	2047
Route 27 Ridership (Annual)	passengers/year	103,334	109,006	114,308
Vehicle-Miles Traveled - No Build	vmt/year	43,612,002	46,632,996	49,989,657
Vehicle-Miles Traveled - Build	vmt/year	43,365,492	46,139,978	49,222,739
Vehicle-Hours Traveled - No Build	vht/year	1,425,547	1,550,974	1,690,338
Vehicle-Hours Traveled - Build	vht/year	1,409,131	1,518,143	1,639,267

Table 5: Assumptions used in Calculation of Transit Benefits

Variable	Units	Value	Source
Average Route 27 Ridership	passengers/day	383	Weekday average passengers impacted by Route 27 change. Calculated based on average of North/South lines, between October 1, 2023, and December 31, 2023.
Transit Ridership Growth Rate	%	Varies by Year	Based on population projections for Pima County from Arizona Office of Economic Opportunity. December 2022.
Route 27 Trips (one-direction)	trips/day	44	Sun Tran service schedule. 23 Northbound, 21 southbound. https://www.suntran.com/routes-services/find-my-bus/
Transit Length (No Build)	miles	2.6	Sun Tran. Between Midvale Park/Drexel and Pima College Desert Vista Campus, average of Route 27 Northbound and Southbound.
Transit Length (Build)	miles	0.6	Sun Tran. Modified route across bridge between Midvale Park/Drexel and Pima College Desert Vista Campus average of Route 27 Northbound and Southbound.
Average Transit Speed	miles/hour	19.2	Sun Tran. Route 27, NB and SB average

7 Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each benefit or impact category identified in **Table ES-5** and provides an overview of the associated methodology, assumptions, and estimates. The assumptions in **Table 6** are used in the estimation of all benefits.

Table 6: General Assumptions used in the Benefit-Cost Analysis

Variable Name	Unit	Value	Source
Discount Rate	%	3.1%	U.S. DOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs
Discount Rate (CO_2)	%	2.0%	
Annualization Factor	days	261	Weekdays per year
Construction Start Year	year	2024	Project Schedule
Construction End Year	year	2027	Project Schedule
First Year of Benefits	year	2028	Project Schedule
Truck Share of Traffic	%	4%	City of Tucson

7.1 Safety Outcomes

Accident costs and impacts on life, limb, and property are a significant component of road user costs. Road safety is a key economic factor in the planning of roads, as well as an important indicator of transportation efficiency, while outside the economic context, highway safety is often the subject of public concern.

7.1.1 Methodology

The safety analysis was completed by Kittelson & Associates using Safety Performance Functions (SPF) to estimate the number of Property Damage Only (PDO) and fatal/injury crashes over the analysis period. Two tools are used to perform the safety analysis:

- HiSafe, companion software to the AASHTO Highway Safety Manual (HSM), is used to calculate the safety benefits for Drexel Road and Irvington Road.
- NCHRP 26515 Analysis Tool, a tool developed as part of the Safety Prediction Models for Six-Lane and On-Way Urban and Suburban Arterials, is used to perform the safety analysis for Valencia Road.

Within both tools, for each location, key roadway features are used to estimate crash and injury frequency. These inputs include, but are not limited to, characteristics such as the following:

- Area characteristics (urban/suburban, number of bus stops, number of schools, number of alcohol sales establishments).
- Segment characteristics (number of lanes, averaged daily traffic, segment length, posted speed, median width, roadside object density).
- Intersection characteristics (number of legs, presence of lighting, number of lanes, approaches with left/right turn lanes, average daily traffic).

Both tools output the estimated total number of PDO crashes and total number of fatal and injury crashes over the one-year span. At all locations, it is assumed that 2.67% of the fatal and injury crashes are fatal crashes. This proportion is determined by analyzing the 2018 through 2022 ADOT crash data in the vicinity of the bridge and computing the percentage of fatalities in fatal and injury crashes.

In general, the Build Alternative is anticipated to improve safety on key arterials in the project area. By providing an east-west connection across the Santa Cruz River via Drexel Road, vehicular volumes on nearby arterials would decrease, enhancing safety on the segments and intersections on Valencia Road and Irvington Road.

7.1.2 Assumptions

The Project is expected to generate substantial benefits for the Safety merit criteria, with the specific benefits described below. The safety benefits are monetized using the assumptions presented in **Table 7**.

Table 7: Assumptions used to Monetize Safety Benefits

Variable	Units	Value	Source
Cost of Fatalities	2022$/fatality	$12,500,000	Treatment of the Economic Value of Preventing Fatalities and Injuries in Preparing Economic Analyses (2022).
Cost of Incapacitating Injuries	2022$/injury	$1,188,200	
Cost of Non-Incapacitating Injuries	2022$/injury	$2,333,800	
Cost of Possible Injuries	2022$/injury	$111,700	
Cost of Injuries (Severity Unknown)	2022$/injury	$217,600	
Cost of Fatal Crashes	2022$/crash	$14,022,900	The Economic and Societal Impact of Motor Vehicle Crashes, 2019 (revised February 2023), Page 46, Table 2-9, Incidence Summary" Inflated to 2022 dollars using the GDP deflator.
Cost of Injury Crashes	2022$/crash	$313,000	
Cost of PDO Crashes	2022$/crash	$9,100	

7.1.3 Benefit Estimates

Table 8 highlights the benefits generated by the Project. The estimated present value of discounted benefits over a 20-year period is $18.6 million.

Table 8: Estimates of Safety Benefits

Values in 2022$	Over the Study Period	
	Undiscounted	Discounted
Avoided Accident Costs	$31.2 M	$18.6 M
Total	**$31.2 M**	**$18.6 M**

7.2 Environmental Sustainability Outcomes

Environmental costs are an important component in the evaluation of transportation projects. The primary environmental impact of vehicle use is exhaust emissions, which impose wide-ranging social costs on people, material, and vegetation. The negative effects of pollution depend not only on the quantity of pollution produced, but also on the types of pollutants emitted as well as the local environmental conditions.

7.2.1 Reduced Air Emissions

Emissions associated with roadway travel under No Build and Build scenarios are estimated based on the travel distances and emission factors on a per mile basis for each pollutant (CO_2, NO_X, VOC, $PM_{2.5}$, and SO_2). To obtain the expected emission costs, the volume of each pollutant is then converted to tons and multiplied by its monetary value (per metric ton). The difference in emission costs between No Build and Build scenarios represent total emission cost savings.

The BCA quantifies Environmental Sustainability outcomes by estimating and monetizing the net reduction in emissions due to the construction of the Project, where the assumptions used to monetize the reduction in emissions are summarized in **Table 9** through **Table 12.**

Table 9: Assumptions used in the Estimation of Environmental Benefits – Emission Values

Year	Emissions Value ($/metric ton)					Source
	CO2	NOx	PM2.5	SO2	VOC	
2024	$233	$20,100	$963,200	$53,800	$0	Technical Support Document: Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors (February 2018)" https://www.epa.gov/sites/default/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf NOX, SOX, and PM2.5 values are inflated from 2015 to 2022 dollars using the GDP deflator. CO2 values are inflated from 2020 to 2022 dollars using the GDP deflator. EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances (November 2023) **Note:** Fuel saved (gasoline, diesel, natural gas, etc.) can be converted into metric tons of emissions using EPA guidelines available at https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references **Note:** The recommended values for reducing CO2 emissions reported in Table A-6 represent the values of future economic damages that can be avoided by reducing emissions in each future year by one metric ton. After using per-ton values to estimate the total value of reducing CO2 emissions in any future year, the result must be further discounted to its present value as of the analysis year used in the BCA, also using a 2.0 percent discount rate.
2025	$237	$20,300	$975,500	$54,800	$0	
2026	$241	$20,600	$993,500	$56,100	$0	
2027	$245	$21,000	$1,011,900	$57,400	$0	
2028	$250	$21,300	$1,030,600	$58,700	$0	
2029	$253	$21,700	$1,049,600	$60,100	$0	
2030	$257	$22,000	$1,069,000	$61,500	$0	
2031	$262	$22,000	$1,069,000	$61,500	$0	
2032	$265	$22,000	$1,069,000	$61,500	$0	
2033	$270	$22,000	$1,069,000	$61,500	$0	
2034	$274	$22,000	$1,069,000	$61,500	$0	
2035	$278	$22,000	$1,069,000	$61,500	$0	
2036	$282	$22,000	$1,069,000	$61,500	$0	
2037	$287	$22,000	$1,069,000	$61,500	$0	
2038	$290	$22,000	$1,069,000	$61,500	$0	
2039	$294	$22,000	$1,069,000	$61,500	$0	
2040	$299	$22,000	$1,069,000	$61,500	$0	
2041	$303	$22,000	$1,069,000	$61,500	$0	
2042	$308	$22,000	$1,069,000	$61,500	$0	
2043	$312	$22,000	$1,069,000	$61,500	$0	
2044	$317	$22,000	$1,069,000	$61,500	$0	
2045	$321	$22,000	$1,069,000	$61,500	$0	
2046	$326	$22,000	$1,069,000	$61,500	$0	
2047	$331	$22,000	$1,069,000	$61,500	$0	
2048	$336	$22,000	$1,069,000	$61,500	$0	
2049	$340	$22,000	$1,069,000	$61,500	$0	
2050	$345	$22,000	$1,069,000	$61,500	$0	

Table 10: Assumptions used in the Estimation Environmental Sustainability Benefits – Autos

Emissions per Gallon of Fuel Burned - Autos (grams/miles)						
Year	NOx	VOC	PM2.5	SO_2	CO_2	Source/Comment
2024	0.098	0.026	0.002	0.0018	270.5	Based on MOVES average annual emission factors for trucks in Pima County, AZ. Moves model run in February 2024.
2025	0.086	0.023	0.002	0.0018	264.3	
2026	0.074	0.021	0.002	0.0017	258.1	
2027	0.062	0.018	0.001	0.0017	251.9	
2028	0.050	0.015	0.001	0.0016	245.6	
2029	0.038	0.013	0.001	0.0016	239.4	
2030	0.026	0.010	0.001	0.0015	233.2	
2031	0.024	0.009	0.001	0.0015	230.9	
2032	0.022	0.009	0.001	0.0015	228.6	
2033	0.020	0.009	0.001	0.0015	226.4	
2034	0.018	0.008	0.001	0.0015	224.1	
2035	0.016	0.008	0.001	0.0015	221.8	
2036	0.013	0.007	0.001	0.0015	219.5	
2037	0.011	0.007	0.001	0.0014	217.3	
2038	0.009	0.007	0.001	0.0014	215.0	
2039	0.007	0.006	0.001	0.0014	212.7	
2040	0.005	0.006	0.001	0.0014	210.4	
2041	0.005	0.006	0.001	0.0014	210.0	
2042	0.004	0.006	0.001	0.0014	209.6	
2043	0.004	0.006	0.001	0.0014	209.1	
2044	0.004	0.006	0.001	0.0014	208.7	
2045	0.004	0.006	0.001	0.0014	208.3	
2046	0.004	0.006	0.001	0.0014	207.8	
2047	0.004	0.006	0.001	0.0014	207.4	
2048	0.003	0.006	0.001	0.0014	207.0	
2049	0.003	0.005	0.001	0.0014	206.6	
2050	0.003	0.005	0.001	0.0014	206.1	

Table 11: Assumptions used in the Estimation Environmental Sustainability Benefits – Bus

Emissions per Gallon of Fuel Burned - Transit Bus (grams/miles)						
Year	NOx	VOC	PM2.5	SO_2	CO_2	Source/Comment
2024	3.119	0.130	0.035	0.0047	1,404.7	Based on MOVES average annual emission factors for trucks in Pima County, AZ. Moves model run in February 2024.
2025	3.006	0.118	0.032	0.0047	1,390.7	
2026	2.894	0.106	0.028	0.0046	1,376.8	
2027	2.782	0.094	0.024	0.0046	1,362.9	
2028	2.670	0.082	0.021	0.0045	1,348.9	
2029	2.558	0.070	0.017	0.0045	1,335.0	
2030	2.446	0.058	0.014	0.0044	1,321.1	
2031	2.409	0.055	0.013	0.0044	1,311.6	
2032	2.373	0.052	0.012	0.0043	1,302.2	
2033	2.336	0.048	0.011	0.0043	1,292.8	
2034	2.300	0.045	0.010	0.0043	1,283.3	
2035	2.263	0.042	0.009	0.0043	1,273.9	
2036	2.227	0.039	0.008	0.0042	1,264.4	
2037	2.190	0.035	0.007	0.0042	1,255.0	
2038	2.153	0.032	0.006	0.0042	1,245.6	
2039	2.117	0.029	0.005	0.0041	1,236.1	
2040	2.080	0.026	0.004	0.0041	1,226.7	
2041	2.074	0.025	0.004	0.0041	1,223.2	
2042	2.068	0.025	0.004	0.0041	1,219.8	
2043	2.062	0.025	0.004	0.0041	1,216.3	
2044	2.056	0.025	0.004	0.0040	1,212.9	
2045	2.050	0.024	0.004	0.0040	1,209.4	
2046	2.044	0.024	0.004	0.0040	1,206.0	
2047	2.038	0.024	0.004	0.0040	1,202.5	
2048	2.032	0.023	0.004	0.0040	1,199.1	
2049	2.026	0.023	0.004	0.0040	1,195.6	
2050	2.020	0.023	0.004	0.0040	1,192.2	

Table 12: Assumptions used in the Estimation Environmental Sustainability Benefits – Truck

Emissions per Gallon of Fuel Burned - Trucks (grams/miles)						
Year	**NOx**	**VOC**	**PM2.5**	**SO_2**	**CO_2**	**Source/Comment**
2024	2.971	0.113	0.065	0.0041	1,214.3	Based on MOVES average annual emission factors for trucks in Pima County, AZ. Moves model run in February 2024.
2025	2.836	0.104	0.059	0.0040	1,193.8	
2026	2.701	0.094	0.052	0.0039	1,173.2	
2027	2.566	0.084	0.045	0.0039	1,152.7	
2028	2.431	0.075	0.039	0.0038	1,132.2	
2029	2.295	0.065	0.032	0.0037	1,111.7	
2030	2.160	0.055	0.025	0.0036	1,091.2	
2031	2.138	0.053	0.024	0.0036	1,082.7	
2032	2.115	0.052	0.023	0.0036	1,074.3	
2033	2.093	0.050	0.022	0.0036	1,065.9	
2034	2.071	0.048	0.021	0.0035	1,057.4	
2035	2.048	0.047	0.020	0.0035	1,049.0	
2036	2.026	0.045	0.019	0.0035	1,040.5	
2037	2.003	0.043	0.018	0.0034	1,032.1	
2038	1.981	0.041	0.017	0.0034	1,023.7	
2039	1.959	0.040	0.016	0.0034	1,015.2	
2040	1.936	0.038	0.015	0.0034	1,006.8	
2041	1.932	0.038	0.015	0.0034	1,005.4	
2042	1.929	0.038	0.015	0.0033	1,004.0	
2043	1.925	0.037	0.015	0.0033	1,002.7	
2044	1.921	0.037	0.015	0.0033	1,001.3	
2045	1.917	0.037	0.015	0.0033	999.9	
2046	1.913	0.037	0.014	0.0033	998.5	
2047	1.909	0.036	0.014	0.0033	997.2	
2048	1.905	0.036	0.014	0.0033	995.8	
2049	1.901	0.036	0.014	0.0033	994.4	
2050	1.897	0.036	0.014	0.0033	993.0	

7.2.2 Benefit Estimates

Table 13 shows the benefit estimates of reducing vehicle delay times and associated emissions. The estimated present value of discounted benefits over a 20-year period is just over $0.7 million.

Table 13: Estimates of Environmental Sustainability Benefits

Values in 2022$	Over the Study Period	
	Undiscounted	Discounted
Avoided CAC Emissions	$0.1 M	$0.04 M
Avoided GHG Emissions	$0.9 M	$0.7 M
Total	**$1.0 M**	**$0.7 M**

7.3 Economic Competitiveness and Opportunity

This Project is expected to improve the economic competitiveness of the region by creating an alternative route to traverse the Santa Cruz River, resulting in a decrease in travel times, vehicle operating costs, congestion costs, and noise pollution costs.

7.3.1 Travel Time Savings

The Drexel Road Bridge Project will generate travel time savings for motorists (automobiles, trucks, and transit users) as a combined result of the more efficient travel route across the Santa Cruz River, and reduced congestion in the Project area.

Vehicle hours traveled for both the Build and No Build scenarios are derived as described in **Section 6**, and then monetized using DOT guidance for value of time of automobile drivers and passengers, as well as heavy vehicle truck drivers. Transit travel time is calculated as a function of travel distance and travel speeds, also provided in **Section 6**, Out-of-pocket vehicle operating cost savings will accrue from decreased vehicle miles traveled and associated per-mile vehicle operating costs.

Value of time for vehicle type, as well as occupancy assumptions for both automobiles and trucks are available in the Benefit-Cost Analysis Guidance for Discretionary Grant Applications published by U.S. DOT. The estimate for travel time savings is the product of hours of delay, vehicle occupancy, and respective value of time.

The assumptions used in the estimation of travel time savings benefits are summarized in the **Table 14**.

Table 14: Assumptions used in the Estimation of Travel Time Savings

Variable	Units	Value	Source
Average Vehicle Occupancy	persons/vehicle	1.67	2017 National Household Travel Survey. As recommended by Benefit-Cost Analysis Guidance for Discretionary Grant Programs. U.S. Department of Transportation. December 2023.
Average Truck Occupancy	persons/vehicle	1	Assumption
Value of Time - Automobile	2022$/hour	$19.60	Office of the Secretary. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. U.S. Department of Transportation. December 2023.
Value of Time - Truck Driver	2022$/hour	$33.50	
Truck Share of Traffic	%	4%	City of Tucson.

7.3.2 Reduced Vehicle Operating Costs

In addition to travel time impacts, the analysis also accounts for incremental savings in vehicle operating costs between Build and No Build scenarios, which stems from reduced roadway travel distances.

Vehicle operating costs are a function of distance traveled and the unit rate of vehicle operating costs, which accounts for gasoline, maintenance costs, tires, and vehicle depreciation. The difference in operational costs between No Build and Build scenarios represent total operating cost savings.

The assumptions used in the estimation of reduced vehicle operating costs are summarized in **Table 15**.

Table 15: Assumptions used in the Estimation of Vehicle Operating Cost Savings

Variable	Units	Value	Source
Vehicle Operating Costs - Autos	2022$/mile	$0.52	American Automobile Association, Your Driving Costs – 2022 Edition (2022).
Vehicle Operating Costs - Trucks / Bus	2022$/mile	$1.32	American Transportation Research Institute, An Analysis of the Operational Costs of Trucking: 2023 Update.

7.3.3 Reduced Transit Operating Costs

The existing path taken by Sun Tran's Route 27 service is 2.6 miles between the stops east of the bridge at Pima College Desert Vista Campus and west of the Bridge near Midvale Park Road and Drexel Road. As a result of the Project, this route would only be approximately 0.6 miles long, a delta of 2.1 miles between the Build and No Build scenarios. In e-mail correspondence with Sun Tran, it is noted that this time and mileage savings would result in approximately $211,000 (2023 Dollars) annually.

7.3.4 Reduced Noise and Congestion Costs

The completion of the Project is expected to reduce the costs of noise and congestion relating to residents living in proximity to the alternative routes across the Santa Cruz River. The analysis estimates these costs by involving the per mile monetization values from the 2023 U. S. DOT BCA guidance and the total vehicle miles in both No Build and Build scenarios. Comparing these two cases provides the total reduction in noise and congestion costs by the Project.

Table 16 highlights the assumptions used in the estimation of the reduction in noise pollution and congestion costs.

Table 16: Assumptions used in the Estimations of Reduced Noise and Congestion Costs

Variable	Units	Value	Source
Congestion Cost - Autos (Urban)	2022$/mile	$0.14	Office of the Secretary. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. U.S. Department of Transportation. Table A-14. December 2023.
Congestion Cost - Truck / Bus (Urban)	2022$/mile	$0.35	
Noise Costs - Autos (Urban)	2022$/mile	$0.002	Office of the Secretary. Benefit-Cost Analysis Guidance for Discretionary Grant Programs. U.S. Department of Transportation. Table A-14. December 2023.
Noise Costs - Truck / Bus (Urban)	2022$/mile	$0.02	

7.3.5 Benefit Estimates

Table 17 highlights the economic competitiveness benefits as a result of the Project. The estimated present value of discounted benefits over a 20-year period is $23.1 million.

Table 17: Estimates of Economic Competitiveness Benefits

Values in 2022$	Over the Study Period	
	Undiscounted	Discounted
Travel Time Savings	$22.1 M	$13.2 M
Vehicle Operating Cost Savings	$5.6 M	$3.3 M
Transit Travel Time Savings	$4.6 M	$2.9 M
Transit Operating Cost Savings	$4.1 M	$2.6 M
Avoided Congestion Costs	$1.6 M	$1.0 M
Avoided Noise Costs	$0.0 M	$0.0 M
Total	**$38.1 M**	**$23.1 M**

7.4 State of Good Repair Outcomes

7.4.1 Change in O&M Costs

To quantify the benefits associated with maintaining the existing transportation network in a state of good repair, the incremental operations and maintenance costs are captured.

The operations and maintenance cost savings are estimated based on the difference in costs between the No Build and Build cases. The estimates are subtracted to determine the incremental operations and maintenance (O&M) costs. Positive values indicate operations and maintenance cost savings, a benefit, while negative values indicate increased operations and maintenance costs, a dis-benefit. Due to the replacement of older facilities, there are incremental O&M cost savings, despite some additional facilities being constructed.

The incremental O&M costs are estimated based on itemized assumptions including pavement maintenance, roadway equipment, bridge maintenance and repair costs. Further detail beyond the table below can be found in the Excel spreadsheet model.[5] The annual O&M costs are shown in **Table 18.**

Table 18: Assumptions used in the Estimation of State of the Change in O&M Costs

Variable	Units	Value	Source
Bridge O&M Share	%	1%	Annual O&M cost assumed to be 1% of bridge specific construction cost, includes routine maintenance and repairs.
Bridge O&M Cost	2022$	$81,890	Calculated based on above and cost estimate.

[5] The O&M calculations are built up through the O&M Savings, Past O&M, 6YR Bridge Plan, and O&M Summary spreadsheet tabs.

Variable	Units	Value	Source
ADOT Bridge Inspection	2022$	$1,338	Inflated from $1250 in 2021 to 2022 dollars using GDP deflator.
ADOT Bridge Inspection Frequency	years	2	Occurs every other year.
Decks - Operation Freeze	2022$	$535	Information provided by City of Tucson. Inflated from 2021 to 2022 dollars using GDP deflator.

7.4.2 Residual Value of Capital Assets

The residual value is estimated to quantify the benefits associated with new infrastructure with a useful life beyond the study period.

The constructed bridge will facilitate growth in passenger and shipping traffic for years to come. Due to the time period considered for the analysis, the remaining (or residual) value of the new infrastructure asset is not fully captured. The bridge related project components are considered to have useful life beyond the study period and their estimated lifespan is deducted from the analysis benefit period to obtain the remainder of the service life outside the study period. The remaining life as a factor of the estimated asset service life is multiplied by the project capital costs to derive the estimate. Future O&M costs for the remainder of the bridge life are subtracted from the remaining residual value to ensure that estimates are adequately conservative.

Additionally, for any right-of-way land acquisition as part of the project, the residual value of that component is expected to equal the initial value of the land.

The assumptions used in the estimation of the residual value of capital assets are summarized in **Table 19**.

Table 19: Assumptions used in the Estimation of the Residual Value of Capital Assets

Variable	Units	Value	Source
Useful Life of Assets - Bridge	years	50	Transportation for America which indicates bridges have an "expected lifespan of 50 years". http://t4america.org/maps-tools/bridges/overview/

7.4.3 Avoided Pavement Damage Costs

In addition to incremental O&M costs, the Project promotes reduced pavement damage to alternative routes across the Santa Cruz River. Asa result of the overall reduction in vehicle miles in the Project area, less strain will be put on the pavement resulting in lowering the frequency in which those roads need to be repaired. Pavement damage costs is a function of vehicle miles and a per mile pavement damage monetized value procured from the Federal Highway Cost Allocation Study. The differences between the costs in the No Build and Build scenarios provide the total reduction in pavement damages.

Table 20 summarizes the assumptions used in the estimation of avoided pavement damage costs.

Table 20: Assumptions in the Estimation of Avoided Pavement Damage Costs

Variable	Units	Value	Source
Pavement Damage (Trucks / Bus)	2022$/mile	$0.05	Assuming 60 kip 5-axle Comb/Rural Interstate. Data based on Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Inflated to 2022$.
Pavement Damage (Autos)	2022$/mile	$0.002	Assuming Auto/Rural Interstate. Data based on Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Inflated to 2022$.

7.4.4 Benefit Estimates

Table 21 shows the estimated State of Good Repair benefits generated by the Project. The estimated present value of discounted benefits over a 20-year period is $1.3 million.

Table 21: Estimates of State of Good Repair Benefits

Values in 2022$	Over the Study Period	
	Undiscounted	Discounted
Incremental O&M Costs	-$1.7 M	-$1.1 M
Residual Value of Assets	$5.0 M	$2.3 M
Avoided Pavement Damage Costs	$0.07 M	$0.04 M
Total	**$3.4 M**	**$1.3 M**

7.5 Mobility and Community Connectivity

The closest existing east-west street connections across the Santa Cruz River are Irvington Road, located one mile north of Drexel Road, and Valencia Road, located one mile to the south. The Drexel Road Bridge Project will provide vital connection for the local community as it will facilitate the crossing of the Sata Cruz River for residents living in Sunnyside and Midvale Park. The Project is projected to enhance accessibility to shopping centers, employment opportunities, services, and other opportunities for individuals experiencing historic disinvestment. The Pima Community College Desert Vista Campus is located immediately adjacent to the project area, southeast of the intersection of Drexel Road and Calle Santa Cruz, and thus area residents will have a new, convenient, and multimodal way to access educational and employment opportunities provided by the campus.

8 Summary of Findings and Benefit-Cost Outcomes

Table 22 and **Table 23** summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the project (24 years). As stated earlier, construction is expected to be completed by 2027 with 2028 being the project opening year. Benefits accrue during the full operation of the project.

Table 22: Overall Results of the Benefit Cost Analysis, 2022 Dollars

Evaluation Metrics	Undiscounted	Discounted
Total Benefits	$73.6 M	$43.7 M
Total Costs	$33.6 M	$29.4 M
Net Present Value (NPV)	$40.0 M	$14.3 M
Return on Investment (ROI)	119.2%	48.5%
Benefit-Cost Ratio (BCR)	2.2	1.5
Payback Period (years)	12.1 years	14.9 years
Internal Rate of Return (IRR)	6.6%	

Considering all monetized benefits and costs, the estimated internal rate of return of the project is 6.6 percent. With a 2 percent real discount rate on CO_2-related impacts and a 3.1 percent real discount rate on all other impacts, the $28.8 million investment would result in $43.7 million in total benefits for a Net Present Value of $14.3 million and a Benefit/Cost ratio of approximately 1.5[6].

Table 23: Summary of Project Benefits

Impact Categories	NPV Over 20 Years of Operations	
	Undiscounted	Discounted
Benefits		
Avoided Accident Costs	$31.2 M	$18.6 M
Travel Time Savings	$22.1 M	$13.2 M
Avoided CAC Emissions	$0.07 M	$0.04 M
Avoided GHG Emissions	$0.9 M	$0.7 M
Vehicle Operating Cost Savings	$5.6 M	$3.3 M
Transit Travel Time Savings	$4.6 M	$2.9 M
Transit Operating Cost Savings	$4.1 M	$2.6 M
Avoided Pavement Damage Costs	$0.07 M	$0.04 M
Avoided Congestion Costs	$1.6 M	$1.0 M
Avoided Noise Costs	$0.03 M	$0.02 M
Residual Value of Assets	$5.0 M	$2.3 M
Incremental O&M Costs	($1.7 M)	($1.1 M)
PV Benefits	**$73.6 M**	**$43.7 M**
Costs		
Capital Cost	$33.6 M	$29.4 M
PV Costs	**$33.6 M**	**$29.4 M**
NPV	**$40.0 M**	**$14.3 M**
BCR	**2.2**	**1.5**

**GHG impacts are discounted at a 2% discount rate per US DOT BCA Requirements.*

[6] When adjusted for equity considerations, the Project's BCR increases to 2.1. See section 10 for full details.

9 Benefit Cost Sensitivity Analysis

9.1 Variation in Key Inputs and Assumptions

The BCA outcomes presented in the previous sections rely on a large number of assumptions and long-term projections; both of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the BCA outcomes: the "critical variables."

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the final results would vary with reasonable departures from the "preferred" or most likely value for the variable; and
- Assess the robustness of the BCA and evaluate, in particular, whether the conclusions reached under the "preferred" set of input values are significantly altered by reasonable departures from those values.

The outcomes of the sensitivity analysis for the Drexel Road Bridge Project are summarized in **Table 24**. The table provides the percentage changes in project NPV associated with variations in variables or parameters, as indicated in the column headers.

Table 24: Quantitative Assessment of Sensitivity, Summary (Discounted)

Original NPV (Discounted at 3.1%)	Original BCR	Parameters	Change in Parameters	New NPV (Discounted at 3.1%)	Change in NPV	New BCR
$14.3 M	**1.5**	Change in Capital Costs	Increase capital costs by 15%	$10.0 M	-29.6%	1.3
			Decrease capital costs by 15%	$18.5 M	+29.6%	1.7
		Change in Value of Time	+25% Value of Time	$18.3 M	+28.3%	1.6
			-25% Value of Time	$10.2 M	-28.3%	1.3
		Transit Benefits	No Transit Benefits Monetized	$8.8 M	-38.4%	1.3
		Change in Congestion	Additional 1% Growth in Congestion per Year (NB)	$20.7 M	+44.9%	1.7
			1% Lower Growth in Congestion per Year (NB)	$7.9 M	-44.9%	1.3

The sensitivity analysis indicates that the Drexel Road Bridge Project is robust across the changes, with the benefit cost ratio exceeding the 1.0 threshold in each of the cases. Even under the scenario where no transit benefits are monetized, the benefit-cost ratio remains at 1.3, well above the breakeven threshold. Overall, the Project will result in beneficial impacts to stakeholders and society that will outweigh the capital costs required for the Project.

10 Distributional Analysis

10.1 Overview

An analysis of distributional effects of the Drexel Road Bridge Project (the Project), in the form of a weighted BCA (wBCA), was performed to represent an alternative value of the Project to society; one that considers how the resulting benefits are distributed among different income groups. A wBCA uses data on the income distribution of beneficiaries to determine the shares of total benefits and costs that would be gained and incurred, respectively, by different income groups. Then, weights are applied to those shares of total benefits and costs to determine a new measure of the Project's value. Weights are computed following economic theory and using economic evidence to the incomes of beneficiaries. The results of a wBCA can be viewed alongside a BCA and according to the Office of Management and Budget (OMB, 2023), either can be used as a rationale for the Project investment.

This section discusses the wBCA for this Project. The distributional aspects involved in a wBCA include:

- the distribution of benefits (relative to incomes of affected persons);
- the magnitude and type of benefits and costs (as estimated by a BCA); and,
- the value of such benefits and costs (relative to individuals' marginal utilities of income).

The key process of a wBCA involves estimating weights, based on the marginal utilities of income MU_i, for individual "i" (or income group). These weights are computed for each individual or group from $w_i^\alpha = (y_\alpha / y_i)^\varepsilon$, relative on income levels y_i. The elasticity of utility of income ε reflects the amount by which utility changes from a change in income. Another constant, the benchmark income level y_α, is included to support the interpretation of results (van der Pol, Bos, & Romijn, 2017). That is, the benchmark income "normalizes" the utility value of monetized benefits and costs by defining a unit of utility to be equal to the utility of income at the benchmark. With normalized weights, the results of a wBCA are measured in "weighted dollars" to distinguish results from actual money. Formally, weighted dollars represent societal utility relative to the marginal utility of income of a person at the benchmark income.

The marginal utility of income has been shown, in various research studies, that a person's utility in ("or value for") an additional dollar declines as a person's income increases. For instance, if a project generates out-of-pocket cost savings for transit users, those savings would be valued more by a lower income person than one earning more. Across a population, this research suggests that persons with lower incomes would value improvements more than those with higher incomes.

This section covers key steps to computing a wBCA including:

1. Determining income groups (e.g. quintiles) from the income distribution in the project region;
2. Apportioning benefits and costs by quintile;
3. Computing weights for different incomes based on marginal utilities of income; and,
4. Multiplying weights with benefits and costs per quintile and summing values across all groups.

A wBCA produces a new measure of societal value - a weighted Net Present Value (wNPV) in the form of:

EQ. 1

$$wNPV = \sum_{i}^{I} \left[\sum_{j}^{J} w_i^{\alpha} \cdot B_{ij} - \sum_{k}^{K} w_i^{\alpha} \cdot C_{ik} \right]$$

The results of a wBCA are measured in different units from a BCA. It is reasonable to define results of a wBCA in terms of "weighted dollars" to distinguish quantitative results from those of a BCA, which is estimated in actual dollars. Weighted dollars refer to the value of the project relative to someone who earns an income at the benchmark level in the study area. The following sections discuss the key elements of an equity and distributional analysis.

The sections that follow cover these elements in several sections: (a) Development of Data for Computing Weights; (b) Estimation of Share of Benefits and Costs by Quintile; (c) Estimation of Weights; and (d) Estimation of Weighted Benefits and Costs. Additional information is contained at the end of this section.

10.2 Formation of Income Groups and Reference Incomes ($\mathbf{y_i}$)

A first step in conducting a wBCA entails compiling and analyzing income data for the project area. All income measures are estimated after accounting for taxes and transfers using data from the U.S. Census and U.S. Treasury (US Dept. of Treasury, 2022).

This step forms income groups that are used in establishing weights and estimating benefits and costs to individuals. US Census data on household income for the Tucson, Arizona Metro Area is presented in **Figure 3**. From these data, income groups are established, as shown in **Figure 4**. Income groups are determined for quintiles – five income bands, each of which is approximately 20% of the population.

The income levels shown in **Figure 4** are 'reference incomes' and computed from a statistical analysis of the data in **Figure 3**. Specifically, a simple log-log linear model can be used to estimate LN(Income cutoff) as a function of LN(Cumulative Percentiles).[7] With estimated parameters, it is straightforward to determine income levels for quintiles, as well as other percentile groupings. Reference incomes of each quintile are the same way, by statistically estimating income cutoffs and mid-points with a log-log function of cumulative percentiles. The results of the statistical analysis generate reference incomes for each quintile that are in turn used as values of y_i in computed weights.

[7] The log-log models produce high r-squared statistics and provide good fits for incomes between the 5th and 95th percentiles.

Figure 3: Regional Income Distribution, Tucson Metropolitan Area, AZ ($2022)

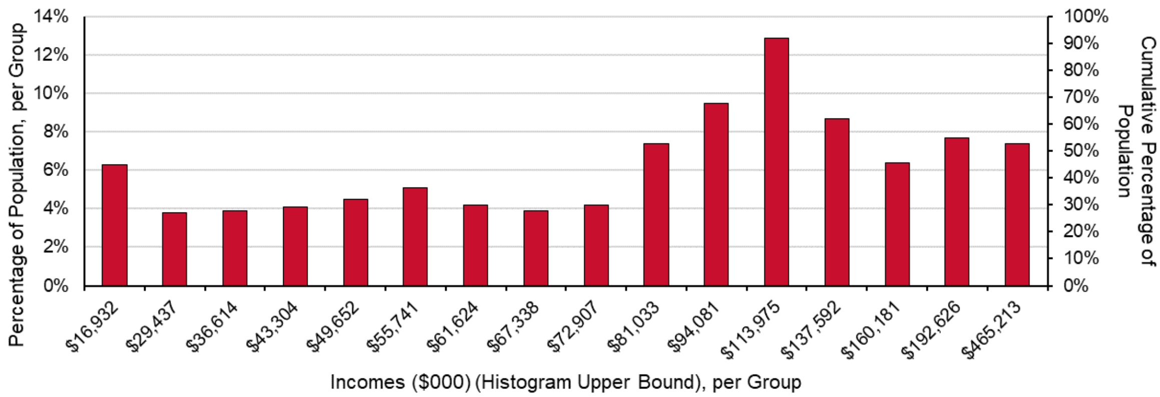
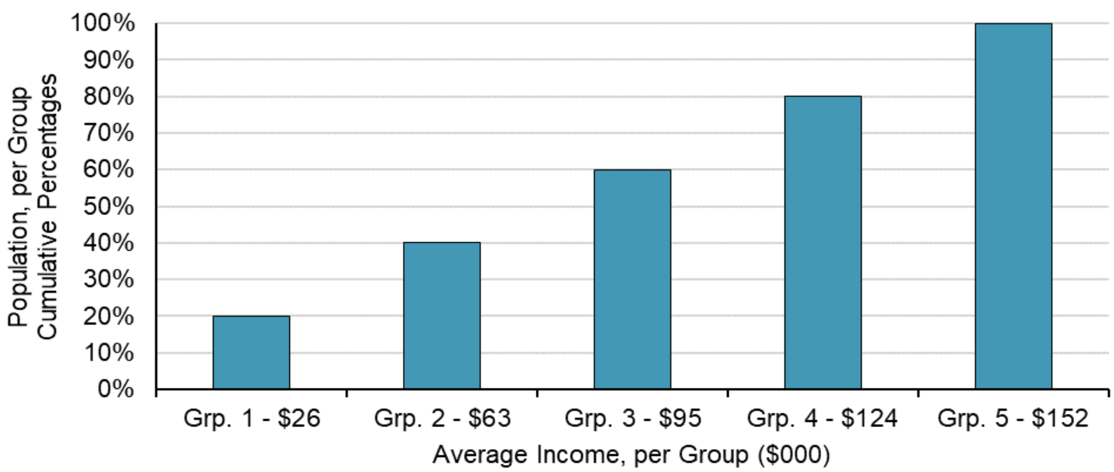


Figure 4: Reference Incomes (Quintiles, in thousands of $2022) for Determining Weighting, Tucson Metropolitan Area, AZ



10.3 Estimation of Share of Benefits and Costs by Quintile

10.3.1 Project Beneficiaries and Shares of Total Benefits

The next step in conducting a wBCA entails identifying individual project beneficiaries and their shares of total benefits. **Table 25** reproduces present value benefits and establishes assumptions about the individuals that are directly affected by each benefit category. Specification of affected persons is important because each sub-group of affected persons may have a different distribution of income. These distributions of income are used to determine the shares of total benefits that would accrue to different income groups.

In most cases, benefit categories are directly associated with the users of the mode that benefits. For instance, time savings for passenger vehicles affect vehicle occupants. In other cases, the assumptions on affected persons include:

- Criterion air contaminant (CAC) emissions are assumed to affect local residents, as defined by those households in the adjacent census tracts.
- Freight time and cost savings: These benefits are assumed to ultimately accrue to employees, owners, and consumers of goods being moved. It is assumed here that the income distribution for

this group can be approximated by the weighted average of households in Ohio vs. households nationwide, based on freight trip destinations.

- GHG reduction: While GHG goals and policies are set nationally, the assumption here is that households across the state are affected by a state's policies on GHG emissions (and thus represent those affected by reductions in the project area).
- Residual value and operations and maintenance cost savings are associated with agency costs or, in this case, cost reductions. These are incorporated on the weighted cost side and not the benefit side.

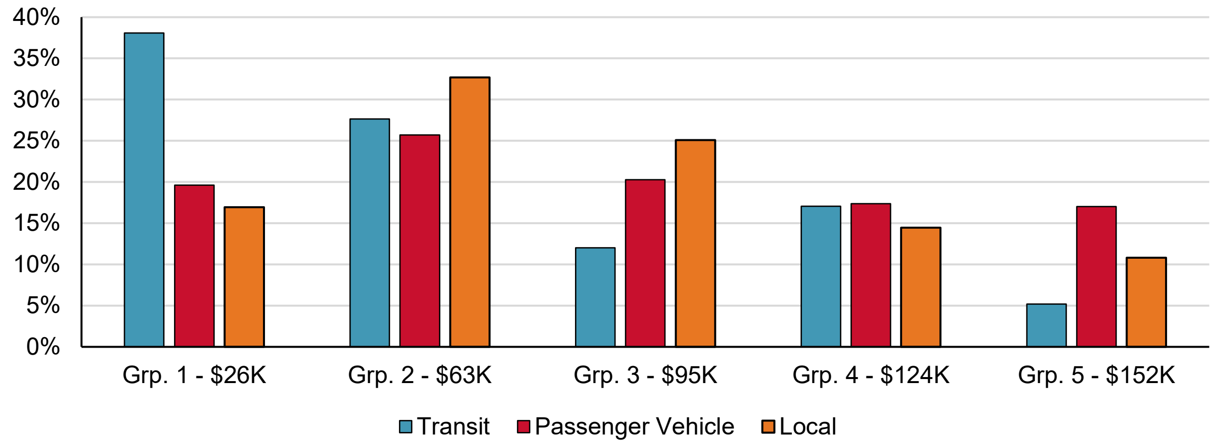
Table 25: Overview of Benefits and Beneficiaries*

Benefit Category	Mode	PV Benefits (3.1%)	Affected Persons
Travel Time Savings	Passenger Vehicle	$12.7	Vehicle Occupants
Vehicle Operating Cost Savings	Passenger Vehicle	$3.0	Vehicle Occupants & Owners
Safety	Passenger Vehicle	$18.6	All Roadway Users
Emissions - CAC	Passenger Vehicle	$0.04	Local Residents Adjacent to the Project Area
Emissions - GHG	Passenger Vehicle	$0.7	Local Residents Adjacent to the Project Area
Transit Travel Time Savings	Transit	$2.9	Transit Users
Travel Time Savings - Freight	Freight	$0.5	Consumers (at Freight Destination)
Avoided Congestion Costs	Passenger Vehicle	$1.0	All Roadway Users
Vehicle Operating Cost Savings - Freight	Freight	$0.3	Consumers (at Freight Destination)
Avoided Noise Costs	Local	$0.02	Local Residents Adjacent to the Project Area

*Some benefits considered in the standard BCA such as residual value, avoided pavement damage, and transit O&M cost savings are modeled as cost savings, as these benefits are allocated to government entities, rather than the public.

Once the affected persons per benefit category are identified, the income distributions of each group of affected persons are obtained and analyzed. **Figure 5** presents the percentages of affected persons per income group. Income data for passenger vehicle, freight-hauled goods customers and households in the project area are summarized from Replica data. The income distribution for persons affected by freight hauling is estimated from Replica data on truck movements and statewide and nationwide income distributions (U.S. Census, 2020). These percentages are used to determine the shares of total benefits that would be gained (or lost) per income group, for a given benefit category and set of affected persons.

Figure 5: Percentages of Users per Income Group, by Mode, Tucson Metropolitan Area, AZ



Data Source: (Replica, 2023), U.S. Census.

Estimate Sources of Project Costs and Shares of Total Cost Burdens by Quintile

Recall from EQ. 1 that project costs must also be apportioned across income groups before weights can be applied. Estimating the shares of costs contributed by people in each quintile (i.e. their 'cost burden') involves analyzing the taxes and fees that contribute to discretionary funds. It is assumed that any governmental revenues that are not dedicated to fund a specific activity would contribute to discretionary funds.[8] In this analysis, costs are spread out among federal, state, and local sources. Thus, the cost burdens per quintile are obtained from US Treasury (US Dept. of Treasury, 2022) analysis of tax burdens by income groups for federal sources, and state and local sources. The allocation of costs to sources is determined by the Project and shown below in **Table 26.**

Table 26: Adjusted Capital Cost Burden Percentages by Quintile

Cost Item and Source of Costs	Present Value Cost	% of Funding by Source
Project Capital Cost	**$29.4**	**100%**
Total Capital Cost for Adjustment*	$27.1	100%
Federal	$21.7	80%
State	$5.4	20%
Local O&M	-$1.5	100%

**Residual value of assets ($2.3 M, discounted) is subtracted from total capital cost in the computation of weights, and O&M (dis)benefits are treated as negative costs to avoid overestimation as they are not adjusted for equity. In this case, the -$1.5 M in O&M represents a cost savings.*

Estimation of Weights

Income weights are computed by $w_i^\alpha = (y_\alpha / y_i)^\varepsilon$ for each income group y_i and parameters for the elasticity of marginal utility of income ($\boldsymbol{\varepsilon}$) and a benchmark income ($\boldsymbol{y_\alpha}$). This section discusses

[8] For instance, federal payroll taxes would not be used for infrastructure projects because they would be fully directed to social security and medicare programs.

approaches to setting these parameters to estimate weights for normal benefit categories as well as those that are monetized with population parameters that require adjusted weights.

Elasticity of Marginal Utility of Income (ε)

The value of elasticity is set to 1.4, following guidelines from OMB (OMB, 2023). Other estimated elasticity values from the literature range from 1.0 to over 2.0 (Acland & Greenberg, 2023).

Benchmark Income (y_α)

Economic theory does not provide guidance for setting a benchmark income and thus its specification is a policy analysis choice. Most analyses discuss the benchmark income as a way of normalizing the marginal utility of income so that results can be measured in more familiar units.[9] Most academic and applied wBCA, including the OMB (2023), reference the median income to be an appropriate benchmark income. [10] This specification though is set without accounting for how projects are funded tax and fee payments that are paid by people at different income levels.

The specification of a benchmark income is important when considering the results of a wBCA in terms of the WNPV (EQ. 1) because weighted net benefits are directly proportional to the benchmark.[11] In contrast, the benchmark does not affect the weighted benefit-cost ratio because it divides by itself and accordingly can provide an unbiased comparison with standard BC ratio results. Accordingly, while a benchmark based on the median income would not affect the weighted BC ratio, it would influence the magnitude of the weighted NPV and if the analytical intent is to compare that with the unweighted NPV of a project, the median may not be a reasonable choice.

This analysis takes a different approach to specifying the benchmark income to enable comparisons between the weighted and unweighted results for this specific project. Here, the benchmark income is computed to *normalize* weighted costs so that they equal the magnitude of unweighted costs. By setting magnitudes for costs equal, the magnitudes of NPVs for this project can be compared.

A *cost-normalizing* benchmark income relies on data on individuals' cost contributions (i.e. their taxes and fees) to governmental discretionary funds that could be used for this project, as discussed above in Step 2. This benchmark income produces weighted costs equal in magnitude to unweighted costs and in turn enables comparisons of weighted and unweighted costs and benefits even though they are in different units. The benchmark income is estimated by combining the shares of cost contributions by quintile (in **Figure 4**) via a weighted average with the MUI per reference income. The benchmark income y_α is determined by solving the weighted cost part of EQ. 1 in this equation,

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[9] Without normalizing weights with a benchmark income, the results of a weighted BCA are in units of utility. With a benchmark income, the results are interpretable relative to the utility of someone who earns the benchmark income.

[10] Many other academic approaches assume the median income is a reasonable benchmark income. In such cases, neither the magnitudes of weighted and unweighted benefits or costs are likely to be comparable. In the approach developed here, the magnitudes of costs are set equal so that comparisons of benefit magnitudes are possible.

[11] The benchmark income is a constant and can be moved outside the summations in EQ. 1.

EQ. 2

$$\sum_{i} \left(\frac{y_{\alpha}}{y_{i}}\right)^{\varepsilon} C_{i} = C$$

where C_i is the cost contribution (via taxes and fees) for group i and y_i is the reference income for group i and ε is the elasticity of marginal utility of income.[12]

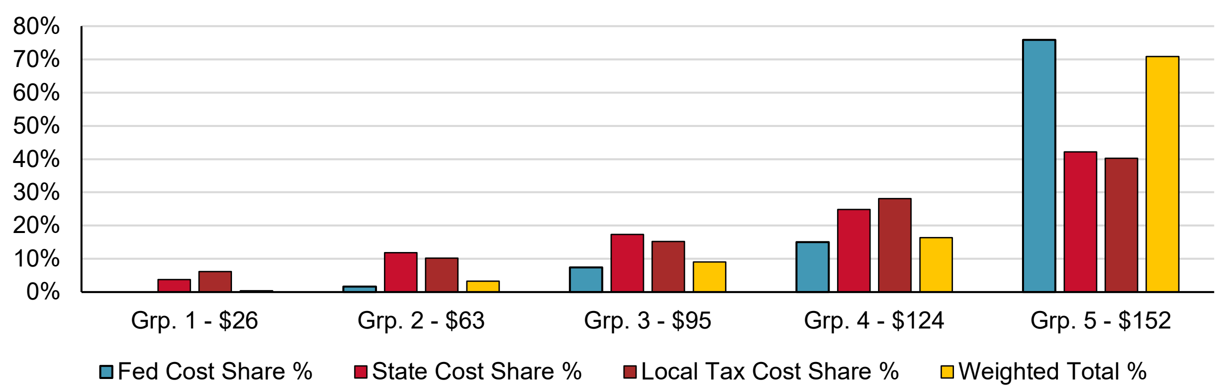
The proportions of cost burden, p_i, which indicate the percentage shares of total cost for a given funding source are defined such that $\sum_i p_i = 1$ and $p_i C = C_i$. Substituting this equality into EQ. 2:

EQ. 3

$$\sum_{i} \left(\frac{y_{\alpha}}{y_{i}}\right)^{\varepsilon} p_i C = C \rightarrow \left(\sum_{i} p_i {y_i}^{-\varepsilon}\right)^{-1} = {y_{\alpha}}^{\varepsilon}$$

The normalizing constant y_{α} is equivalent to a cost burden-weighted harmonic mean of incomes, for a given elasticity. Equivalently, this equation indicates that y_{α} is the income representing the weighted average of marginal utilities, where this weight is based on the shares of cost burdens.[13] Using the equation above and the data in Figure 6, the benchmark income is estimated to be about $128.5 thousand.

Figure 6: Cost Share by Income and Funding Source



Data Sources: (US Dept. of Treasury, 2022), (ITEP, 2018), (Replica, 2023)

Estimated Weights

For benefit categories in transportation projects that are monetized with a population average (or median) income, such as value of travel time savings, and safety (reduced accident risk), weights need to be adjusted. The reason for the adjustment is that a population average value is applied equally to all beneficiaries and weights must be applied to the value to individuals. Adjusted weights implicitly replace a population valuation parameter with an individualized one since benefits are a function of income. For

[12] This equation is applicable for one funding source. If other funding sources are supporting the project, the total cost burden C_i per group i must combine the percentage share of funding by source and differing cost burdens by source. The source of funding is important because individuals at different income levels, and thus having different marginal utilities of income, contribute different amounts to the cost of a project through fees, taxes and other forms.

[13] A similar approach is explored by Van der Pol, Bos, & Romijn (2017).

instance, the benefits of timing savings are directly proportional to wage rates used in valuation. Accordingly, an individual's wage rate would generate the individualized benefit of those time savings. Since incomes are a function of wage rates, the weights in EQ. 5 can be adjusted by assuming that income is proportional to wage rates. The BCA categories associated with each type of weight include:

Table 27: Type of Weight per Benefit Category

Benefit Category	Mode	Affected Persons	Type of Weight
Travel Time Savings	Passenger Vehicle	Vehicle Occupants	Adjusted Weights (median income)
Vehicle Operating Cost Savings	Passenger Vehicle	Vehicle Occupants & Owners	Normal Income Weights
Safety	Passenger Vehicle	All Roadway Users	Adjusted Weights (average income)
Emissions - CAC	Passenger Vehicle	Local Residents Adjacent to the Project Area	Adjusted Weights (average income)
Emissions - GHG	Passenger Vehicle	Local Residents Adjacent to the Project Area	Normal Income Weights
Transit Travel Time Savings	Transit	Transit Users	Adjusted Weights (median income)
Travel Time Savings - Freight	Freight	Consumers (at Freight Destination)	Normal Income Weights
Avoided Congestion Costs	Passenger Vehicle	All Roadway Users	Adjusted Weights (median income)
Vehicle Operating Cost Savings - Freight	Freight	Consumers (at Freight Destination)	Normal Income Weights
Avoided Noise Costs	Local	Local Residents Adjacent to the Project Area	Adjusted Weights (average income)

The approach to adjusting weights uses travel time savings benefits as an example but is generally applicable to any benefit category with a known population-based valuation parameter. Standard benefits of travel time savings are computed by combining a function of the median wage rate, $f(\tilde{v})$[14], with average travel time savings $\bar{t}$. Standard benefits for individual i are $B_i^{\tilde{v}} = \bar{t} \cdot f(\tilde{v})$, but individualized benefits on a person's actual value of time v_i are $B_i^{v_i} = \bar{t} \cdot f(v_i)$. Since benefits are proportional to the valuation parameter, individualized time savings benefits can be estimated from a population-valued benefit by multiplying it with the ratio of travel time savings values, $B_i^{v_i} = \left(f(v_i)/f(\tilde{v})\right) \cdot B_i^{\tilde{v}}$.

Income-weighted benefits for travel time savings are equal to: $\hat{B}_i^{v_i} = w_i^n \cdot B_i^{v_i}$, assuming the incomes used to compute weights are proportional to wage rates $f(v)$, then weights can be computed as a ratio of wages, $w_i^n = \left(f(v_i)/f(\tilde{v})\right)^{\varepsilon}$. This assumption is reasonable if wages are the primary contributor to incomes, and this is certainly the case for most people. When benefits are estimated with a median income parameter, the ratio of the value of time savings can be combined so that $\hat{B}_i^{v_i} = w_i^n \cdot$

[14] The value of travel time savings is typically defined as a function of median wages. For instance, non-business travel time is generally valued at one-half the median wage, as discussed in (U.S.-DOT 2020).

$\left(f(v_i)/f(\tilde{v})\right)^{\varepsilon} \cdot B_i^{\tilde{v}}$, which simplifies to find weighted benefits per individual as $\hat{B}^{v_i} = (w_i^n)^{\varepsilon-1} \cdot B_i^{\tilde{v}}$. The smaller elasticity value on weights, $\varepsilon - 1$, captures the remaining level of weighted dollars per income level i that be necessary to equal the total weighted benefits if the benefits were instead originally estimated at an affected persons actual wage rate (their WTP for time savings).[15] A general form for adjusting weights is $\tilde{w}_i^{\alpha} = \left(y_\alpha / y_{Pop}\right) \cdot (y_\alpha / y_i)^{\varepsilon-1}$ where y_α is the benchmark income, y_i is the individualized valuation parameter for a benefit category, and y_{Pop} is the population value parameter with which benefits are estimated.

Table 28 presents normal weights (EQ. 5) and adjusted income weights based on benefits categories that are monetized with median and average incomes, respectively.

Table 28: Estimated Income Weights

Income Group	Average Ann. HH Income ($000)	Normal Income Weights	Adjusted Weights (median income)	Adjusted Weights (average income)
1	$26.0	9.4	2.4	1.84
2	$63.0	2.7	1.7	1.29
3	$94.9	1.5	1.4	1.10
4	$124.2	1.1	1.3	0.99
5	$152.0	0.8	1.2	0.91

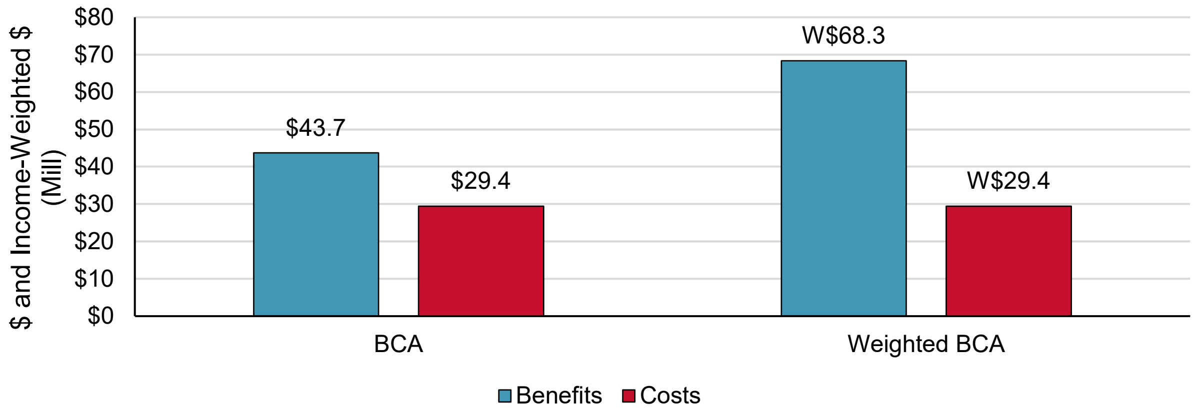
10.4 Compute Weighted Benefits, and Costs

Once weights are estimated, and each type of benefit and cost are apportioned, for each income group respectively, the computation of weighted benefits and costs is straightforward.[16] The results of the wBCA for the Projects is presented in **Figure 7**. This figure shows both standard BCA and weighted BCAs on the same chart, noting that the units of measure on vertical axis represent the magnitudes of both dollars and weighted dollars for each analysis. The results for the weighted BCA are scaled such that the weighted costs have the same magnitude as the standard BCA costs. Accordingly, it is clear to see that the weighted benefits increased relative to weighted costs, compared to the counterparts in a BCA. This finding indicates that, relative to the value of money raised for the projects (through taxes), there is greater value for beneficiaries after accounting for their utility of benefits.

[15] This also means that a population parameter, such as a median wage rate, implicitly captures equity aspects of the project at an elasticity value of $\varepsilon = 1$.

[16] The Compute Weighted Benefits, and Costs section provides more details on the related computations and steps.

Figure 7: Present Value of Unweighted and Weighted BCA Metrics



The results in **Table 29** present the numerical values as shown in **Figure 7** as well as the net benefits and associated BC ratio from a weighted BCA. In both analyses, weighted net benefits are greater than zero and BC ratios are greater than 1. Because weighted net benefits are scaled relative to a benchmark income, the value of net benefits depends on the benchmark. However, the BC ratios of BCA and weighted BCA may be compared. The weighted BC ratio indicates that value of net benefits exceeds the value for money, relative to incomes of those affected by the project and based on what people would be willing to pay.

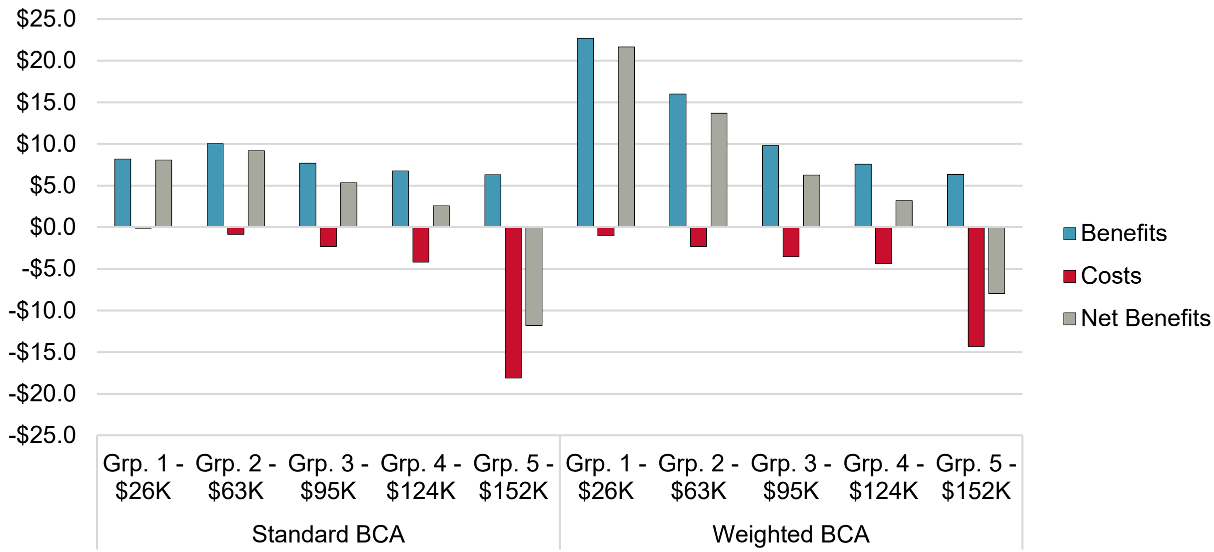
Table 29: Comparisons of weighted and unweighted BCAs

BCA Metric	BCA	Weighted-BCA
Benefits ($M)	$43.7	W$68.3*
Costs ($M)	$29.4	W$29.4
NPV ($M)	$14.3	W$38.9
BC Ratio	1.5	2.1

*Total weighted benefits presented in table 29 slightly differ from those in figure 7 as the weighted benefits include the unadjusted O&M and residual value benefits.

Another point of reference for the Project is shown in **Figure 8**. This figure shows the magnitudes of benefits, costs, and net benefits for BCA and Weighted BCA by quintile. Since both BCA and weighted BCA are analyzed with the same magnitude of costs, the magnitude of benefits and net benefits may be similarly compared. In this case, it is clear the difference in magnitude of weighted benefits, relative to unweighted benefits, is greatest for the lowest three income groups. Interestingly, while the highest quintile pays the most in the form of taxes and fees that would fund the project, the value of these payments decreases when weighted, and this quintile's negative net benefits from a standard BCA perspective, increases when weighted.

Figure 8: Benefits, Costs, and Net Benefits Comparison, Weighted vs. Unweighted, by Quintile ($2022)



As can be seen from **Figure 8,** the majority of benefits are adjusted towards individuals in lower income quintiles. Nearly one-third of total benefits are allocated towards individuals in the lowest income quintile, due to the fact that they generate more marginal utility from improvements associated with the project, such as improved transit operations and reduction congestion. Furthermore, the cost burden is less heavily distributed towards individuals in lower income quintiles, as they contribute a smaller share of state and local taxes. In summary, individuals in lower income quintiles benefit more from public infrastructure projects such as this, and bear less burden of taxation.

Table 30 presents the results of monetized BCA-based benefits and weighted benefits by category. This view of weighted BCA shows how the utility value of each benefit category is scaled up as weighted benefits. For instance, the weighted value of travel time benefits for passenger vehicles is about three times higher than the magnitude of standard benefits.[17] Similarly, impacts on journey quality for cyclists and pedestrians more than triple in magnitude.

Table 30: Estimated Unweighted and Weighted Benefits ($M, PV @ 3.1%)

Category	Standard Benefits	Weighted Benefits
Travel Time Savings	$12.7	W$20.6
Vehicle Operating Cost Savings	$3.0	W$9.6
Safety	$18.6	W$23.2
Emissions - CAC	$0.04	W$0.1
Emissions - GHG	$0.7	W$2.0
Transit Travel Time Savings	$2.9	W$5.3
Travel Time Savings - Freight	$0.5	W$1.3

[17] A comparison of magnitudes is only reasonable here since the magnitudes of costs between weighted and standard BCAs is the same.

Category	Standard Benefits	Weighted Benefits
Avoided Congestion Costs	$1.0	W$1.6
Vehicle Operating Cost Savings - Freight	$0.3	W$0.8
Avoided Noise Costs	$0.02	W$0.02
Total	**$39.8**	**W$64.4**

10.5 Discussion

This analysis applied a weighted BCA approach to assess several dimensions of the distribution of benefits and costs. Key figures and tables that provide information on three key dimensions of distribution include:

- the distribution of benefits and costs (relative to incomes of affected persons);
- the magnitude and type of benefits and costs (as estimated by a BCA); and,
- the value of such benefits and costs (relative to individuals' marginal utilities of income).

In the weighted BCA, the BCR is higher than in the standard BCA. This further emphasizes the importance of benefits to users and local populations, especially lower income populations that value benefits and costs on a differently than higher income groups. This is shown in Figure 3 and Figure 6; a substantial share of benefits accrues to lower income persons. These benefits, as shown in Table 5, cover all types of outcomes form the projects.

Based on a BCA, the distributional aspects of this project indicate that the project is worth funding since it provides greater weighted value for beneficiaries than the overall weighted cost.

10.6 Background on Weighted-BCA

An alternative to BCA draws from concepts related to Social Welfare Functions (SWF) which recognize differences in the value of benefits and costs for individuals (Adler M. , 2019). SWFs draw from decades of academic economic research that has focused on the impact of policies and projects on social welfare. A weighted-BCA is derived from a particular form of SWF – the utilitarian SWF ("USWF") – since it has appealing properties for project valuation. The principal difference between BCA and weighted BCA entails the representation of economic utility, or "satisfaction," from an alternative (e.g., a decision, action or event). A weighted BCA recognizes a more complete value of individuals' utilities in both the *consumptive value* of a good or service (as determined by a WTP) and the *value of a change in consumption (or income)* associated with that consumption. Adapting this concept to a project, the consumptive value is based on monetized net benefits and the value of net benefits differs for individuals at different income levels.

The utility value of a project outcome to an individual is captured mathematically as a marginal utility of income ("MU"). MU for different income levels indicate how the utility of each additional dollar declines as a person's income increases (Cowell & Gardiner, 1999). At the same time, the value of an additional dollar generates more utility for a lower-income person than a wealthier one. In project evaluations, it is assumed that MU relates to the monetized values of project outcomes and costs. Issues to consider in this assumption are discussed below.

The MU enters a weighted-BCA equation as a "utility weight."[18] Utility weights are multiplied with BCA-estimated benefits and costs (Fleurbaey & Rossi, 2016) to determine the societal utility of a project. Utility weights are computed for different levels of income of persons affected by a project. Higher weights are estimated for lower income persons, and vice versa. The magnitude of a weight is also determined by an elasticity of utility of income that determines how much additional utility is gained at different levels of income. Research studies, using a variety of methods, have estimated elasticity parameters that can be used in actual project evaluations (Acland & Greenberg, 2023).

Utility weights "w_i" are computed from the utility of income by taking the utility function's first derivative $\delta U/\delta y_i$ to reveal the amount by which utility changes relative to a change in income. In economic terms, this derivative is the marginal utility of income "MU_i" and is assumed to differ for each individual "i" who has a different level of income. EQ. 4 shows that MU_i, from an isoelastic utility function depends on the elasticity of income utility ε, and income level y_i:

EQ. 4:

$$w_i = MU_i = \left(\frac{1}{y_i}\right)^{\varepsilon}$$

This function is consistent with analytical findings which indicate that as income increases, MU_i declines (for any value of ε). The value of ε captures the degree to which an increase in income provides additional utility (Adler M. , 2016). Note that when $\varepsilon = 0$, all weights equal 1 and USWF reduces to a standard BCA approach. Values of ε have been estimated in a variety of economics studies and the choice of which value to apply in models is an important policy decision or evaluated through sensitivity analyses.

Most literature discusses "normalizing" weights with an income level, y_α , before multiplying them with benefits and costs (van der Pol, Bos, & Romijn, 2017). A normalizing income, or "benchmark income of a reference person", entails defining this income level equal to a unit of utility. The benchmark income is therefore a reference point for considering changes in utility for all beneficiaries relative to their incomes. By normalizing weights, the utilities at all levels of income are evaluated relative to the MU at that level of income.[19] The income weights of a y_α benchmark income are:

EQ. 5

$$w_i^{\alpha} = \left(\frac{y_\alpha}{y_i}\right)^{\varepsilon}$$

The results of a weighted-BCA are in units of "weighted dollars" that are not the same as the real currency dollars with value in a market. "Weighted dollars" measure utility from the perspective of persons who earn a benchmark level of income. A weighted-BCA involves a sum of individual utilities from changes in project outcomes. For a project with J benefit categories and K sources of funding (and cost burdens at an individual level), it is necessary to determine the shares of benefits and costs that are attributable to each individual. As shown in EQ. 6, the net present weighted value "$NPWV$" equals the difference in weighted benefits and costs.

EQ. 6

$$NPWV = \sum_{i}^{I}\left[\sum_{j}^{J} w_i^{\alpha} \cdot B_{ij} - \sum_{k}^{K} w_i^{\alpha} \cdot C_{ik}\right]$$

[18] These weights are variously called "distributional weights", "welfare weights" and "equity weights".

[19] A commonly discussed benchmark income in the literature is a population's median income, and its corresponding MU is based on y_{Med}^{ε}.

Computing $NPWV$ is straightforward since weights can be applied to already estimated benefits and costs from a BCA. Of course, applying weights to benefits and costs in present value form requires the assumption that relative incomes do not change much over time. In addition, it is assumed that individuals in each income groups have the same characteristics of project use or impact and thus, the portions of benefits and costs can be estimated as the percentage of beneficiaries per group. Also, since utility weights are derived from the utility of a change in income, *monetized values* of benefits would have to be similarly interpretable as a change in income, as noted above.

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City of Tucson
Drexel Road Bridge Project
Rebuilding American Infrastructure with Sustainability and Equity (RAISE)
February 28, 2024

Disclaimer

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By retaining and using this Model, the Recipients represent to HDR that they are capable of making their own independent assessment as to the validity of the assumptions, data and results contained in this Model.

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Key Inputs

Inputs	Value
Discount Rate	3.1%
Discount Rate, GHG	2.0%
Base Year	2022
Construction Complete	2027
First Full Year of Operations	2028
Final Year of Study	2047
Operational Period (Years	20

Results of the Cost Benefit Analysis

Summary of Results Over the Study Period. All Values in Millions of 2022$

Impact Categories	NPV Over 20 Years of Operations	
	Undiscounted	3.1%
Benefits		
Avoided Accident Costs	$31.2 M	$18.6 M
Travel Time Savings	$22.1 M	$13.2 M
Avoided CAC Emissions	$0.1 M	$0.04 M
Avoided GHG Emissions	$0.9 M	$0.7 M
Vehicle Operating Cost Savings	$5.6 M	$3.3 M
Transit Travel Time Savings	$4.61 M	$2.90 M
Transit Operating Cost Savings	$4.07 M	$2.58 M
Avoided Pavement Damage Cost	$0.07 M	$0.04 M
Avoided Congestion Costs	$1.6 M	$1.0 M
Avoided Noise Costs	$0.03 M	$0.02 M
Residual Value of Assets	$5.0 M	$2.3 M
Incremental O&M Costs	($1.7 M)	($1.1 M)
PV of Benefits	**$73.6 M**	**$43.7 M**
Costs		
Project Capital Costs	$33.6 M	$29.4 M
PV of Costs	**$33.6 M**	**$29.4 M**
Net Present Value (NPV)	**$40.0 M**	**$14.3 M**

**GHG impacts are discounted at a 2% discount rate per US DOT BCA Requirements*

BCA Summary Results	Undiscounted	Discounted at 3.1%
Net Present Value (NPV)	**$40.0 M**	**$14.3 M**
Benefit Cost Ratio (BCR)	**2.2**	**1.5**
Discounted Payback Period (DPP	**12.1 years**	**14.9 years**
Internal Rate of Return (IRR)	**6.6%**	

For the purposes of the BCR, O&M is considered a negative benefit and only up-front project capital costs are used in the denominator.

Key Quantified Impacts	Unit	Total Over Study Period	Annual Average
Change in GHG Emissions	metric tons	3,116	155.8
Change in CAC Emissions	metric tons	2.1	0.11
Avoided Fatal Accidents	fatal accidents	1.2	0.1
Avoided Injury Accidents	injury accidents	44.2	2.2
Avoided PDO Accidents	PDO accidents	35.5	1.8
Avoided Vehicle Travel Time	hours	674,876	33,744
Avoided Person Travel Time	hours	1,108,956	55,448
Avoided Transit Travel Time	hours	235,123	11,756

Summary of Results by Year, Undiscounted. All Values in 2022$

Impact Category	Total (M)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Avoided Accident Costs	$31.2 M	$0	$0	$0	$0	$763,536	$841,330	$920,291	$1,000,433	$1,081,770	$1,164,316	$1,248,086	$1,333,095	$1,419,358	$1,506,888	$1,595,703	$1,685,816	$1,777,244	$1,870,002	$1,964,106	$2,059,571	$2,156,415	$2,254,654	$2,254,654	$2,254,654
Travel Time Savings	$22.1 M	$0	$0	$0	$0	$537,829	$597,588	$657,347	$717,106	$776,865	$836,624	$896,382	$956,141	$1,015,900	$1,075,659	$1,135,418	$1,195,176	$1,254,935	$1,314,694	$1,374,453	$1,434,212	$1,493,971	$1,553,729	$1,613,488	$1,673,247
Avoided CAC Emissions	$0.1 M	$0	$0	$0	$0	$3,395	$3,284	$3,119	$3,166	$3,206	$3,239	$3,265	$3,284	$3,295	$3,299	$3,296	$3,285	$3,268	$3,353	$3,438	$3,521	$3,604	$3,686	$3,767	$3,847
Avoided GHG Emissions	$0.9 M	$0	$0	$0	$0	$25,334	$27,031	$28,778	$30,982	$32,963	$35,204	$37,332	$39,467	$41,610	$43,911	$45,909	$48,063	$50,385	$52,959	$55,756	$58,421	$61,321	$64,074	$67,075	$70,128
Vehicle Operating Cost Savings	$5.6 M	$0	$0	$0	$0	$136,073	$151,192	$166,312	$181,431	$196,550	$211,669	$226,789	$241,908	$257,027	$272,146	$287,266	$302,385	$317,504	$332,623	$347,743	$362,862	$377,981	$393,100	$408,220	$423,339
Transit Travel Time Savings	$4.6 M	$0	$0	$0	$0	$218,222	$219,564	$220,939	$222,352	$223,742	$225,088	$226,400	$227,688	$228,955	$230,200	$231,421	$232,615	$233,783	$234,929	$236,054	$237,157	$238,238	$239,303	$240,355	$241,396
Transit Operating Cost Savings	$4.1 M	$0	$0	$0	$0	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598
Avoided Pavement Damage Cost	$0.1 M	$0	$0	$0	$0	$2,338	$2,456	$2,575	$2,693	$2,812	$2,930	$3,049	$3,167	$3,286	$3,404	$3,523	$3,641	$3,760	$3,878	$3,996	$4,115	$4,233	$4,352	$4,470	$4,589
Avoided Congestion Costs	$1.6 M	$0	$0	$0	$0	$44,256	$48,262	$52,269	$56,275	$60,282	$64,289	$68,295	$72,302	$76,308	$80,315	$84,322	$88,328	$92,335	$96,341	$100,348	$104,355	$108,361	$112,368	$116,374	$120,381
Avoided Noise Costs	$0.0 M	$0	$0	$0	$0	$988	$1,055	$1,122	$1,190	$1,257	$1,325	$1,392	$1,460	$1,527	$1,595	$1,662	$1,730	$1,797	$1,865	$1,932	$2,000	$2,067	$2,135	$2,202	$2,270
Residual Value of Assets	$5.0 M	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,009,886
Incremental O&M Costs	($1.7 M)	$0	$0	$0	$0	($82,425)	($82,425)	($83,763)	($82,425)	($83,763)	($82,425)	($83,763)	($82,425)	($83,763)	($82,425)	($83,763)	($82,425)	($83,763)	($82,425)	($83,763)	($82,425)	($83,763)	($82,425)	($83,763)	($82,425)
Project Capital Costs	$33.6 M	$0	$4,126,650	$14,728,792	$14,728,792	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Benefits	**$73.6 M**	**$0**	**$0**	**$0**	**$0**	**$1,853,144**	**$2,012,937**	**$2,172,587**	**$2,336,801**	**$2,499,282**	**$2,665,857**	**$2,830,825**	**$2,999,685**	**$3,167,101**	**$3,338,591**	**$3,508,354**	**$3,682,213**	**$3,854,846**	**$4,031,818**	**$4,207,661**	**$4,387,387**	**$4,566,027**	**$4,748,574**	**$4,830,440**	**$9,924,909**
Total Costs	**$33.6 M**	**$0**	**$4,126,650**	**$14,728,792**	**$14,728,792**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Net Impacts	**$40.0 M**	**$0**	**($4,126,650)**	**($14,728,792)**	**($14,728,792)**	**$1,853,144**	**$2,012,937**	**$2,172,587**	**$2,336,801**	**$2,499,282**	**$2,665,857**	**$2,830,825**	**$2,999,685**	**$3,167,101**	**$3,338,591**	**$3,508,354**	**$3,682,213**	**$3,854,846**	**$4,031,818**	**$4,207,661**	**$4,387,387**	**$4,566,027**	**$4,748,574**	**$4,830,440**	**$9,924,909**
Cumulative Net Impacts		$0	($4,126,650)	($18,855,442)	($33,584,234)	($31,731,091)	($29,718,153)	($27,545,566)	($25,208,765)	($22,709,483)	($20,043,626)	($17,212,801)	($14,213,115)	($11,046,015)	($7,707,424)	($4,199,070)	($516,857)	$3,337,989	$7,369,806	$11,577,468	$15,964,855	$20,530,882	$25,279,456	$30,109,896	$40,034,806
Cumulative Benefits		$0	$0	$0	$0	$1,853,144	$3,866,081	$6,038,668	$8,375,469	$10,874,751	$13,540,608	$16,371,434	$19,371,119	$22,538,220	$25,876,811	$29,385,164	$33,067,377	$36,922,223	$40,954,041	$45,161,702	$49,549,089	$54,115,116	$58,863,691	$63,694,131	$73,619,040
Cumulative Costs		$0	$4,126,650	$18,855,442	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234	$33,584,234

Summary of Results by Year, Discounted at 3.1% All Values in 2022$

Impact Category	Total (M)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Avoided Accident Costs	$18.6 M	$0	$0	$0	$0	$635,737	$679,447	$720,868	$760,081	$797,165	$832,196	$865,248	$896,393	$925,701	$953,238	$979,069	$1,003,259	$1,025,867	$1,046,954	$1,066,575	$1,084,788	$1,101,645	$1,117,199	$1,083,607	$1,051,025
Travel Time Savings	$13.2 M	$0	$0	$0	$0	$447,809	$482,605	$514,903	$544,823	$572,478	$597,977	$621,426	$642,924	$662,567	$680,447	$696,654	$711,270	$724,378	$736,055	$746,374	$755,408	$763,223	$769,885	$775,457	$779,998
Avoided CAC Emissions	$0.0 M	$0	$0	$0	$0	$2,826	$2,652	$2,443	$2,406	$2,363	$2,315	$2,264	$2,208	$2,149	$2,087	$2,022	$1,955	$1,886	$1,877	$1,867	$1,855	$1,841	$1,826	$1,810	$1,793
Avoided GHG Emissions	$0.7 M	$0	$0	$0	$0	$22,496	$23,532	$24,562	$25,924	$27,041	$28,313	$29,436	$30,510	$31,535	$32,626	$33,442	$34,324	$35,277	$36,353	$37,522	$38,545	$39,665	$40,633	$41,702	$42,745
Vehicle Operating Cost Savings	$3.3 M	$0	$0	$0	$0	$113,298	$122,101	$130,273	$137,843	$144,839	$151,291	$157,224	$162,663	$167,632	$172,156	$176,257	$179,955	$183,271	$186,225	$188,836	$191,121	$193,099	$194,784	$196,194	$197,343
Transit Travel Time Savings	$2.9 M	$0	$0	$0	$0	$181,696	$177,317	$173,063	$168,932	$164,878	$160,882	$156,954	$153,101	$149,323	$145,622	$141,992	$138,433	$134,945	$131,529	$128,185	$124,912	$121,709	$118,576	$115,517	$112,529
Transit Operating Cost Savings	$2.6 M	$0	$0	$0	$0	$169,520	$164,423	$159,479	$154,684	$150,033	$145,522	$141,146	$136,902	$132,786	$128,793	$124,921	$121,165	$117,522	$113,988	$110,561	$107,236	$104,012	$100,884	$97,851	$94,909
Avoided Pavement Damage Cost	$0.0 M	$0	$0	$0	$0	$1,947	$1,984	$2,017	$2,046	$2,072	$2,094	$2,114	$2,130	$2,143	$2,153	$2,161	$2,167	$2,170	$2,171	$2,170	$2,167	$2,163	$2,156	$2,148	$2,139
Avoided Congestion Costs	$1.0 M	$0	$0	$0	$0	$36,848	$38,976	$40,942	$42,755	$44,422	$45,950	$47,346	$48,617	$49,768	$50,806	$51,737	$52,566	$53,298	$53,938	$54,492	$54,964	$55,358	$55,679	$55,931	$56,117
Avoided Noise Costs	$0.0 M	$0	$0	$0	$0	$822	$852	$879	$904	$927	$947	$965	$982	$996	$1,009	$1,020	$1,029	$1,037	$1,044	$1,049	$1,053	$1,056	$1,058	$1,058	$1,058
Residual Value of Assets	$2.3 M	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,335,400
Incremental O&M Costs	($1.1 M)	$0	$0	$0	$0	($68,629)	($66,565)	($65,612)	($62,623)	($61,726)	($58,913)	($58,070)	($55,424)	($54,630)	($52,141)	($51,394)	($49,053)	($48,350)	($46,147)	($45,486)	($43,414)	($42,792)	($40,842)	($40,257)	($38,423)
Project Capital Costs	$29.4 M	$0	$3,765,491	$13,035,644	$12,643,689	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Benefits	**$43.7 M**	**$0**	**$0**	**$0**	**$0**	**$1,544,371**	**$1,627,324**	**$1,703,817**	**$1,777,776**	**$1,844,492**	**$1,908,575**	**$1,966,053**	**$2,021,004**	**$2,069,970**	**$2,116,797**	**$2,157,881**	**$2,197,071**	**$2,231,302**	**$2,263,987**	**$2,292,146**	**$2,318,636**	**$2,340,978**	**$2,361,840**	**$2,331,019**	**$4,636,633**
Total Costs	**$29.4 M**	**$0**	**$3,765,491**	**$13,035,644**	**$12,643,689**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Net Impacts	**$14.3 M**	**$0**	**($3,765,491)**	**($13,035,644)**	**($12,643,689)**	**$1,544,371**	**$1,627,324**	**$1,703,817**	**$1,777,776**	**$1,844,492**	**$1,908,575**	**$1,966,053**	**$2,021,004**	**$2,069,970**	**$2,116,797**	**$2,157,881**	**$2,197,071**	**$2,231,302**	**$2,263,987**	**$2,292,146**	**$2,318,636**	**$2,340,978**	**$2,361,840**	**$2,331,019**	**$4,636,633**
Cumulative Net Impacts		$0	($3,765,491)	($16,801,135)	($29,444,824)	($27,900,453)	($26,273,129)	($24,569,311)	($22,791,536)	($20,947,044)	($19,038,469)	($17,072,416)	($15,051,412)	($12,981,442)	($10,864,645)	($8,706,764)	($6,509,693)	($4,278,391)	($2,014,404)	$277,742	$2,596,378	$4,937,356	$7,299,197	$9,630,216	$14,266,848
Cumulative Benefits		$0	$0	$0	$0	$1,544,371	$3,171,695	$4,875,512	$6,653,288	$8,497,780	$10,406,355	$12,372,407	$14,393,412	$16,463,382	$18,580,179	$20,738,060	$22,935,131	$25,166,432	$27,430,419	$29,722,566	$32,041,202	$34,382,180	$36,744,020	$39,075,039	$43,711,672
Cumulative Costs		$0	$3,765,491	$16,801,135	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824	$29,444,824

		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Discount Factor	**2%**	0.96	0.94	0.92	0.91	0.89	0.87	0.85	0.84	0.82	0.80	0.79	0.77	0.76	0.74	0.73	0.71	0.70	0.69	0.67	0.66	0.65	0.63	0.62	0.61
Discount Factor	**3%**	0.94	0.91	0.89	0.86	0.83	0.81	0.78	0.76	0.74	0.71	0.69	0.67	0.65	0.63	0.61	0.60	0.58	0.56	0.54	0.53	0.51	0.50	0.48	0.47

Key Quantified Impacts	Unit	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Change in GHG Emissions	metric tons/year	0.0	0.0	0.0	0.0	101.3	106.8	112.0	118.3	124.4	130.4	136.2	142.0	147.6	153.0	158.3	163.5	168.5	174.8	181.0	187.2	193.4	199.6	205.8	211.9
Change in CAC Emissions	metric tons/year	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Avoided Fatal Crashes	crashes/year	0.00	0.00	0.00	0.00	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09
Avoided Injury Crashes	crashes/year	0.00	0.00	0.00	0.00	1.08	1.19	1.31	1.42	1.54	1.65	1.77	1.89	2.01	2.14	2.26	2.39	2.52	2.65	2.79	2.92	3.06	3.20	3.20	3.20
Avoided PDO Crashes	crashes/year	0.00	0.00	0.00	0.00	0.80	0.89	0.99	1.09	1.19	1.29	1.39	1.50	1.61	1.71	1.82	1.93	2.05	2.16	2.28	2.39	2.51	2.63	2.63	2.63
Change in Vehicle Travel Time	hours/year	0	0	0	0	16,416	18,240	20,064	21,888	23,712	25,536	27,360	29,184	31,008	32,832	34,656	36,480	38,304	40,128	41,952	43,776	45,600	47,424	49,248	51,072
Change in Person Travel Time	hours/year	0	0	0	0	26,975	29,972	32,969	35,966	38,963	41,960	44,958	47,955	50,952	53,949	56,946	59,944	62,941	65,938	68,935	71,932	74,929	77,927	80,924	83,921
Change in Transit Travel Time	hours/year	0	0	0	0	11,134	11,202	11,272	11,344	11,415	11,484	11,551	11,617	11,681	11,745	11,807	11,868	11,928	11,986	12,044	12,100	12,155	12,209	12,263	12,316

Project Inputs

Variable	Unit	Value	Source/Comment
General Inputs			
Grams per Ton	grams/metric ton	1,000,000	Known
Feet per Mile	feet/mile	5,280	Known
Annualization Factor	days	365	Known
Weekdays per Year	days	261	Known
Minutes per Hour	minutes/hour	60	Known
Seconds per Minute	seconds/minute	60	Known
Economic Inputs			
Discount Rate	%	3.1%	Office of the Secretary. Benefit-Cost Analysis Guidance for Dicretionary Grant Programs. U.S. Department of Transportation. December 2023. Obtained from:
Discount Rate, GHG Emissions	%	2.0%	https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance
Years of Benefits	years	20	
Current Year	year	2024	
Base Year of Analysis	year	2022	Base year
End Year of Analysis	year	2047	
Construction Start		2025	
Construction End	year	2027	Project schedule. City of Tucson
First Year of Operations	year	2028	
Useful Life of Assets - Bridge	years	50	Transportation for America which indicates bridges have an "expected lifespan of 50 years". http://t4america.org/maps-tools/bridges/overview/
Last Year of Bridge Useful Life	year	2077	
Useful Life of Roadway Assets (Capacity Expar	years	20	Office of the Secretary. Benefit-Cost Analysis Guidance for Dicretionary Grant Programs. U.S. Department of Transportation. December 2023. Obtained from: https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance
Traffic Inputs			
Truck Share of Traffic	%	4%	City of Tucson.
Average Vehicle Occupancy	persons/vehicle	1.67	2017 National Household Travel Survey. As reccomended by Benefit-Cost Analysis Guidance for Dicretionary Grant Programs. U.S. Department of Transportation. December 2023.
Average Truck Occupancy	persons/vehicle	1.0	Assumption
Project Segment (No-Build)	miles	2.6	City of Tucson
Project Segment (Build)	miles	0.6	City of Tucson
Maintenance Inputs			
Bridge O&M Share	%	1%	Annual O&M cost assumed to be 1% of bridge specific construction cost, includes routine maintenance and repairs.
Bridge O&M Cost	2022$	$81,890	Calculated based on above and cost estimate.
ADOT Bridge Inspection	2022$	$1,338	Inflated from $1250 in 2021 to 2022 dollars using GDP deflator.
ADOT Bridge Inspection Frequency	years	2	Occurs every other year.
Decks - Operation Freeze	2022$	$535	Information provided by City of Tucscon. Inflated from 2021 to 2022 dollars using GDP deflator.
Monetization Factors			
Value of Time - Automobile	2022$/hour	$19.60	Office of the Secretary. Benefit-Cost Analysis Guidance for Dicretionary Grant Programs. U.S. Department of Transportation. December 2023. Obtained from:
Value of Time - Truck Driver	2022$/hour	$33.50	https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance
K - Killed	2022$/fatality	$12,500,000	
A - Incapacitating	2022$/injury	$1,188,200	
B - Non-Incapacitating	2022$/injury	$2,333,800	
C - Possible Injury	2022$/injury	$111,700	Treatment of the Economic Value of Preventing Fatalities and Injuries in Preparing Economic Analyses (2022). https://www.transportation.gov/office-policy/transportation-
U - Injured (Severity Unknown)	2022$/injury	$217,600	policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis

Fatal Crashes	2022$/crash	$14,022,900	
Injury Crashes	2022$/crash	$313,000	
PDO Accidents	2022$/crash	$9,100	The Economic and Societal Impact of Motor Vehicle Crashes, 2019 (revised February 2023), Page 46, Table 2-9, Incidence Summary"Inflated to 2022 dollars using the GDP deflator.
Pavement Damage (Trucks / Bus)	2022$/mile	$0.054	Assuming 60 kip 5-axle Comb/Rural Interstate. Data based on Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Inflated to 2022$
Pavement Damage (Autos)	2022$/mile	$0.002	Assuming Auto/Rural Interstate. Data based on Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Inflated to 2022$
Vehicle Operating Costs - Autos	2022$/mile	$0.52	American Automobile Association, Your Driving Costs – 2022 Edition (2022) https://newsroom.aaa.com/wp content/uploads/2022/08/2022-YourDrivingCosts FactSheet-7-1.pdf
Vehicle Operating Costs - Trucks / Bus	2022$/mile	$1.32	American Transportation Research Institute, An Analysis of the Operational Costs of Trucking: 2023 Update https://truckingresearch.org/wp content/uploads/2023/06/ATRI-Operational-Cost of-Trucking-06-2023.pdf
Congestion Cost - Autos (Urban)	2022$/mile	$0.14	Office of the Secretary. Benefit-Cost Analysis Guidance for Dicretionary Grant Programs. U.S. Department of Transportation. Table A-14. December 2023. Obtained from: ht
Congestion Cost - Truck / Bus (Urban)	2022$/mile	$0.35	
Noise Costs - Autos (Urban)	2022$/mile	$0.002	Office of the Secretary. Benefit-Cost Analysis Guidance for Dicretionary Grant Programs. U.S. Department of Transportation. Table A-14. December 2023. Obtained from: ht
Noise Costs - Truck / Bus (Urban)	2022$/mile	$0.016	
Transit Inputs			
Average Route 27 Ridership	passengers/day	383	Weekday average passengers impacted by Route 27 change. Calculated based on average of North/South lines, between October 1, 2023 and December 31, 2023.
Transit Ridership Growth Rate	%	Varies by Year	Based on population projections for Pima County from Arizona Office of Economic Opportunity. December 2022.
Route 27 Trips (one-direction)	trips/day	44	Sun Tran service schedule. 23 Northbound, 21 southbound. https://www.suntran.com/routes-services/find-my-bus/
Transit Length (No Build)	miles	2.6	Sun Tran. Between Midvale Park/Drexel and Pima College Desert Vista Campus, average of Route 27 Northbound and Southbound.
Transit Length (Build)	miles	0.6	Sun Tran. Modified route across bridge between Midvale Park/Drexel and Pima College Desert Vista Campus average of Route 27 Northbound and Southbound.
Miles Saved (Build)	miles	2.1	Calculated.
Average Transit Speed	miles/hour	19.2	Sun Tran. Route 27, NB and SB average
Transit Agency Operating Cost Savings	2022$/year	$203,598	Based on email discussion with Sun Tran on January 30, 2024. Deflated to 2022$.

From: Bob McGee <bob.mcgee@tucsonaz.gov>
Sent: Wednesday, November 29, 2023 5:30 PM
To: James Castaneda <James.Castaneda@tucsonaz.gov>
Cc: Patrick Hartley <Patrick.Hartley@tucsonaz.gov>; Rhett Crowninshield <Rhett.Crowninshield@tucsonaz.gov>; Davita Mueller <Davita.Mueller@tucsonaz.gov>; China Langer <clanger@tmdinc.net>; Anna Joos <ajoos@tmdinc.net>
Subject: Re: Drexel Rd Bridge

Hello, James! The proposed Drexel Bridge poses opportunities for Sun Tran to streamline service along Drexel from Cardinal to Calle Santa Cruz. As shown in the attached image, Rt 27 - Midvale Park currently serves Drexel and under present conditions would be the most likely to use the bridge. Again, under current conditions, if we would use the proposed bridge as part of Rt .27 routing and not have to deviate south on Midvale Rd. to Valencia and back up Calle Santa Cruz to Drexel, we would save significant time and miles. I have completed a fairly quick cost analysis and determined the bridge would save approximately $211,000 yearly.

Emissions per Gallon of Fuel Burned - Autos (grams/miles)						
Year	NOx	VOC	PM2.5	SO_2	CO_2	Source/Comment
2024	0.098	0.026	0.002	0.0018	270.5	Based on MOVES average annual emission factors for trucks in Pima County, AZ. Moves model run in February 2024.
2025	0.086	0.023	0.002	0.0018	264.3	
2026	0.074	0.021	0.002	0.0017	258.1	
2027	0.062	0.018	0.001	0.0017	251.9	
2028	0.050	0.015	0.001	0.0016	245.6	
2029	0.038	0.013	0.001	0.0016	239.4	
2030	0.026	0.010	0.001	0.0015	233.2	
2031	0.024	0.009	0.001	0.0015	230.9	
2032	0.022	0.009	0.001	0.0015	228.6	
2033	0.020	0.009	0.001	0.0015	226.4	
2034	0.018	0.008	0.001	0.0015	224.1	
2035	0.016	0.008	0.001	0.0015	221.8	
2036	0.013	0.007	0.001	0.0015	219.5	
2037	0.011	0.007	0.001	0.0014	217.3	
2038	0.009	0.007	0.001	0.0014	215.0	
2039	0.007	0.006	0.001	0.0014	212.7	
2040	0.005	0.006	0.001	0.0014	210.4	
2041	0.005	0.006	0.001	0.0014	210.0	
2042	0.004	0.006	0.001	0.0014	209.6	
2043	0.004	0.006	0.001	0.0014	209.1	
2044	0.004	0.006	0.001	0.0014	208.7	
2045	0.004	0.006	0.001	0.0014	208.3	
2046	0.004	0.006	0.001	0.0014	207.8	
2047	0.004	0.006	0.001	0.0014	207.4	
2048	0.003	0.006	0.001	0.0014	207.0	
2049	0.003	0.005	0.001	0.0014	206.6	
2050	0.003	0.005	0.001	0.0014	206.1	

Year	Emissions Value ($/metric ton)					Source
	CO2	NOx	PM2.5	SO2	VOC	
2024	$233	$20,100	$963,200	$53,800	$0	Technical Support Document: Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors (February 2018)" https://www.epa.gov/sites/default/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf NOX, SOX, and PM2.5 values are inflated from 2015 to 2022 dollars using the GDP deflator. CO2 values are inflated from 2020 to 2022 dollars using the GDP deflator. EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances (November 2023) **Note:** Fuel saved (gasoline, diesel, natural gas, etc.) can be converted into metric tons of emissions using EPA guidelines available at https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references **Note:** The recommended values for reducing CO2 emissions reported in Table A-6 represent the values of future economic damages that can be avoided by reducing emissions in each future year by one metric ton. After using per-ton values to estimate the total value of reducing CO2 emissions in any future year, the result must be further discounted to its present value as of the
2025	$237	$20,300	$975,500	$54,800	$0	
2026	$241	$20,600	$993,500	$56,100	$0	
2027	$245	$21,000	$1,011,900	$57,400	$0	
2028	$250	$21,300	$1,030,600	$58,700	$0	
2029	$253	$21,700	$1,049,600	$60,100	$0	
2030	$257	$22,000	$1,069,000	$61,500	$0	
2031	$262	$22,000	$1,069,000	$61,500	$0	
2032	$265	$22,000	$1,069,000	$61,500	$0	
2033	$270	$22,000	$1,069,000	$61,500	$0	
2034	$274	$22,000	$1,069,000	$61,500	$0	
2035	$278	$22,000	$1,069,000	$61,500	$0	
2036	$282	$22,000	$1,069,000	$61,500	$0	
2037	$287	$22,000	$1,069,000	$61,500	$0	
2038	$290	$22,000	$1,069,000	$61,500	$0	
2039	$294	$22,000	$1,069,000	$61,500	$0	
2040	$299	$22,000	$1,069,000	$61,500	$0	
2041	$303	$22,000	$1,069,000	$61,500	$0	
2042	$308	$22,000	$1,069,000	$61,500	$0	
2043	$312	$22,000	$1,069,000	$61,500	$0	
2044	$317	$22,000	$1,069,000	$61,500	$0	
2045	$321	$22,000	$1,069,000	$61,500	$0	
2046	$326	$22,000	$1,069,000	$61,500	$0	
2047	$331	$22,000	$1,069,000	$61,500	$0	
2048	$336	$22,000	$1,069,000	$61,500	$0	
2049	$340	$22,000	$1,069,000	$61,500	$0	
2050	$345	$22,000	$1,069,000	$61,500	$0	

Year	Fuel Prices ($/gallon)		Source
	Gasoline	Diesel Fuel	
2024	$2.48	$3.21	EIA's Annual Energy Outlook 2023. Table 57: Components of Selected Petroleum Product Prices. Fuel prices are net of state and federal taxes. Values in 2022$ per USDOT guidance. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=70-AEO2023&cases=ref2023&sourcekey=0
2025	$2.26	$2.93	
2026	$2.24	$2.80	
2027	$2.22	$2.68	
2028	$2.23	$2.58	
2029	$2.24	$2.59	
2030	$2.25	$2.60	
2031	$2.25	$2.63	
2032	$2.27	$2.65	
2033	$2.28	$2.67	
2034	$2.30	$2.68	
2035	$2.31	$2.71	
2036	$2.34	$2.72	
2037	$2.35	$2.74	
2038	$2.37	$2.76	
2039	$2.38	$2.77	
2040	$2.39	$2.78	
2041	$2.39	$2.81	
2042	$2.41	$2.81	
2043	$2.40	$2.83	
2044	$2.42	$2.82	
2045	$2.42	$2.83	
2046	$2.48	$2.87	
2047	$2.48	$2.88	
2048	$2.51	$2.89	
2049	$2.52	$2.90	
2050	$2.55	$2.90	

Emissions per Gallon of Fuel Burned - Trucks (grams/miles)						
Year	NOx	VOC	PM2.5	SO_2	CO_2	Source/Comment
2024	2.971	0.113	0.065	0.0041	1,214.3	Based on MOVES average annual emission factors for trucks in Pima County, AZ. Moves model run in February 2024.
2025	2.836	0.104	0.059	0.0040	1,193.8	
2026	2.701	0.094	0.052	0.0039	1,173.2	
2027	2.566	0.084	0.045	0.0039	1,152.7	
2028	2.431	0.075	0.039	0.0038	1,132.2	
2029	2.295	0.065	0.032	0.0037	1,111.7	
2030	2.160	0.055	0.025	0.0036	1,091.2	
2031	2.138	0.053	0.024	0.0036	1,082.7	
2032	2.115	0.052	0.023	0.0036	1,074.3	
2033	2.093	0.050	0.022	0.0036	1,065.9	
2034	2.071	0.048	0.021	0.0035	1,057.4	
2035	2.048	0.047	0.020	0.0035	1,049.0	
2036	2.026	0.045	0.019	0.0035	1,040.5	
2037	2.003	0.043	0.018	0.0034	1,032.1	
2038	1.981	0.041	0.017	0.0034	1,023.7	
2039	1.959	0.040	0.016	0.0034	1,015.2	
2040	1.936	0.038	0.015	0.0034	1,006.8	
2041	1.932	0.038	0.015	0.0034	1,005.4	
2042	1.929	0.038	0.015	0.0033	1,004.0	
2043	1.925	0.037	0.015	0.0033	1,002.7	
2044	1.921	0.037	0.015	0.0033	1,001.3	
2045	1.917	0.037	0.015	0.0033	999.9	
2046	1.913	0.037	0.014	0.0033	998.5	
2047	1.909	0.036	0.014	0.0033	997.2	
2048	1.905	0.036	0.014	0.0033	995.8	
2049	1.901	0.036	0.014	0.0033	994.4	
2050	1.897	0.036	0.014	0.0033	993.0	

Emissions per Gallon of Fuel Burned - Transit Bus (grams/miles)						
Year	NOx	VOC	PM2.5	SO_2	CO_2	Source/Comment
2024	3.119	0.130	0.035	0.0047	1,404.7	Based on MOVES average annual emission factors for trucks in Pima County, AZ. Moves model run in February 2024.
2025	3.006	0.118	0.032	0.0047	1,390.7	
2026	2.894	0.106	0.028	0.0046	1,376.8	
2027	2.782	0.094	0.024	0.0046	1,362.9	
2028	2.670	0.082	0.021	0.0045	1,348.9	
2029	2.558	0.070	0.017	0.0045	1,335.0	
2030	2.446	0.058	0.014	0.0044	1,321.1	
2031	2.409	0.055	0.013	0.0044	1,311.6	
2032	2.373	0.052	0.012	0.0043	1,302.2	
2033	2.336	0.048	0.011	0.0043	1,292.8	
2034	2.300	0.045	0.010	0.0043	1,283.3	
2035	2.263	0.042	0.009	0.0043	1,273.9	
2036	2.227	0.039	0.008	0.0042	1,264.4	
2037	2.190	0.035	0.007	0.0042	1,255.0	
2038	2.153	0.032	0.006	0.0042	1,245.6	
2039	2.117	0.029	0.005	0.0041	1,236.1	
2040	2.080	0.026	0.004	0.0041	1,226.7	
2041	2.074	0.025	0.004	0.0041	1,223.2	
2042	2.068	0.025	0.004	0.0041	1,219.8	
2043	2.062	0.025	0.004	0.0041	1,216.3	
2044	2.056	0.025	0.004	0.0040	1,212.9	
2045	2.050	0.024	0.004	0.0040	1,209.4	
2046	2.044	0.024	0.004	0.0040	1,206.0	
2047	2.038	0.024	0.004	0.0040	1,202.5	
2048	2.032	0.023	0.004	0.0040	1,199.1	
2049	2.026	0.023	0.004	0.0040	1,195.6	
2050	2.020	0.023	0.004	0.0040	1,192.2	

Project Capital Costs

Project Cost in 2022$	Inflation Adjust	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Construction Costs	0.96	$0	$0	$6,498,213	$6,498,213	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction Costs - Bridge Structure	0.96	$0	$0	$4,094,495	$4,094,495	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Right-of-Way	0.96	$0	$96,492	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Public Art	0.96	$0	$0	$105,927	$105,927	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Contingency & Soft Costs	0.96	$0	$4,030,158	$4,030,158	$4,030,158	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Capital Cost		$0	$4,126,650	$14,728,792	$14,728,792	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sensitivity	1.00																								

Cost Allocation	Total Cost	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Construction Costs	$13,468,920			50.0%	50.0%																				
Construction Costs - Bridge Structure	$8,486,707			50.0%	50.0%																				
Right-of-Way	$100,000		100.0%																						
Public Art	$219,556			50.0%	50.0%																				
Contingency & Soft Costs	$12,530,032		33.3%	33.3%	33.3%																				

Demand

Variable	Unit	Growth / Factor	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Transit Ridership															
Pima County Population Growth	%		0.7%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Average Weekday Route 27 Ridership	passengers/day		386	389	391	394	396	398	401	403	406	408	411	413	415
Route 27 Ridership (Annual)	passengers/year	261	100,780	101,510	102,102	102,711	103,334	103,970	104,621	105,290	105,948	106,585	107,207	107,817	108,416
Bus Trips	trips/year	261	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484
No-Build Scenario															
Automotive Traffic															
Annual Vehicle-Hours Traveled	vht/year		0	0	0	0	1,425,547	1,439,483	1,453,420	1,467,356	1,481,292	1,495,229	1,509,165	1,523,102	1,537,038
Auto VHT	vht/year		0	0	0	0	1,368,525	1,381,904	1,395,283	1,408,662	1,422,041	1,435,420	1,448,799	1,462,178	1,475,557
Truck VHT	vht/year	4%	0	0	0	0	57,022	57,579	58,137	58,694	59,252	59,809	60,367	60,924	61,482
Annual Vehicle-Miles Traveled	vmt/year		0	0	0	0	43,612,002	43,947,668	44,283,334	44,619,000	44,954,666	45,290,332	45,625,998	45,961,664	46,297,330
Auto Vehicle-Miles Traveled	vmt/year		0	0	0	0	41,867,522	42,189,761	42,512,001	42,834,240	43,156,479	43,478,719	43,800,958	44,123,198	44,445,437
Truck Vehicle-Miles Traveled	vmt/year	4%	0	0	0	0	1,744,480	1,757,907	1,771,333	1,784,760	1,798,187	1,811,613	1,825,040	1,838,467	1,851,893
Incremental Bus VMT	vmt/year	2.6	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260
Build Scenario															
Automotive Traffic															
Annual Vehicle-Hours Traveled	vht/year		0	0	0	0	1,409,131	1,421,243	1,433,356	1,445,468	1,457,581	1,469,693	1,481,805	1,493,918	1,506,030
Auto VHT	vht/year		0	0	0	0	1,352,766	1,364,394	1,376,022	1,387,649	1,399,277	1,410,905	1,422,533	1,434,161	1,445,789
Truck VHT	vht/year	4%	0	0	0	0	56,365	56,850	57,334	57,819	58,303	58,788	59,272	59,757	60,241
Annual Vehicle-Miles Traveled	vmt/year		0	0	0	0	43,365,492	43,673,768	43,982,045	44,290,321	44,598,597	44,906,873	45,215,149	45,523,425	45,831,701
Auto Vehicle-Miles Traveled	vmt/year		0	0	0	0	41,630,873	41,926,818	42,222,763	42,518,708	42,814,653	43,110,598	43,406,543	43,702,488	43,998,433
Truck Vehicle-Miles Traveled	vmt/year	4%	0	0	0	0	1,734,620	1,746,951	1,759,282	1,771,613	1,783,944	1,796,275	1,808,606	1,820,937	1,833,268
Incremental Bus VMT	vmt/year	0.6	30,260	30,260	30,260	30,260	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503
Project Impact															
Bus Miles Avoided	vmt/year		0	0	0	0	23,757	23,757	23,757	23,757	23,757	23,757	23,757	23,757	23,757
Change in Auto VHT	vht/year		0	0	0	0	-15,759	-17,510	-19,261	-21,012	-22,763	-24,514	-26,265	-28,016	-29,767
Change in Truck VHT	vht/year		0	0	0	0	-657	-730	-803	-876	-948	-1,021	-1,094	-1,167	-1,240
Change in Auto VMT	vmt/year		0	0	0	0	-236,649	-262,943	-289,238	-315,532	-341,826	-368,121	-394,415	-420,710	-447,004
Change in Truck VMT	vmt/year		0	0	0	0	-9,860	-10,956	-12,052	-13,147	-14,243	-15,338	-16,434	-17,530	-18,625

Variable	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Transit Ridership														
Pima County Population Growth	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Average Weekday Route 27 Ridership	418	420	422	424	426	428	430	432	434	436	438	440	442	444
Route 27 Ridership (Annual)	109,006	109,584	110,150	110,703	111,245	111,778	112,301	112,812	113,316	113,815	114,308	114,798	115,286	115,775
Bus Trips	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484	11,484
No-Build Scenario														
Automotive Traffic														
Annual Vehicle-Hours Traveled	1,550,974	1,564,911	1,578,847	1,592,784	1,606,720	1,620,656	1,634,593	1,648,529	1,662,466	1,676,402	1,690,338	1,704,275	1,718,211	1,732,148
Auto VHT	1,488,935	1,502,314	1,515,693	1,529,072	1,542,451	1,555,830	1,569,209	1,582,588	1,595,967	1,609,346	1,622,725	1,636,104	1,649,483	1,662,862
Truck VHT	62,039	62,596	63,154	63,711	64,269	64,826	65,384	65,941	66,499	67,056	67,614	68,171	68,728	69,286
Annual Vehicle-Miles Traveled	46,632,996	46,968,663	47,304,329	47,639,995	47,975,661	48,311,327	48,646,993	48,982,659	49,318,325	49,653,991	49,989,657	50,325,323	50,660,989	50,996,655
Auto Vehicle-Miles Traveled	44,767,677	45,089,916	45,412,155	45,734,395	46,056,634	46,378,874	46,701,113	47,023,353	47,345,592	47,667,832	47,990,071	48,312,310	48,634,550	48,956,789
Truck Vehicle-Miles Traveled	1,865,320	1,878,747	1,892,173	1,905,600	1,919,026	1,932,453	1,945,880	1,959,306	1,972,733	1,986,160	1,999,586	2,013,013	2,026,440	2,039,866
Incremental Bus VMT	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260
Build Scenario														
Automotive Traffic														
Annual Vehicle-Hours Traveled	1,518,143	1,530,255	1,542,367	1,554,480	1,566,592	1,578,705	1,590,817	1,602,929	1,615,042	1,627,154	1,639,267	1,651,379	1,663,492	1,675,604
Auto VHT	1,457,417	1,469,045	1,480,673	1,492,301	1,503,929	1,515,556	1,527,184	1,538,812	1,550,440	1,562,068	1,573,696	1,585,324	1,596,952	1,608,580
Truck VHT	60,726	61,210	61,695	62,179	62,664	63,148	63,633	64,117	64,602	65,086	65,571	66,055	66,540	67,024
Annual Vehicle-Miles Traveled	46,139,978	46,448,254	46,756,530	47,064,806	47,373,082	47,681,358	47,989,634	48,297,910	48,606,187	48,914,463	49,222,739	49,531,015	49,839,291	50,147,567
Auto Vehicle-Miles Traveled	44,294,378	44,590,324	44,886,269	45,182,214	45,478,159	45,774,104	46,070,049	46,365,994	46,661,939	46,957,884	47,253,829	47,549,774	47,845,719	48,141,665
Truck Vehicle-Miles Traveled	1,845,599	1,857,930	1,870,261	1,882,592	1,894,923	1,907,254	1,919,585	1,931,916	1,944,247	1,956,579	1,968,910	1,981,241	1,993,572	2,005,903
Incremental Bus VMT	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503
Project Impact														
Bus Miles Avoided	23,757	23,757	23,757	23,757	23,757	23,757	23,757	23,757	23,757	23,757	23,757	23,757	23,757	23,757
Change in Auto VHT	-31,519	-33,270	-35,021	-36,772	-38,523	-40,274	-42,025	-43,776	-45,527	-47,278	-49,029	-50,780	-52,531	-54,282
Change in Truck VHT	-1,313	-1,386	-1,459	-1,532	-1,605	-1,678	-1,751	-1,824	-1,897	-1,970	-2,043	-2,116	-2,189	-2,262
Change in Auto VMT	-473,298	-499,593	-525,887	-552,181	-578,476	-604,770	-631,064	-657,359	-683,653	-709,947	-736,242	-762,536	-788,830	-815,125
Change in Truck VMT	-19,721	-20,816	-21,912	-23,008	-24,103	-25,199	-26,294	-27,390	-28,486	-29,581	-30,677	-31,772	-32,868	-33,964

Original NPV (Discounted at 3.1%)	Original BCR	Parameters	Change in Parameters	New NPV (Discounted at 3.1%)	Change in NPV	New BCR
$14.3 M	**1.5**	Change in Capital Costs	Increase capital costs by 15%	$10.0 M	-29.6%	1.3
			Decrease capital costs by 15%	$18.5 M	+29.6%	1.7
		Change in Value of Time	+25% Value of Time	$18.3 M	+28.3%	1.6
			-25% Value of Time	$10.2 M	-28.3%	1.3
		Transit Benefits	No Transit Benefits Monetized	$8.8 M	-38.4%	1.3

Travel Time Savings

Variable	Unit	Growth / Factor	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
No-Build																										
Automobile Vehicle Hours Traveled	vehicle hours/year		0	0	0	0	1,368,525	1,381,904	1,395,283	1,408,662	1,422,041	1,435,420	1,448,799	1,462,178	1,475,557	1,488,935	1,502,314	1,515,693	1,529,072	1,542,451	1,555,830	1,569,209	1,582,588	1,595,967	1,609,346	1,622,725
Truck Vehicle Hours Traveled	vehicle hours/year		0	0	0	0	57,022	57,579	58,137	58,694	59,252	59,809	60,367	60,924	61,482	62,039	62,596	63,154	63,711	64,269	64,826	65,384	65,941	66,499	67,056	67,614
Total Person Hours of Delay - Passenger Vehicles	person-hours/year	1.67	0	0	0	0	2,285,437	2,307,780	2,330,122	2,352,465	2,374,808	2,397,151	2,419,494	2,441,837	2,464,179	2,486,522	2,508,865	2,531,208	2,553,551	2,575,894	2,598,236	2,620,579	2,642,922	2,665,265	2,687,608	2,709,951
Total Person Hours of Delay - Trucks	person-hours/year	1.0	0	0	0	0	57,022	57,579	58,137	58,694	59,252	59,809	60,367	60,924	61,482	62,039	62,596	63,154	63,711	64,269	64,826	65,384	65,941	66,499	67,056	67,614
Travel Time Costs - Passengers Vehicles	2022$/year	$19.60	$0	$0	$0	$0	$44,794,560	$45,232,479	$45,670,399	$46,108,318	$46,546,238	$46,984,157	$47,422,077	$47,859,996	$48,297,916	$48,735,835	$49,173,755	$49,611,674	$50,049,594	$50,487,513	$50,925,433	$51,363,352	$51,801,272	$52,239,191	$52,677,111	$53,115,030
Travel Time Costs - Trucks	2022$/year	$33.50	$0	$0	$0	$0	$1,910,233	$1,928,908	$1,947,582	$1,966,257	$1,984,932	$2,003,607	$2,022,281	$2,040,956	$2,059,631	$2,078,306	$2,096,981	$2,115,655	$2,134,330	$2,153,005	$2,171,680	$2,190,354	$2,209,029	$2,227,704	$2,246,379	$2,265,053
Total Travel Time Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$46,704,793**	**$47,161,387**	**$47,617,981**	**$48,074,576**	**$48,531,170**	**$48,987,764**	**$49,444,358**	**$49,900,953**	**$50,357,547**	**$50,814,141**	**$51,270,735**	**$51,727,329**	**$52,183,924**	**$52,640,518**	**$53,097,112**	**$53,553,706**	**$54,010,301**	**$54,466,895**	**$54,923,489**	**$55,380,083**
Build																										
Automobile Vehicle Hours Traveled	vehicle hours/year		0	0	0	0	1,352,766	1,364,394	1,376,022	1,387,649	1,399,277	1,410,905	1,422,533	1,434,161	1,445,789	1,457,417	1,469,045	1,480,673	1,492,301	1,503,929	1,515,556	1,527,184	1,538,812	1,550,440	1,562,068	1,573,696
Truck Vehicle Hours Traveled	vehicle hours/year		0	0	0	0	56,365	56,850	57,334	57,819	58,303	58,788	59,272	59,757	60,241	60,726	61,210	61,695	62,179	62,664	63,148	63,633	64,117	64,602	65,086	65,571
Total Person Hours of Delay - Passenger Vehicles	person-hours/year	1.67	0	0	0	0	2,259,119	2,278,537	2,297,956	2,317,375	2,336,793	2,356,212	2,375,630	2,395,049	2,414,468	2,433,886	2,453,305	2,472,724	2,492,142	2,511,561	2,530,979	2,550,398	2,569,817	2,589,235	2,608,654	2,628,072
Total Person Hours of Delay - Trucks	person-hours/year	1.0	0	0	0	0	56,365	56,850	57,334	57,819	58,303	58,788	59,272	59,757	60,241	60,726	61,210	61,695	62,179	62,664	63,148	63,633	64,117	64,602	65,086	65,571
Travel Time Costs - Passengers Vehicles	2022$/year	$19.60	$0	$0	$0	$0	$44,278,728	$44,659,333	$45,039,937	$45,420,542	$45,801,147	$46,181,752	$46,562,357	$46,942,961	$47,323,566	$47,704,171	$48,084,776	$48,465,381	$48,845,985	$49,226,590	$49,607,195	$49,987,800	$50,368,405	$50,749,009	$51,129,614	$51,510,219
Travel Time Costs - Trucks	2022$/year	$33.50	$0	$0	$0	$0	$1,888,235	$1,904,466	$1,920,697	$1,936,927	$1,953,158	$1,969,389	$1,985,619	$2,001,850	$2,018,081	$2,034,311	$2,050,542	$2,066,772	$2,083,003	$2,099,234	$2,115,464	$2,131,695	$2,147,926	$2,164,156	$2,180,387	$2,196,617
Total Travel Time Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$46,166,963**	**$46,563,799**	**$46,960,634**	**$47,357,470**	**$47,754,305**	**$48,151,140**	**$48,547,976**	**$48,944,811**	**$49,341,647**	**$49,738,482**	**$50,135,318**	**$50,532,153**	**$50,928,988**	**$51,325,824**	**$51,722,659**	**$52,119,495**	**$52,516,330**	**$52,913,166**	**$53,310,001**	**$53,706,836**
Project Impacts																										
Avoided Vehicle Hours Traveled	vehicle hours/year		0	0	0	0	16,416	18,240	20,064	21,888	23,712	25,536	27,360	29,184	31,008	32,832	34,656	36,480	38,304	40,128	41,952	43,776	45,600	47,424	49,248	51,072
Avoided Person Hours Traveled	person-hours/year		0	0	0	0	26,975	29,972	32,969	35,966	38,963	41,960	44,958	47,955	50,952	53,949	56,946	59,944	62,941	65,938	68,935	71,932	74,929	77,927	80,924	83,921
Avoided Travel Time Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$537,829**	**$597,588**	**$657,347**	**$717,106**	**$776,865**	**$836,624**	**$896,382**	**$956,141**	**$1,015,900**	**$1,075,659**	**$1,135,418**	**$1,195,176**	**$1,254,935**	**$1,314,694**	**$1,374,453**	**$1,434,212**	**$1,493,971**	**$1,553,729**	**$1,613,488**	**$1,673,247**

Avoided Emissions

Variable	Unit	Constant	2024	2025	2026	2027	2028	2029	2030	2031
Factors										
Value of CO_2	2022$/year		$233.00	$237.00	$241.00	$245.00	$250.00	$253.00	$257.00	$262.00
Value of NOX	2022$/year		$20,100	$20,300	$20,600	$21,000	$21,300	$21,700	$22,000	$22,000
Value of VOC	2022$/year		$0	$0	$0	$0	$0	$0	$0	$0
Value of PM	2022$/year		$963,200	$975,500	$993,500	$1,011,900	$1,030,600	$1,049,600	$1,069,000	$1,069,000
Value of SO_2	2022$/year		$53,800	$54,800	$56,100	$57,400	$58,700	$60,100	$61,500	$61,500
Passenger Vehicle Emissions										
CO_2 per Gallon of Fuel Burnec	grams/mile		270.53	264.31	258.08	251.85	245.63	239.40	233.17	230.90
NOx per Gallon of Fuel Burnec	grams/mile		0.10	0.09	0.07	0.06	0.05	0.04	0.03	0.02
VOC per Gallon of Fuel Burnec	grams/mile		0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01
PM per Gallon of Fuel Burnec	grams/mile		0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001
SO_2 per Gallon of Fuel Burnec	grams/mile		0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Truck Emissions										
CO_2 per Gallon of Fuel Burnec	grams/mile		1,214.27	1,193.75	1,173.24	1,152.72	1,132.21	1,111.69	1,091.18	1,082.74
NOx per Gallon of Fuel Burnec	grams/mile		2.97	2.84	2.70	2.57	2.43	2.30	2.16	2.14
VOC per Gallon of Fuel Burnec	grams/mile		0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.05
PM per Gallon of Fuel Burnec	grams/mile		0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02
SO_2 per Gallon of Fuel Burnec	grams/mile		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transit Bus Emissions										
CO_2 per Gallon of Fuel Burnec	grams/mile		1,404.68	1,390.74	1,376.81	1,362.87	1,348.93	1,335.00	1,321.06	1,311.62
NOx per Gallon of Fuel Burnec	grams/mile		3.12	3.01	2.89	2.78	2.67	2.56	2.45	2.41
VOC per Gallon of Fuel Burnec	grams/mile		0.13	0.12	0.11	0.09	0.08	0.07	0.06	0.05
PM per Gallon of Fuel Burnec	grams/mile		0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01
SO_2 per Gallon of Fuel Burnec	grams/mile		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No-Build										
Vehicle Miles Traveled - Passenger Vehicles	vehicle-miles/year		0	0	0	0	41,867,522	42,189,761	42,512,001	42,834,240
Vehicle Miles Traveled - Trucks	vehicle-miles/year		0	0	0	0	1,744,480	1,757,907	1,771,333	1,784,760
Incremental Vehicle Miles Traveled - Transit Bu	vehicle-miles/year		30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260
CO_2 Emissions	grams/year		42,506,155	42,084,416	41,662,678	41,240,940	12,299,663,761	12,094,818,928	11,885,410,091	11,862,504,053
NOx Emissions	grams/year		94,367	90,975	87,584	84,192	6,426,648	5,726,435	5,014,831	4,919,718
VOC Emissions	grams/year		3,919	3,559	3,199	2,839	767,976	643,910	517,865	501,681
PM Emission froms	grams/year		1,067	958	849	741	127,137	113,139	98,914	96,874
SO_2 Emissions	grams/year		143	141	140	138	75,059	73,762	72,438	72,287
CO_2 Emissions	metric tons/year	1,000,000	43	42	42	41	12,300	12,095	11,885	11,863
NOx Emissions	metric tons/year	1,000,000	0.094	0.091	0.088	0.084	6.427	5.726	5.015	4.920
VOC Emissions	metric tons/year	1,000,000	0.004	0.004	0.003	0.003	0.768	0.644	0.518	0.502
PM Emission froms	metric tons/year	1,000,000	0.001	0.001	0.001	0.001	0.127	0.113	0.099	0.097
SO_2 Emissions	metric tons/year	1,000,000	0.000	0.000	0.000	0.000	0.075	0.074	0.072	0.072
CO_2 Emission Costs	2022$/year		$9,904	$9,974	$10,041	$10,104	$3,074,916	$3,059,989	$3,054,550	$3,107,976
NOx Emission Costs	2022$/year		$1,897	$1,847	$1,804	$1,768	$136,888	$124,264	$110,326	$108,234
VOC Emission Costs	2022$/year		$0	$0	$0	$0	$0	$0	$0	$0
PM Emission Costs	2022$/year		$1,028	$935	$844	$750	$131,027	$118,751	$105,740	$103,558
SO_2 Emission Costs	2022$/year		$8	$8	$8	$8	$4,406	$4,433	$4,455	$4,446
Total Emission Costs	**2022$/year**		**$12,836**	**$12,763**	**$12,697**	**$12,629**	**$3,347,237**	**$3,307,437**	**$3,275,071**	**$3,324,214**
Build										
Vehicle Miles Traveled - Passenger Vehicles	vehicle-miles/year		0	0	0	0	41,630,873	41,926,818	42,222,763	42,518,708
Vehicle Miles Traveled - Trucks	vehicle-miles/year		0	0	0	0	1,734,620	1,746,951	1,759,282	1,771,613
Incremental Vehicle Miles Traveled - Transit Bu	vehicle-miles/year		30,260	30,260	30,260	30,260	6,503	6,503	6,503	6,503
CO_2 Emissions	grams/year		42,506,155	42,084,416	41,662,678	41,240,940	12,198,325,964	11,987,975,314	11,773,433,077	11,744,252,662
NOx Emissions	grams/year		94,367	90,975	87,584	84,192	6,327,344	5,630,455	4,923,106	4,826,773
VOC Emissions	grams/year		3,919	3,559	3,199	2,839	761,703	638,247	512,972	496,693
PM Emission froms	grams/year		1,067	958	849	741	125,926	112,027	97,919	95,862
SO_2 Emissions	grams/year		143	141	140	138	74,528	73,197	71,841	71,651
CO_2 Emissions	metric tons/year	1,000,000	43	42	42	41	12,198	11,988	11,773	11,744
NOx Emissions	metric tons/year	1,000,000	0.094	0.091	0.088	0.084	6.327	5.630	4.923	4.827
VOC Emissions	metric tons/year	1,000,000	0.004	0.004	0.003	0.003	0.762	0.638	0.513	0.497
PM Emission froms	metric tons/year	1,000,000	0.001	0.001	0.001	0.001	0.126	0.112	0.098	0.096
SO_2 Emissions	metric tons/year	1,000,000	0.000	0.000	0.000	0.000	0.075	0.073	0.072	0.072
CO_2 Emission Costs	2022$/year		$9,904	$9,974	$10,041	$10,104	$3,049,581	$3,032,958	$3,025,772	$3,076,994
NOx Emission Costs	2022$/year		$1,897	$1,847	$1,804	$1,768	$134,772	$122,181	$108,308	$106,189
VOC Emission Costs	2022$/year		$0	$0	$0	$0	$0	$0	$0	$0
PM Emission Costs	2022$/year		$1,028	$935	$844	$750	$129,779	$117,583	$104,675	$102,476
SO_2 Emission Costs	2022$/year		$8	$8	$8	$8	$4,375	$4,399	$4,418	$4,407
Total Emission Costs	**2022$/year**		**$12,836**	**$12,763**	**$12,697**	**$12,629**	**$3,318,508**	**$3,277,121**	**$3,243,174**	**$3,290,066**
Project Impact										
Avoided CO_2 Emission	**metric tons/year**		**0**	**0**	**0**	**0**	**101**	**107**	**112**	**118**
Avoided NOx Emission	**metric tons/year**		**0.000**	**0.000**	**0.000**	**0.000**	**0.099**	**0.096**	**0.092**	**0.093**
Avoided VOC Emission	**metric tons/year**		**0.000**	**0.000**	**0.000**	**0.000**	**0.006**	**0.006**	**0.005**	**0.005**
Avoided PM Emission	**metric tons/year**		**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.001**	**0.001**
Avoided SO_2 Emission	**metric tons/year**		**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.001**	**0.001**	**0.001**
Avoided CAC Emission Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$25,334**	**$27,031**	**$28,778**	**$30,982**
Avoided CAC Emission Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$3,395**	**$3,284**	**$3,119**	**$3,166**

Variable	2032	2033	2034	2035	2036	2037	2038	2039
Factors								
Value of CO_2	$265.00	$270.00	$274.00	$278.00	$282.00	$287.00	$290.00	$294.00
Value of NOX	$22,000	$22,000	$22,000	$22,000	$22,000	$22,000	$22,000	$22,000
Value of VOC	$0	$0	$0	$0	$0	$0	$0	$0
Value of PM	$1,069,000	$1,069,000	$1,069,000	$1,069,000	$1,069,000	$1,069,000	$1,069,000	$1,069,000
Value of SO_2	$61,500	$61,500	$61,500	$61,500	$61,500	$61,500	$61,500	$61,500
Passenger Vehicle Emissions								
CO_2 per Gallon of Fuel Burnec	228.63	226.35	224.08	221.81	219.54	217.26	214.99	212.72
NOx per Gallon of Fuel Burnec	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
VOC per Gallon of Fuel Burnec	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PM per Gallon of Fuel Burnec	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SO_2 per Gallon of Fuel Burnec	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Truck Emissions								
CO_2 per Gallon of Fuel Burnec	1,074.30	1,065.86	1,057.42	1,048.98	1,040.54	1,032.10	1,023.66	1,015.23
NOx per Gallon of Fuel Burnec	2.12	2.09	2.07	2.05	2.03	2.00	1.98	1.96
VOC per Gallon of Fuel Burnec	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.04
PM per Gallon of Fuel Burnec	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
SO_2 per Gallon of Fuel Burnec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transit Bus Emissions								
CO_2 per Gallon of Fuel Burnec	1,302.19	1,292.75	1,283.32	1,273.88	1,264.44	1,255.01	1,245.57	1,236.14
NOx per Gallon of Fuel Burnec	2.37	2.34	2.30	2.26	2.23	2.19	2.15	2.12
VOC per Gallon of Fuel Burnec	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03
PM per Gallon of Fuel Burnec	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
SO_2 per Gallon of Fuel Burnec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No-Build								
Vehicle Miles Traveled - Passenger Vehicles	43,156,479	43,478,719	43,800,958	44,123,198	44,445,437	44,767,677	45,089,916	45,412,155
Vehicle Miles Traveled - Trucks	1,798,187	1,811,613	1,825,040	1,838,467	1,851,893	1,865,320	1,878,747	1,892,173
Incremental Vehicle Miles Traveled - Transit Bu	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260
CO_2 Emissions	11,837,906,730	11,811,618,123	11,783,638,231	11,753,967,055	11,722,604,595	11,689,550,850	11,654,805,821	11,618,369,508
NOx Emissions	4,822,626	4,723,556	4,622,509	4,519,483	4,414,480	4,307,499	4,198,540	4,087,603
VOC Emissions	485,196	468,410	451,323	433,935	416,247	398,257	379,967	361,376
PM Emission froms	94,792	92,669	90,504	88,298	86,050	83,761	81,430	79,058
SO_2 Emissions	72,126	71,954	71,772	71,579	71,376	71,163	70,938	70,704
CO_2 Emissions	11,838	11,812	11,784	11,754	11,723	11,690	11,655	11,618
NOx Emissions	4.823	4.724	4.623	4.519	4.414	4.307	4.199	4.088
VOC Emissions	0.485	0.468	0.451	0.434	0.416	0.398	0.380	0.361
PM Emission froms	0.095	0.093	0.091	0.088	0.086	0.084	0.081	0.079
SO_2 Emissions	0.072	0.072	0.072	0.072	0.071	0.071	0.071	0.071
CO_2 Emission Costs	$3,137,045	$3,189,137	$3,228,717	$3,267,603	$3,305,774	$3,354,901	$3,379,894	$3,415,801
NOx Emission Costs	$106,098	$103,918	$101,695	$99,429	$97,119	$94,765	$92,368	$89,927
VOC Emission Costs	$0	$0	$0	$0	$0	$0	$0	$0
PM Emission Costs	$101,333	$99,063	$96,749	$94,391	$91,988	$89,541	$87,049	$84,513
SO_2 Emission Costs	$4,436	$4,425	$4,414	$4,402	$4,390	$4,376	$4,363	$4,348
Total Emission Costs	**$3,348,912**	**$3,396,543**	**$3,431,575**	**$3,465,824**	**$3,499,270**	**$3,543,583**	**$3,563,673**	**$3,594,589**
Build								
Vehicle Miles Traveled - Passenger Vehicles	42,814,653	43,110,598	43,406,543	43,702,488	43,998,433	44,294,378	44,590,324	44,886,269
Vehicle Miles Traveled - Trucks	1,783,944	1,796,275	1,808,606	1,820,937	1,833,268	1,845,599	1,857,930	1,870,261
Incremental Vehicle Miles Traveled - Transit Bu	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503
CO_2 Emissions	11,713,518,970	11,681,232,000	11,647,391,753	11,611,998,228	11,575,051,425	11,536,551,344	11,496,497,986	11,454,891,351
NOx Emissions	4,728,625	4,628,659	4,526,877	4,423,279	4,317,864	4,210,633	4,101,585	3,990,721
VOC Emissions	480,138	463,306	446,198	428,814	411,153	393,216	375,003	356,514
PM Emission froms	93,766	91,633	89,461	87,251	85,003	82,718	80,394	78,031
SO_2 Emissions	71,452	71,243	71,025	70,797	70,559	70,312	70,055	69,788
CO_2 Emissions	11,714	11,681	11,647	11,612	11,575	11,537	11,496	11,455
NOx Emissions	4.729	4.629	4.527	4.423	4.318	4.211	4.102	3.991
VOC Emissions	0.480	0.463	0.446	0.429	0.411	0.393	0.375	0.357
PM Emission froms	0.094	0.092	0.089	0.087	0.085	0.083	0.080	0.078
SO_2 Emissions	0.071	0.071	0.071	0.071	0.071	0.070	0.070	0.070
CO_2 Emission Costs	$3,104,083	$3,153,933	$3,191,385	$3,228,136	$3,264,165	$3,310,990	$3,333,984	$3,367,738
NOx Emission Costs	$104,030	$101,831	$99,591	$97,312	$94,993	$92,634	$90,235	$87,796
VOC Emission Costs	$0	$0	$0	$0	$0	$0	$0	$0
PM Emission Costs	$100,236	$97,955	$95,634	$93,272	$90,869	$88,425	$85,941	$83,416
SO_2 Emission Costs	$4,394	$4,381	$4,368	$4,354	$4,339	$4,324	$4,308	$4,292
Total Emission Costs	**$3,312,743**	**$3,358,100**	**$3,390,978**	**$3,423,073**	**$3,454,366**	**$3,496,373**	**$3,514,468**	**$3,543,241**
Project Impact								
Avoided CO_2 Emission	**124**	**130**	**136**	**142**	**148**	**153**	**158**	**163**
Avoided NOx Emission	**0.094**	**0.095**	**0.096**	**0.096**	**0.097**	**0.097**	**0.097**	**0.097**
Avoided VOC Emission	**0.005**	**0.005**	**0.005**	**0.005**	**0.005**	**0.005**	**0.005**	**0.005**
Avoided PM Emission	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Avoided SO_2 Emission	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Avoided CAC Emission Costs	**$32,963**	**$35,204**	**$37,332**	**$39,467**	**$41,610**	**$43,911**	**$45,909**	**$48,063**
Avoided CAC Emission Costs	**$3,206**	**$3,239**	**$3,265**	**$3,284**	**$3,295**	**$3,299**	**$3,296**	**$3,285**

Variable	2040	2041	2042	2043	2044	2045	2046	2047
Factors								
Value of CO_2	$299.00	$303.00	$308.00	$312.00	$317.00	$321.00	$326.00	$331.00
Value of NOX	$22,000	$22,000	$22,000	$22,000	$22,000	$22,000	$22,000	$22,000
Value of VOC	$0	$0	$0	$0	$0	$0	$0	$0
Value of PM	$1,069,000	$1,069,000	$1,069,000	$1,069,000	$1,069,000	$1,069,000	$1,069,000	$1,069,000
Value of SO_2	$61,500	$61,500	$61,500	$61,500	$61,500	$61,500	$61,500	$61,500
Passenger Vehicle Emissions								
CO_2 per Gallon of Fuel Burnec	210.45	210.01	209.58	209.15	208.71	208.28	207.85	207.42
NOx per Gallon of Fuel Burnec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VOC per Gallon of Fuel Burnec	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PM per Gallon of Fuel Burnec	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SO_2 per Gallon of Fuel Burnec	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Truck Emissions								
CO_2 per Gallon of Fuel Burnec	1,006.79	1,005.41	1,004.04	1,002.66	1,001.28	999.91	998.53	997.16
NOx per Gallon of Fuel Burnec	1.94	1.93	1.93	1.92	1.92	1.92	1.91	1.91
VOC per Gallon of Fuel Burnec	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
PM per Gallon of Fuel Burnec	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
SO_2 per Gallon of Fuel Burnec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transit Bus Emissions								
CO_2 per Gallon of Fuel Burnec	1,226.70	1,223.25	1,219.79	1,216.34	1,212.88	1,209.43	1,205.98	1,202.52
NOx per Gallon of Fuel Burnec	2.08	2.07	2.07	2.06	2.06	2.05	2.04	2.04
VOC per Gallon of Fuel Burnec	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02
PM per Gallon of Fuel Burnec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO_2 per Gallon of Fuel Burnec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No-Build								
Vehicle Miles Traveled - Passenger Vehicles	45,734,395	46,056,634	46,378,874	46,701,113	47,023,353	47,345,592	47,667,832	47,990,071
Vehicle Miles Traveled - Trucks	1,905,600	1,919,026	1,932,453	1,945,880	1,959,306	1,972,733	1,986,160	1,999,586
Incremental Vehicle Miles Traveled - Transit Bu	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260
CO_2 Emissions	11,580,241,910	11,638,904,504	11,697,251,351	11,755,282,450	11,812,997,800	11,870,397,402	11,927,481,256	11,984,249,362
NOx Emissions	3,974,688	3,986,332	3,997,756	4,008,960	4,019,944	4,030,707	4,041,251	4,051,574
VOC Emissions	342,484	342,318	342,115	341,877	341,603	341,294	340,948	340,566
PM Emission froms	76,645	76,766	76,881	76,990	77,093	77,191	77,282	77,368
SO_2 Emissions	70,459	70,813	71,165	71,515	71,863	72,209	72,553	72,896
CO_2 Emissions	11,580	11,639	11,697	11,755	11,813	11,870	11,927	11,984
NOx Emissions	3.975	3.986	3.998	4.009	4.020	4.031	4.041	4.052
VOC Emissions	0.342	0.342	0.342	0.342	0.342	0.341	0.341	0.341
PM Emission froms	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
SO_2 Emissions	0.070	0.071	0.071	0.072	0.072	0.072	0.073	0.073
CO_2 Emission Costs	$3,462,492	$3,526,588	$3,602,753	$3,667,648	$3,744,720	$3,810,398	$3,888,359	$3,966,787
NOx Emission Costs	$87,443	$87,699	$87,951	$88,197	$88,439	$88,676	$88,908	$89,135
VOC Emission Costs	$0	$0	$0	$0	$0	$0	$0	$0
PM Emission Costs	$81,933	$82,062	$82,185	$82,302	$82,413	$82,517	$82,615	$82,706
SO_2 Emission Costs	$4,333	$4,355	$4,377	$4,398	$4,420	$4,441	$4,462	$4,483
Total Emission Costs	**$3,636,202**	**$3,700,705**	**$3,777,266**	**$3,842,545**	**$3,919,991**	**$3,986,031**	**$4,064,343**	**$4,143,111**
Build								
Vehicle Miles Traveled - Passenger Vehicles	45,182,214	45,478,159	45,774,104	46,070,049	46,365,994	46,661,939	46,957,884	47,253,829
Vehicle Miles Traveled - Trucks	1,882,592	1,894,923	1,907,254	1,919,585	1,931,916	1,944,247	1,956,579	1,968,910
Incremental Vehicle Miles Traveled - Transit Bu	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503
CO_2 Emissions	11,411,731,437	11,464,122,946	11,516,224,470	11,568,036,012	11,619,557,570	11,670,789,144	11,721,730,735	11,772,382,342
NOx Emissions	3,878,040	3,887,776	3,897,309	3,906,640	3,915,769	3,924,696	3,933,420	3,941,943
VOC Emissions	337,748	337,424	337,068	336,678	336,256	335,800	335,312	334,791
PM Emission froms	75,631	75,714	75,791	75,862	75,929	75,990	76,045	76,095
SO_2 Emissions	69,512	69,828	70,142	70,454	70,764	71,072	71,379	71,684
CO_2 Emissions	11,412	11,464	11,516	11,568	11,620	11,671	11,722	11,772
NOx Emissions	3.878	3.888	3.897	3.907	3.916	3.925	3.933	3.942
VOC Emissions	0.338	0.337	0.337	0.337	0.336	0.336	0.335	0.335
PM Emission froms	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
SO_2 Emissions	0.070	0.070	0.070	0.070	0.071	0.071	0.071	0.072
CO_2 Emission Costs	$3,412,108	$3,473,629	$3,546,997	$3,609,227	$3,683,400	$3,746,323	$3,821,284	$3,896,659
NOx Emission Costs	$85,317	$85,531	$85,741	$85,946	$86,147	$86,343	$86,535	$86,723
VOC Emission Costs	$0	$0	$0	$0	$0	$0	$0	$0
PM Emission Costs	$80,850	$80,938	$81,020	$81,097	$81,168	$81,233	$81,292	$81,346
SO_2 Emission Costs	$4,275	$4,294	$4,314	$4,333	$4,352	$4,371	$4,390	$4,409
Total Emission Costs	**$3,582,549**	**$3,644,393**	**$3,718,072**	**$3,780,603**	**$3,855,066**	**$3,918,271**	**$3,993,502**	**$4,069,136**
Project Impact								
Avoided CO_2 Emission	**169**	**175**	**181**	**187**	**193**	**200**	**206**	**212**
Avoided NOx Emission	**0.097**	**0.099**	**0.100**	**0.102**	**0.104**	**0.106**	**0.108**	**0.110**
Avoided VOC Emission	**0.005**	**0.005**	**0.005**	**0.005**	**0.005**	**0.005**	**0.006**	**0.006**
Avoided PM Emission	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Avoided SO_2 Emission	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Avoided CAC Emission Costs	**$50,385**	**$52,959**	**$55,756**	**$58,421**	**$61,321**	**$64,074**	**$67,075**	**$70,128**
Avoided CAC Emission Costs	**$3,268**	**$3,353**	**$3,438**	**$3,521**	**$3,604**	**$3,686**	**$3,767**	**$3,847**

Safety Benefits

Variable	Unit	Growth / Factor	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
No-Build														
Fatal Crashes	crashes/year		0.493	0.499	0.504	0.509	0.515	0.520	0.525	0.531	0.537	0.542	0.548	0.554
Injury Crashes	crashes/year		18.0	18.2	18.4	18.6	18.8	19.0	19.2	19.4	19.6	19.8	20.0	20.2
PDO Crashes	crashes/year		25.6	25.8	26.1	26.3	26.6	26.8	27.1	27.3	27.6	27.8	28.1	28.3
Cost of Fatal Crashes	2022$/year	$14,022,900	$6,918,531	$6,991,557	$7,065,355	$7,139,931	$7,215,295	$7,291,454	$7,368,417	$7,446,192	$7,524,789	$7,604,214	$7,684,479	$7,765,590
Cost of Injury Crashes	2022$/year	$313,000	$5,629,319	$5,688,737	$5,748,783	$5,809,463	$5,870,783	$5,932,751	$5,995,372	$6,058,655	$6,122,605	$6,187,231	$6,252,539	$6,318,536
Cost of PDO Crashes	2022$/year	$9,100	$233,001	$235,158	$237,335	$239,532	$241,749	$243,987	$246,246	$248,526	$250,826	$253,148	$255,492	$257,857
Total Accident Costs	**2022$/year**		**$12,780,850**	**$12,915,453**	**$13,051,473**	**$13,188,926**	**$13,327,828**	**$13,468,192**	**$13,610,035**	**$13,753,373**	**$13,898,220**	**$14,044,593**	**$14,192,509**	**$14,341,982**
Build														
Fatal Crashes	crashes/year		0.493	0.499	0.504	0.509	0.485	0.487	0.490	0.492	0.494	0.497	0.499	0.502
Injury Crashes	crashes/year		18.0	18.2	18.4	18.6	17.7	17.8	17.8	17.9	18.0	18.1	18.2	18.3
PDO Crashes	crashes/year		25.6	25.8	26.1	26.3	25.8	25.9	26.1	26.2	26.4	26.5	26.7	26.8
Cost of Fatal Crashes	2022$/year	$14,022,900	$6,918,531	$6,991,557	$7,065,355	$7,139,931	$6,798,293	$6,832,041	$6,865,957	$6,900,041	$6,934,294	$6,968,718	$7,003,312	$7,038,078
Cost of Injury Crashes	2022$/year	$313,000	$5,629,319	$5,688,737	$5,748,783	$5,809,463	$5,531,486	$5,558,946	$5,586,542	$5,614,274	$5,642,145	$5,670,154	$5,698,302	$5,726,590
Cost of PDO Crashes	2022$/year	$9,100	$233,001	$235,158	$237,335	$239,532	$234,513	$235,876	$237,246	$238,625	$240,011	$241,406	$242,808	$244,219
Total Accident Costs	**2022$/year**		**$12,780,850**	**$12,915,453**	**$13,051,473**	**$13,188,926**	**$12,564,292**	**$12,626,862**	**$12,689,744**	**$12,752,940**	**$12,816,451**	**$12,880,278**	**$12,944,423**	**$13,008,887**
Project Impacts														
Avoided Fatal Crashes	crashes/year		0.00	0.00	0.00	0.00	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05
Avoided Injury Crashes	crashes/year		0.0	0.0	0.0	0.0	1.1	1.2	1.3	1.4	1.5	1.7	1.8	1.9
Avoided PDO Crashes	crashes/year		0.0	0.0	0.0	0.0	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
Avoided Accident Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$763,536**	**$841,330**	**$920,291**	**$1,000,433**	**$1,081,770**	**$1,164,316**	**$1,248,086**	**$1,333,095**

Variable	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
No-Build												
Fatal Crashes	0.560	0.566	0.572	0.578	0.584	0.590	0.596	0.602	0.609	0.615	0.615	0.615
Injury Crashes	20.4	20.6	20.8	21.1	21.3	21.5	21.7	22.0	22.2	22.4	22.4	22.4
PDO Crashes	28.6	28.9	29.1	29.4	29.7	29.9	30.2	30.5	30.8	31.1	31.1	31.1
Cost of Fatal Crashes	$7,847,558	$7,930,391	$8,014,098	$8,098,688	$8,184,172	$8,270,558	$8,357,855	$8,446,075	$8,535,225	$8,625,316	$8,625,316	$8,625,316
Cost of Injury Crashes	$6,385,229	$6,452,627	$6,520,736	$6,589,564	$6,659,118	$6,729,406	$6,800,437	$6,872,217	$6,944,755	$7,018,058	$7,018,058	$7,018,058
Cost of PDO Crashes	$260,244	$262,653	$265,084	$267,538	$270,015	$272,514	$275,037	$277,583	$280,153	$282,746	$282,746	$282,746
Total Accident Costs	**$14,493,031**	**$14,645,670**	**$14,799,918**	**$14,955,790**	**$15,113,305**	**$15,272,479**	**$15,433,329**	**$15,595,875**	**$15,760,132**	**$15,926,121**	**$15,926,121**	**$15,926,121**
Build												
Fatal Crashes	0.504	0.507	0.509	0.512	0.514	0.517	0.520	0.522	0.525	0.527	0.527	0.527
Injury Crashes	18.4	18.5	18.6	18.7	18.8	18.8	18.9	19.0	19.1	19.2	19.2	19.2
PDO Crashes	27.0	27.2	27.3	27.5	27.6	27.8	27.9	28.1	28.3	28.4	28.4	28.4
Cost of Fatal Crashes	$7,073,017	$7,108,129	$7,143,416	$7,178,877	$7,214,515	$7,250,330	$7,286,322	$7,322,493	$7,358,844	$7,395,375	$7,395,375	$7,395,375
Cost of Injury Crashes	$5,755,018	$5,783,587	$5,812,298	$5,841,152	$5,870,149	$5,899,289	$5,928,575	$5,958,006	$5,987,583	$6,017,307	$6,017,307	$6,017,307
Cost of PDO Crashes	$245,638	$247,065	$248,501	$249,945	$251,397	$252,858	$254,327	$255,805	$257,291	$258,786	$258,786	$258,786
Total Accident Costs	**$13,073,673**	**$13,138,782**	**$13,204,215**	**$13,269,974**	**$13,336,061**	**$13,402,477**	**$13,469,224**	**$13,536,303**	**$13,603,717**	**$13,671,467**	**$13,671,467**	**$13,671,467**
Project Impacts												
Avoided Fatal Crashes	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09
Avoided Injury Crashes	2.0	2.1	2.3	2.4	2.5	2.7	2.8	2.9	3.1	3.2	3.2	3.2
Avoided PDO Crashes	1.6	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.5	2.6	2.6	2.6
Avoided Accident Costs	**$1,419,358**	**$1,506,888**	**$1,595,703**	**$1,685,816**	**$1,777,244**	**$1,870,002**	**$1,964,106**	**$2,059,571**	**$2,156,415**	**$2,254,654**	**$2,254,654**	**$2,254,654**

Vehicle Operating Cost Savings

Variable	Unit	Constant	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
No-Build														
Vehicle Miles Traveled - Passenger Vehicles	vehicle-miles/year		0	0	0	0	41,867,522	42,189,761	42,512,001	42,834,240	43,156,479	43,478,719	43,800,958	44,123,198
Vehicle Miles Traveled - Trucks	vehicle-miles/year		0	0	0	0	1,744,480	1,757,907	1,771,333	1,784,760	1,798,187	1,811,613	1,825,040	1,838,467
Vehicle Operating Costs - Passenger Vehicles	2022$/year	$0.52	$0	$0	$0	$0	$21,771,111	$21,938,676	$22,106,240	$22,273,805	$22,441,369	$22,608,934	$22,776,498	$22,944,063
Vehicle Operating Costs - Trucks	2022$/year	$1.32	$0	$0	$0	$0	$2,302,714	$2,320,437	$2,338,160	$2,355,883	$2,373,606	$2,391,330	$2,409,053	$2,426,776
Total Vehicle Operating Costs	**2022$/year**		$0	$0	$0	$0	$24,073,825	$24,259,113	$24,444,400	$24,629,688	$24,814,976	$25,000,263	$25,185,551	$25,370,839
Build														
Vehicle Miles Traveled - Passenger Vehicles	vehicle-miles/year		0	0	0	0	41,630,873	41,926,818	42,222,763	42,518,708	42,814,653	43,110,598	43,406,543	43,702,488
Vehicle Miles Traveled - Trucks	vehicle-miles/year		0	0	0	0	1,734,620	1,746,951	1,759,282	1,771,613	1,783,944	1,796,275	1,808,606	1,820,937
Vehicle Operating Costs - Passenger Vehicles	2022$/year	$0.520	$0	$0	$0	$0	$21,648,054	$21,801,945	$21,955,837	$22,109,728	$22,263,620	$22,417,511	$22,571,402	$22,725,294
Vehicle Operating Costs - Trucks	2022$/year	$1.32	$0	$0	$0	$0	$2,289,698	$2,305,975	$2,322,252	$2,338,529	$2,354,806	$2,371,083	$2,387,360	$2,403,637
Total Vehicle Operating Costs	**2022$/year**		$0	$0	$0	$0	$23,937,752	$24,107,920	$24,278,089	$24,448,257	$24,618,425	$24,788,594	$24,958,762	$25,128,931
Project Impact														
Avoided Vehicle Operating Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$136,073**	**$151,192**	**$166,312**	**$181,431**	**$196,550**	**$211,669**	**$226,789**	**$241,908**

Variable	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
No-Build												
Vehicle Miles Traveled - Passenger Vehicles	44,445,437	44,767,677	45,089,916	45,412,155	45,734,395	46,056,634	46,378,874	46,701,113	47,023,353	47,345,592	47,667,832	47,990,071
Vehicle Miles Traveled - Trucks	1,851,893	1,865,320	1,878,747	1,892,173	1,905,600	1,919,026	1,932,453	1,945,880	1,959,306	1,972,733	1,986,160	1,999,586
Vehicle Operating Costs - Passenger Vehicles	$23,111,627	$23,279,192	$23,446,756	$23,614,321	$23,781,885	$23,949,450	$24,117,014	$24,284,579	$24,452,143	$24,619,708	$24,787,272	$24,954,837
Vehicle Operating Costs - Trucks	$2,444,499	$2,462,222	$2,479,945	$2,497,669	$2,515,392	$2,533,115	$2,550,838	$2,568,561	$2,586,284	$2,604,008	$2,621,731	$2,639,454
Total Vehicle Operating Costs	$25,556,126	$25,741,414	$25,926,702	$26,111,989	$26,297,277	$26,482,565	$26,667,852	$26,853,140	$27,038,428	$27,223,715	$27,409,003	$27,594,291
Build												
Vehicle Miles Traveled - Passenger Vehicles	43,998,433	44,294,378	44,590,324	44,886,269	45,182,214	45,478,159	45,774,104	46,070,049	46,365,994	46,661,939	46,957,884	47,253,829
Vehicle Miles Traveled - Trucks	1,833,268	1,845,599	1,857,930	1,870,261	1,882,592	1,894,923	1,907,254	1,919,585	1,931,916	1,944,247	1,956,579	1,968,910
Vehicle Operating Costs - Passenger Vehicles	$22,879,185	$23,033,077	$23,186,968	$23,340,860	$23,494,751	$23,648,643	$23,802,534	$23,956,425	$24,110,317	$24,264,208	$24,418,100	$24,571,991
Vehicle Operating Costs - Trucks	$2,419,914	$2,436,191	$2,452,468	$2,468,745	$2,485,022	$2,501,299	$2,517,576	$2,533,853	$2,550,130	$2,566,407	$2,582,684	$2,598,961
Total Vehicle Operating Costs	$25,299,099	$25,469,268	$25,639,436	$25,809,604	$25,979,773	$26,149,941	$26,320,110	$26,490,278	$26,660,447	$26,830,615	$27,000,783	$27,170,952
Project Impact												
Avoided Vehicle Operating Costs	**$257,027**	**$272,146**	**$287,266**	**$302,385**	**$317,504**	**$332,623**	**$347,743**	**$362,862**	**$377,981**	**$393,100**	**$408,220**	**$423,339**

Avoided External Highway Use Costs

Variable	Unit	Constant	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
No-Build														
Vehicle Miles Traveled - Passenger Vehicles	vehicle-miles/year		0	0	0	0	41,867,522	42,189,761	42,512,001	42,834,240	43,156,479	43,478,719	43,800,958	44,123,198
Vehicle Miles Traveled - Trucks	vehicle-miles/year		0	0	0	0	1,744,480	1,757,907	1,771,333	1,784,760	1,798,187	1,811,613	1,825,040	1,838,467
Incremental Vehicle Miles Traveled - Transit Bus	vehicle-miles/year		30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260
Pavement Damage														
Cost of Pavement Damage - Passenger Vehicles	2022$/year	$0.002	$0	$0	$0	$0	$95,236	$95,969	$96,702	$97,435	$98,168	$98,901	$99,634	$100,367
Cost of Pavement Damage - Trucks	2022$/year	$0.05	$0	$0	$0	$0	$93,389	$94,108	$94,827	$95,546	$96,264	$96,983	$97,702	$98,421
Cost of Pavement Damage - Transit Bus	2022$/year	$0.05	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620
Total Cost of Pavement Damage	2022$/year		$1,620	$1,620	$1,620	$1,620	$190,246	$191,697	$193,149	$194,601	$196,053	$197,505	$198,956	$200,408
Congestion Costs														
Congestion Cost - Passenger Vehicles	2022$/year	$0.138	$0	$0	$0	$0	$5,777,718	$5,822,187	$5,866,656	$5,911,125	$5,955,594	$6,000,063	$6,044,532	$6,089,001
Congestion Cost - Trucks	2022$/year	$0.345	$0	$0	$0	$0	$601,846	$606,478	$611,110	$615,742	$620,374	$625,007	$629,639	$634,271
Congestion Cost - Transit Bus	2022$/year	$0.345	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440
Total Congestion Cost	2022$/year		$10,440	$10,440	$10,440	$10,440	$6,390,003	$6,439,105	$6,488,206	$6,537,307	$6,586,408	$6,635,510	$6,684,611	$6,733,712
Noise Costs														
Congestion Cost - Passenger Vehicles	2022$/year	$0.002	$0	$0	$0	$0	$79,548	$80,161	$80,773	$81,385	$81,997	$82,610	$83,222	$83,834
Congestion Cost - Trucks	2022$/year	$0.016	$0	$0	$0	$0	$27,912	$28,127	$28,341	$28,556	$28,771	$28,986	$29,201	$29,415
Congestion Cost - Transit Bus	2022$/year	$0.016	$484	$484	$484	$484	$484	$484	$484	$484	$484	$484	$484	$484
Total Congestion Cost	2022$/year		$484	$484	$484	$484	$107,944	$108,771	$109,598	$110,425	$111,252	$112,080	$112,907	$113,734
Build														
Vehicle Miles Traveled - Passenger Vehicles	vehicle-miles/year		0	0	0	0	41,630,873	41,926,818	42,222,763	42,518,708	42,814,653	43,110,598	43,406,543	43,702,488
Vehicle Miles Traveled - Trucks	vehicle-miles/year		0	0	0	0	1,734,620	1,746,951	1,759,282	1,771,613	1,783,944	1,796,275	1,808,606	1,820,937
Avoided Vehicle Miles Traveled - Bus	vehicle-miles/year		30,260	30,260	30,260	30,260	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503
Pavement Damage														
Cost of Pavement Damage - Passenger Vehicles	2022$/year	$0.002	$0	$0	$0	$0	$94,698	$95,371	$96,045	$96,718	$97,391	$98,064	$98,737	$99,410
Cost of Pavement Damage - Trucks	2022$/year	$0.05	$0	$0	$0	$0	$92,861	$93,521	$94,182	$94,842	$95,502	$96,162	$96,822	$97,482
Cost of Pavement Damage - Transit Bus	2022$/year	$0.05	$1,620	$1,620	$1,620	$1,620	$348	$348	$348	$348	$348	$348	$348	$348
Total Cost of Pavement Damage	**2022$/year**		$1,620	$1,620	$1,620	$1,620	$187,908	$189,241	$190,574	$191,908	$193,241	$194,574	$195,908	$197,241
Congestion Costs														
Congestion Cost - Passenger Vehicles	2022$/year	$0.138	$0	$0	$0	$0	$5,745,060	$5,785,901	$5,826,741	$5,867,582	$5,908,422	$5,949,263	$5,990,103	$6,030,943
Congestion Cost - Trucks	2022$/year	$0.345	$0	$0	$0	$0	$598,444	$602,698	$606,952	$611,206	$615,461	$619,715	$623,969	$628,223
Congestion Cost - Transit Bus	2022$/year	$0.345	$10,440	$10,440	$10,440	$10,440	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244
Total Congestion Cost	2022$/year		$10,440	$10,440	$10,440	$10,440	$6,345,748	$6,390,842	$6,435,937	$6,481,032	$6,526,126	$6,571,221	$6,616,316	$6,661,410
Noise Costs														
Congestion Cost - Passenger Vehicles	2022$/year	$0.002	$0	$0	$0	$0	$79,099	$79,661	$80,223	$80,786	$81,348	$81,910	$82,472	$83,035
Congestion Cost - Trucks	2022$/year	$0.016	$0	$0	$0	$0	$27,754	$27,951	$28,149	$28,346	$28,543	$28,740	$28,938	$29,135
Congestion Cost - Transit Bus	2022$/year	$0.016	$484	$484	$484	$484	$104	$104	$104	$104	$104	$104	$104	$104
Total Congestion Cost	2022$/year		$484	$484	$484	$484	$106,957	$107,716	$108,476	$109,235	$109,995	$110,755	$111,514	$112,274
Project Impact														
Avoided Pavement Damage Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$2,338**	**$2,456**	**$2,575**	**$2,693**	**$2,812**	**$2,930**	**$3,049**	**$3,167**
Avoided Congestion Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$44,256**	**$48,262**	**$52,269**	**$56,275**	**$60,282**	**$64,289**	**$68,295**	**$72,302**
Avoided Noise Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$988**	**$1,055**	**$1,122**	**$1,190**	**$1,257**	**$1,325**	**$1,392**	**$1,460**

Variable	Unit	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
No-Build													
Vehicle Miles Traveled - Passenger Vehicles	vehicle-miles/year	44,445,437	44,767,677	45,089,916	45,412,155	45,734,395	46,056,634	46,378,874	46,701,113	47,023,353	47,345,592	47,667,832	47,990,071
Vehicle Miles Traveled - Trucks	vehicle-miles/year	1,851,893	1,865,320	1,878,747	1,892,173	1,905,600	1,919,026	1,932,453	1,945,880	1,959,306	1,972,733	1,986,160	1,999,586
Incremental Vehicle Miles Traveled - Transit Bus	vehicle-miles/year	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260	30,260
Pavement Damage													
Cost of Pavement Damage - Passenger Vehicles	2022$/year	$101,100	$101,833	$102,566	$103,299	$104,032	$104,765	$105,498	$106,231	$106,964	$107,697	$108,430	$109,163
Cost of Pavement Damage - Trucks	2022$/year	$99,139	$99,858	$100,577	$101,296	$102,015	$102,733	$103,452	$104,171	$104,890	$105,609	$106,327	$107,046
Cost of Pavement Damage - Transit Bus	2022$/year	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620	$1,620
Total Cost of Pavement Damage	2022$/year	$201,860	$203,312	$204,763	$206,215	$207,667	$209,119	$210,571	$212,022	$213,474	$214,926	$216,378	$217,830
Congestion Costs													
Congestion Cost - Passenger Vehicles	2022$/year	$6,133,470	$6,177,939	$6,222,408	$6,266,877	$6,311,346	$6,355,816	$6,400,285	$6,444,754	$6,489,223	$6,533,692	$6,578,161	$6,622,630
Congestion Cost - Trucks	2022$/year	$638,903	$643,535	$648,168	$652,800	$657,432	$662,064	$666,696	$671,329	$675,961	$680,593	$685,225	$689,857
Congestion Cost - Transit Bus	2022$/year	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440	$10,440
Total Congestion Cost	2022$/year	$6,782,813	$6,831,915	$6,881,016	$6,930,117	$6,979,218	$7,028,319	$7,077,421	$7,126,522	$7,175,623	$7,224,724	$7,273,826	$7,322,927
Noise Costs													
Congestion Cost - Passenger Vehicles	2022$/year	$84,446	$85,059	$85,671	$86,283	$86,895	$87,508	$88,120	$88,732	$89,344	$89,957	$90,569	$91,181
Congestion Cost - Trucks	2022$/year	$29,630	$29,845	$30,060	$30,275	$30,490	$30,704	$30,919	$31,134	$31,349	$31,564	$31,779	$31,993
Congestion Cost - Transit Bus	2022$/year	$484	$484	$484	$484	$484	$484	$484	$484	$484	$484	$484	$484
Total Congestion Cost	2022$/year	$114,561	$115,388	$116,215	$117,042	$117,869	$118,696	$119,523	$120,350	$121,177	$122,005	$122,832	$123,659
Build													
Vehicle Miles Traveled - Passenger Vehicles	vehicle-miles/year	43,998,433	44,294,378	44,590,324	44,886,269	45,182,214	45,478,159	45,774,104	46,070,049	46,365,994	46,661,939	46,957,884	47,253,829
Vehicle Miles Traveled - Trucks	vehicle-miles/year	1,833,268	1,845,599	1,857,930	1,870,261	1,882,592	1,894,923	1,907,254	1,919,585	1,931,916	1,944,247	1,956,579	1,968,910
Avoided Vehicle Miles Traveled - Bus	vehicle-miles/year	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503	6,503
Pavement Damage													
Cost of Pavement Damage - Passenger Vehicles	2022$/year	$100,084	$100,757	$101,430	$102,103	$102,776	$103,450	$104,123	$104,796	$105,469	$106,142	$106,816	$107,489
Cost of Pavement Damage - Trucks	2022$/year	$98,142	$98,803	$99,463	$100,123	$100,783	$101,443	$102,103	$102,763	$103,423	$104,084	$104,744	$105,404
Cost of Pavement Damage - Transit Bus	2022$/year	$348	$348	$348	$348	$348	$348	$348	$348	$348	$348	$348	$348
Total Cost of Pavement Damage	**2022$/year**	$198,574	$199,908	$201,241	$202,574	$203,907	$205,241	$206,574	$207,907	$209,241	$210,574	$211,907	$213,241
Congestion Costs													
Congestion Cost - Passenger Vehicles	2022$/year	$6,071,784	$6,112,624	$6,153,465	$6,194,305	$6,235,145	$6,275,986	$6,316,826	$6,357,667	$6,398,507	$6,439,348	$6,480,188	$6,521,028
Congestion Cost - Trucks	2022$/year	$632,477	$636,732	$640,986	$645,240	$649,494	$653,749	$658,003	$662,257	$666,511	$670,765	$675,020	$679,274
Congestion Cost - Transit Bus	2022$/year	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244	$2,244
Total Congestion Cost	2022$/year	$6,706,505	$6,751,600	$6,796,694	$6,841,789	$6,886,883	$6,931,978	$6,977,073	$7,022,167	$7,067,262	$7,112,357	$7,157,451	$7,202,546
Noise Costs													
Congestion Cost - Passenger Vehicles	2022$/year	$83,597	$84,159	$84,722	$85,284	$85,846	$86,409	$86,971	$87,533	$88,095	$88,658	$89,220	$89,782
Congestion Cost - Trucks	2022$/year	$29,332	$29,530	$29,727	$29,924	$30,121	$30,319	$30,516	$30,713	$30,911	$31,108	$31,305	$31,503
Congestion Cost - Transit Bus	2022$/year	$104	$104	$104	$104	$104	$104	$104	$104	$104	$104	$104	$104
Total Congestion Cost	2022$/year	$113,033	$113,793	$114,553	$115,312	$116,072	$116,831	$117,591	$118,351	$119,110	$119,870	$120,629	$121,389
Project Impact													
Avoided Pavement Damage Costs	**2022$/year**	**$3,286**	**$3,404**	**$3,523**	**$3,641**	**$3,760**	**$3,878**	**$3,996**	**$4,115**	**$4,233**	**$4,352**	**$4,470**	**$4,589**
Avoided Congestion Costs	**2022$/year**	**$76,308**	**$80,315**	**$84,322**	**$88,328**	**$92,335**	**$96,341**	**$100,348**	**$104,355**	**$108,361**	**$112,368**	**$116,374**	**$120,381**
Avoided Noise Costs	**2022$/year**	**$1,527**	**$1,595**	**$1,662**	**$1,730**	**$1,797**	**$1,865**	**$1,932**	**$2,000**	**$2,067**	**$2,135**	**$2,202**	**$2,270**

Incremental O&M Costs

Variable	Unit	Growth / Factor	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Build														
Bridge O&M Cost	2022$/year		$0	$0	$0	$0	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890
Decks - Operation Freeze	2022$/year		$0	$0	$0	$0	$535	$535	$535	$535	$535	$535	$535	$535
ADOT Bridge Inspection	2022$/year		$0	$0	$0	$0	$0	$0	$1,338	$0	$1,338	$0	$1,338	$0
Project Impacts														
Change in O&M Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**-$82,425**	**-$82,425**	**-$83,763**	**-$82,425**	**-$83,763**	**-$82,425**	**-$83,763**	**-$82,425**

Variable	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Build												
Bridge O&M Cost	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890	$81,890
Decks - Operation Freeze	$535	$535	$535	$535	$535	$535	$535	$535	$535	$535	$535	$535
ADOT Bridge Inspection	$1,338	$0	$1,338	$0	$1,338	$0	$1,338	$0	$1,338	$0	$1,338	$0
Project Impacts												
Change in O&M Costs	**-$83,763**	**-$82,425**	**-$83,763**	**-$82,425**	**-$83,763**	**-$82,425**	**-$83,763**	**-$82,425**	**-$83,763**	**-$82,425**	**-$83,763**	**-$82,425**

Transit Operating Cost Savings

Variable	Unit	Growth / Factor	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Build														
Transit Operating Cost Savings	2022$/year		$0	$0	$0	$0	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598
Project Impacts														
Total Change in Transit Operating Costs	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**

Variable	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Build												
Transit Operating Cost Savings	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598	$203,598
Project Impacts												
Total Change in Transit Operating Costs	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**	**$203,598**

Transit Travel Time Savings

Variable	Unit	Growth / Factor	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
General																										
Route 27 Annual Ridership	passengers/year		100,780	101,510	102,102	102,711	103,334	103,970	104,621	105,290	105,948	106,585	107,207	107,817	108,416	109,006	109,584	110,150	110,703	111,245	111,778	112,301	112,812	113,316	113,815	114,308
No-Build																										
Transit Miles Traveled	miles/year	2.6	265,555	267,480	269,040	270,643	272,285	273,960	275,676	277,438	279,173	280,852	282,490	284,097	285,677	287,231	288,754	290,244	291,702	293,132	294,535	295,912	297,261	298,589	299,902	301,201
Transit Travel Time	hours/year	19.2	13,831	13,931	14,012	14,096	14,182	14,269	14,358	14,450	14,540	14,628	14,713	14,797	14,879	14,960	15,039	15,117	15,193	15,267	15,340	15,412	15,482	15,552	15,620	15,688
Cost of Transit Travel Time	2022$/year	$19.60	$271,087	$273,052	$274,645	$276,281	$277,958	$279,668	$281,419	$283,218	$284,989	$286,703	$288,375	$290,015	$291,629	$293,215	$294,770	$296,291	$297,779	$299,238	$300,672	$302,077	$303,454	$304,809	$306,149	$307,476
Build																										
Transit Miles Traveled	miles/year	0.6	265,555	267,480	269,040	270,643	58,517	58,877	59,246	59,624	59,997	60,358	60,710	61,055	61,395	61,729	62,056	62,376	62,690	62,997	63,299	63,594	63,884	64,170	64,452	64,731
Transit Travel Time	hours/year	19.2	13,831	13,931	14,012	14,096	3,048	3,066	3,086	3,105	3,125	3,144	3,162	3,180	3,198	3,215	3,232	3,249	3,265	3,281	3,297	3,312	3,327	3,342	3,357	3,371
Cost of Transit Travel Time	2022$/year	$19.60	$271,087	$273,052	$274,645	$276,281	$59,736	$60,103	$60,480	$60,866	$61,247	$61,615	$61,975	$62,327	$62,674	$63,015	$63,349	$63,676	$63,996	$64,309	$64,617	$64,919	$65,215	$65,507	$65,795	$66,080
Project Impacts																										
Change in Transit Travel Time	**hours/year**		0	0	0	0	11,134	11,202	11,272	11,344	11,415	11,484	11,551	11,617	11,681	11,745	11,807	11,868	11,928	11,986	12,044	12,100	12,155	12,209	12,263	12,316
Total Change Cost of Transit Travel Time	**2022$/year**		**$0**	**$0**	**$0**	**$0**	**$218,222**	**$219,564**	**$220,939**	**$222,352**	**$223,742**	**$225,088**	**$226,400**	**$227,688**	**$228,955**	**$230,200**	**$231,421**	**$232,615**	**$233,783**	**$234,929**	**$236,054**	**$237,157**	**$238,238**	**$239,303**	**$240,355**	**$241,396**

Residual Value

Variable	Unit	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
General Inputs and Calculations																									
Operational Period (years)	20																								
Useful Life of Bridges	50																								
Remaining Useful Life	30																								
Project Cost of Components	$8,188,990																								
Residual Value	$4,913,394																								
Useful Life of Roadway Assets	20																								
Remaining Useful Life	0																								
Project Cost of Components	$12,996,425																								
Residual Value	$0																								
Right-of-Way	$96,492																								
Total Residual Value	$5,009,886																								
Project Impact																									
Residual Value	2022$/year	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,009,886

Capital Cost Inputs

Capital Cost Item	Total Cost (2023$)	
Subtotal A		
Fuel Adjustment Allowance	$50,000	
Clearing and Grubbing (Noxious and Invasive Species Control Allowance	$2,000	
Clearing and Gubbing	$42,500	
Removal of Structures & Obstructions	$15,000	
Removal of Bituminous Pavement	$76,480	
Removal of Signs and Delineators	$2,000	
Roadway Excavation	$112,140	
Drainage Excavation	$40,775	
Borrow	$75,450	
Aggregate Base (Roadway)	$449,487	
Aggregate Base (MUP)	$51,608	
Tack Coat	$12,000	
Asphaltic Concrete (Roadway)	$867,650	
Asphaltic Concrete (MUP)	$99,900	
Pipe, Corrugated Metal, 48"	$72,000	
Pipe, Reinforced Concrete, Class III, 36"	$350,000	
Utility Impact Allowance	$250,000	
Box Culvert 1	$94,198	
Concrete Retaining Wall	$1,081,640	
Pipe Culvert Headwall	$7,500	
Permanent Signing	$25,000	
Drilled Shaft (6' Diameter)	$2,161,600	
Traffic Control	$150,000	
Pavement Marking (White Extruded Thermoplastic (0.090")	$11,456	
Pavement Marking (Yellow Extruded Thermoplastic (0.090")	$7,800	
Pavement Marking (White Hot-Sprayed Thermoplastic)	$6,750	
Pavement Marking, Preformed, Type 1, Green Stripe	$123,675	
Pavement Marker, Reflective, (Typde D, Yellow, Two-Way)	$648	
Painted Pavement Marking	$2,173	
Traffic Signals (Intersection)	$825,000	
Electrical Conduit (PVC)	$56,250	
Street Lighting	$450,000	
Landscape (Grading, Ground Cover, Planting)	$110,000	
Landscaping Establishment	$27,500	
Landscape Irrigation System	$110,000	
AZPDES/NPDES (Original)	$27,500	
Mobilization (8%)	$1,453,000	
Guard Rail Terminal (MSKT)	$10,000	
Concrete Curb (Precast segment w/ delineators)	$41,400	
Concrete Curb	$160,475	
Concrete Sidewalk	$200,450	
Curb Access Ramp	$56,250	
Concrete Channel Lining	$195,600	
Soil Cement Bank Protection	$966,000	
Construction Survey and Layout (5%)	$908,000	
Engineer's Field Office	$100,000	
Handrail	$88,065	
Additional Unknown Items (8%)	$1,442,000	$13,468,920

Subtotal B (Lump Sum Structure No.1) - Bridge		
Structural Concrete (f'c = 3,500)	$1,220,800	
Structural Concrete (f'c = 4,500)	$2,381,400	$21,955,627
Traffic and Pedestrian Railing	$431,900	
Single Slope Bridge Concrete Barrier and Transition	$246,800	
Bridge Deck Joint Assembly (Strip Seal Joint)	$87,200	
Approach Slab	$136,320	
Precast, P/S Member	$2,961,400	
Restrainers, Vertical Earthquake (fixed)	$12,600	
Restrainers, Vertical Earthquake (Expansion)	$16,800	
Reinforcing Steel	$991,487	$8,486,707
Other Project Costs Not Part of Bid		
Design	$2,600,000	
Public Art (1% of Subtotal A)	$219,556	
Right-of-Way	$100,000	
Riparian Habitat In-Lieu Fee or Other Environment Mitigations	$50,000	
Post Design / As-Builts (1% of Subtotal A)	$219,556	
Construction Engineering (14% of Subtotal A)	$3,073,788	
Construction Contingency (30% of Subtotal A)	$6,586,688	
Total Estimated Project Cost (Inflation Removed)	**$34,805,215**	

Traffic Demand Model Outputs

All traffic data provided by Kittelson & Associates -methodology described in the technical appendix.

		VHT					
		Annual (weekdays)		Passenger Vehicle		Trucks	
Calendar Year	Project Year	No Build	Build	No Build	Build	No Build	Build
2024	1	0	0	0	0	0	0
2025	2	0	0	0	0	0	0
2026	3	0	0	0	0	0	0
2027	4	0	0	0	0	0	0
2028	5	1,425,547	1,409,131	1,368,525	1,352,766	57,022	56,365
2029	6	1,439,483	1,421,243	1,381,904	1,364,394	57,579	56,850
2030	7	1,453,420	1,433,356	1,395,283	1,376,022	58,137	57,334
2031	8	1,467,356	1,445,468	1,408,662	1,387,649	58,694	57,819
2032	9	1,481,292	1,457,581	1,422,041	1,399,277	59,252	58,303
2033	10	1,495,229	1,469,693	1,435,420	1,410,905	59,809	58,788
2034	11	1,509,165	1,481,805	1,448,799	1,422,533	60,367	59,272
2035	12	1,523,102	1,493,918	1,462,178	1,434,161	60,924	59,757
2036	13	1,537,038	1,506,030	1,475,557	1,445,789	61,482	60,241
2037	14	1,550,974	1,518,143	1,488,935	1,457,417	62,039	60,726
2038	15	1,564,911	1,530,255	1,502,314	1,469,045	62,596	61,210
2039	16	1,578,847	1,542,367	1,515,693	1,480,673	63,154	61,695
2040	17	1,592,784	1,554,480	1,529,072	1,492,301	63,711	62,179
2041	18	1,606,720	1,566,592	1,542,451	1,503,929	64,269	62,664
2042	19	1,620,656	1,578,705	1,555,830	1,515,556	64,826	63,148
2043	20	1,634,593	1,590,817	1,569,209	1,527,184	65,384	63,633
2044	21	1,648,529	1,602,929	1,582,588	1,538,812	65,941	64,117
2045	22	1,662,466	1,615,042	1,595,967	1,550,440	66,499	64,602
2046	23	1,676,402	1,627,154	1,609,346	1,562,068	67,056	65,086
2047	24	1,690,338	1,639,267	1,622,725	1,573,696	67,614	65,571
2048	25	1,704,275	1,651,379	1,636,104	1,585,324	68,171	66,055
2049	26	1,718,211	1,663,492	1,649,483	1,596,952	68,728	66,540
2050	27	1,732,148	1,675,604	1,662,862	1,608,580	69,286	67,024
Total		**36,104,440**	**35,469,177**	**34,660,263**	**34,050,410**	**1,444,178**	**1,418,767**

		VMT					
		Annual (weekdays)		Passenger Vehicle		Trucks	
Calendar Year	Project Year	No Build	Build	No Build	Build	No Build	Build
2024	1	0	0	0	0	0	0
2025	2	0	0	0	0	0	0
2026	3	0	0	0	0	0	0
2027	4	0	0	0	0	0	0
2028	5	43,612,002	43,365,492	41,867,522	41,630,873	1,744,480	1,734,620
2029	6	43,947,668	43,673,768	42,189,761	41,926,818	1,757,907	1,746,951
2030	7	44,283,334	43,982,045	42,512,001	42,222,763	1,771,333	1,759,282
2031	8	44,619,000	44,290,321	42,834,240	42,518,708	1,784,760	1,771,613
2032	9	44,954,666	44,598,597	43,156,479	42,814,653	1,798,187	1,783,944
2033	10	45,290,332	44,906,873	43,478,719	43,110,598	1,811,613	1,796,275
2034	11	45,625,998	45,215,149	43,800,958	43,406,543	1,825,040	1,808,606
2035	12	45,961,664	45,523,425	44,123,198	43,702,488	1,838,467	1,820,937
2036	13	46,297,330	45,831,701	44,445,437	43,998,433	1,851,893	1,833,268
2037	14	46,632,996	46,139,978	44,767,677	44,294,378	1,865,320	1,845,599
2038	15	46,968,663	46,448,254	45,089,916	44,590,324	1,878,747	1,857,930
2039	16	47,304,329	46,756,530	45,412,155	44,886,269	1,892,173	1,870,261
2040	17	47,639,995	47,064,806	45,734,395	45,182,214	1,905,600	1,882,592
2041	18	47,975,661	47,373,082	46,056,634	45,478,159	1,919,026	1,894,923
2042	19	48,311,327	47,681,358	46,378,874	45,774,104	1,932,453	1,907,254
2043	20	48,646,993	47,989,634	46,701,113	46,070,049	1,945,880	1,919,585
2044	21	48,982,659	48,297,910	47,023,353	46,365,994	1,959,306	1,931,916
2045	22	49,318,325	48,606,187	47,345,592	46,661,939	1,972,733	1,944,247
2046	23	49,653,991	48,914,463	47,667,832	46,957,884	1,986,160	1,956,579
2047	24	49,989,657	49,222,739	47,990,071	47,253,829	1,999,586	1,968,910
2048	25	50,325,323	49,531,015	48,312,310	47,549,774	2,013,013	1,981,241
2049	26	50,660,989	49,839,291	48,634,550	47,845,719	2,026,440	1,993,572
2050	27	50,996,655	50,147,567	48,956,789	48,141,665	2,039,866	2,005,903
Total		**1,087,999,559**	**1,075,400,185**	**1,044,479,576**	**1,032,384,178**	**43,519,982**	**43,016,007**

Accident Model Outputs

All accident data provided by Kittelson & Associates -methodology described in the technical appendix.

BUILD - 2045			NO BUILD - 2045		
Irvington	F	0.170346	Irvington	F	0.182895
	I	6.209654		I	6.667105
	PDO	12.8		PDO	13.8
	Total	19.18		Total	20.65
Drexel	F	0.025365	Drexel	F	0.03471
	I	0.924635		I	1.26529
	PDO	2.17		PDO	2.13
	Total	3.12		Total	3.43
Valencia	F	0.3316674	Valencia	F	0.3974829
	I	12.0903326		I	14.4895171
	PDO	13.468		PDO	15.141
	Total	25.89		Total	30.028
Totals	**F**	**0.5273784**	**Totals**	**F**	**0.6150879**
	I	**19.2246216**		**I**	**22.4219121**
	PDO	**28.438**		**PDO**	**31.071**
	Total	**48.19**		**Total**	**54.108**

BUILD - 2030			NO BUILD - 2030		
Irvington	Total F	0.154059	Irvington	Total F	0.154326
	Total I	5.615941		Total I	5.625674
	Total PDO	11.67		Total PDO	11.78
	Total Annual	17.44		Total Annual	17.56
Drexel	Total F	0.016554	Drexel	Total F	0.036312
	Total I	0.603446		Total I	1.323688
	Total PDO	1.43		Total PDO	2.22
	Total Annual	2.05		Total Annual	3.58
Valencia	Total F	0.3190116	Valencia	Total F	0.334818
	Total I	11.6289884		Total I	12.205182
	Total PDO	12.971		Total PDO	13.06
	Total Annual	24.919		Total Annual	25.6
Totals	**Total F**	**0.4896246**	**Totals**	**Total F**	**0.525456**
	Total I	**17.8483754**		**Total I**	**19.154544**
	Total PDO	**26.071**		**Total PDO**	**27.06**
	Total Annual	**44.409**		**Total Annual**	**46.74**

Variable	Unit	Factor	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
No-Build															
Fatal Crashes	crashes/year	1.1%	0.49	0.50	0.50	0.51	0.51	0.52	0.53	0.53	0.54	0.54	0.55	0.55	0.56
Injury Crashes	crashes/year	1.1%	17.99	18.17	18.37	18.56	18.76	18.95	19.15	19.36	19.56	19.77	19.98	20.19	20.40
PDO Crashes	crashes/year	0.9%	25.60	25.84	26.08	26.32	26.57	26.81	27.06	27.31	27.56	27.82	28.08	28.34	28.60
Build															
Fatal Crashes	crashes/year	0.5%	0.48	0.48	0.48	0.48	0.48	0.49	0.49	0.49	0.49	0.50	0.50	0.50	0.50
Injury Crashes	crashes/year	0.5%	17.33	17.41	17.50	17.59	17.67	17.76	17.85	17.94	18.03	18.12	18.21	18.30	18.39
PDO Crashes	crashes/year	0.6%	25.18	25.33	25.47	25.62	25.77	25.92	26.07	26.22	26.37	26.53	26.68	26.84	26.99

Variable	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
No-Build														
Fatal Crashes	0.57	0.57	0.58	0.58	0.59	0.60	0.60	0.61	0.62	0.62	0.62	0.62	0.62	0.62
Injury Crashes	20.62	20.83	21.05	21.28	21.50	21.73	21.96	22.19	22.42	22.42	22.42	22.42	22.42	22.42
PDO Crashes	28.86	29.13	29.40	29.67	29.95	30.22	30.50	30.79	31.07	31.07	31.07	31.07	31.07	31.07
Build														
Fatal Crashes	0.51	0.51	0.51	0.51	0.52	0.52	0.52	0.52	0.53	0.53	0.53	0.53	0.53	0.53
Injury Crashes	18.48	18.57	18.66	18.75	18.85	18.94	19.04	19.13	19.22	19.22	19.22	19.22	19.22	19.22
PDO Crashes	27.15	27.31	27.47	27.63	27.79	27.95	28.11	28.27	28.44	28.44	28.44	28.44	28.44	28.44

Truck Emissions

MOVES Average Annual Emissions Factors for Trucks

MOVES run conducted on February 6, 2024, Pima County, Arizona

2020

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	5526.65	28.0628	0.6232	0.5734	0.0186	1.6055
5	3252.09	15.3942	0.3389	0.3118	0.0109	0.8661
10	2165.67	9.2534	0.2121	0.1952	0.0073	0.4656
15	1903.14	7.2783	0.1827	0.1681	0.0064	0.3291
20	1713.99	5.9741	0.1602	0.1473	0.0058	0.2558
25	1567.56	5.1760	0.1454	0.1337	0.0053	0.2133
30	1529.69	4.7295	0.1383	0.1272	0.0051	0.1883
35	1330.01	3.8878	0.1084	0.0997	0.0045	0.1665
40	1296.32	3.5123	0.1000	0.0920	0.0044	0.1522
45	1270.55	3.2203	0.0936	0.0861	0.0043	0.1411
50	1231.28	2.9133	0.0840	0.0773	0.0041	0.1307
55	1191.10	2.6363	0.0737	0.0678	0.0040	0.1214
60	1180.98	2.5318	0.0681	0.0626	0.0040	0.1139
65	1239.54	2.7062	0.0701	0.0645	0.0042	0.1097
70	1292.30	2.8623	0.0720	0.0662	0.0043	0.1060
75	1345.84	3.0268	0.0748	0.0688	0.0045	0.1044

2030

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	4591.58	22.4044	0.1601	0.1473	0.0153	0.6256
5	2750.07	12.4004	0.0900	0.0828	0.0092	0.3317
10	1845.42	7.3273	0.0585	0.0539	0.0062	0.1781
15	1617.65	5.5441	0.0511	0.0470	0.0054	0.1278
20	1458.86	4.3823	0.0446	0.0410	0.0049	0.0977
25	1333.97	3.6840	0.0407	0.0375	0.0045	0.0817
30	1301.68	3.2446	0.0388	0.0357	0.0043	0.0739
35	1120.19	2.5247	0.0297	0.0274	0.0037	0.0605
40	1091.18	2.1602	0.0273	0.0251	0.0036	0.0552
45	1069.04	1.8766	0.0254	0.0234	0.0036	0.0510
50	1029.91	1.5621	0.0226	0.0208	0.0034	0.0458
55	988.76	1.2731	0.0195	0.0180	0.0033	0.0406
60	979.66	1.1723	0.0181	0.0167	0.0033	0.0376
65	1023.53	1.2724	0.0188	0.0173	0.0034	0.0382
70	1063.49	1.3623	0.0193	0.0178	0.0036	0.0387
75	1106.48	1.4631	0.0201	0.0185	0.0037	0.0404

2040

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	4257.28	21.4002	0.0897	0.0825	0.0142	0.4525
5	2558.88	11.8658	0.0529	0.0487	0.0085	0.2377
10	1718.54	6.9834	0.0358	0.0329	0.0057	0.1277
15	1503.54	5.2395	0.0319	0.0294	0.0050	0.0924
20	1353.31	4.1068	0.0278	0.0256	0.0045	0.0697
25	1237.23	3.4291	0.0255	0.0234	0.0041	0.0586
30	1207.54	2.9946	0.0244	0.0225	0.0040	0.0538
35	1034.90	2.2957	0.0182	0.0168	0.0035	0.0419
40	1006.79	1.9363	0.0167	0.0153	0.0034	0.0381
45	985.35	1.6566	0.0154	0.0142	0.0033	0.0351
50	946.29	1.3422	0.0135	0.0124	0.0032	0.0308
55	904.74	1.0508	0.0113	0.0104	0.0030	0.0262
60	894.34	0.9444	0.0105	0.0096	0.0030	0.0239
65	932.59	1.0292	0.0110	0.0101	0.0031	0.0251
70	967.62	1.1055	0.0114	0.0105	0.0032	0.0262
75	1006.12	1.1921	0.0120	0.0110	0.0034	0.0283

2050

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	4203.68	21.2312	0.0803	0.0738	0.0140	0.4321
5	2528.06	11.7792	0.0478	0.0440	0.0084	0.2268
10	1698.06	6.9300	0.0325	0.0299	0.0057	0.1217
15	1485.07	5.1903	0.0290	0.0267	0.0050	0.0881
20	1336.28	4.0616	0.0252	0.0232	0.0045	0.0663
25	1221.63	3.3870	0.0230	0.0212	0.0041	0.0557
30	1192.32	2.9522	0.0221	0.0203	0.0040	0.0512
35	1021.08	2.2566	0.0164	0.0151	0.0034	0.0394
40	993.03	1.8974	0.0150	0.0138	0.0033	0.0357
45	971.63	1.6180	0.0139	0.0128	0.0032	0.0328
50	932.55	1.3038	0.0121	0.0112	0.0031	0.0286
55	890.90	1.0122	0.0102	0.0094	0.0030	0.0240
60	880.07	0.9034	0.0095	0.0087	0.0029	0.0217
65	917.38	0.9849	0.0099	0.0091	0.0031	0.0230
70	951.59	1.0584	0.0103	0.0095	0.0032	0.0242
75	989.35	1.1421	0.0109	0.0100	0.0033	0.0262

2060

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	4194.81	21.1332	0.0739	0.0680	0.0140	0.4185
5	2523.21	11.7305	0.0443	0.0408	0.0084	0.2196
10	1694.97	6.9012	0.0303	0.0279	0.0057	0.1179
15	1482.31	5.1644	0.0270	0.0248	0.0049	0.0855
20	1333.88	4.0381	0.0233	0.0215	0.0044	0.0642
25	1219.40	3.3651	0.0213	0.0196	0.0041	0.0539
30	1190.15	2.9300	0.0204	0.0188	0.0040	0.0496
35	1019.28	2.2368	0.0152	0.0140	0.0034	0.0379
40	991.27	1.8775	0.0139	0.0128	0.0033	0.0342
45	969.91	1.5980	0.0128	0.0118	0.0032	0.0314
50	930.88	1.2841	0.0112	0.0103	0.0031	0.0271
55	889.26	0.9928	0.0095	0.0087	0.0030	0.0226
60	878.41	0.8831	0.0088	0.0081	0.0029	0.0203
65	915.59	0.9631	0.0092	0.0085	0.0031	0.0217
70	949.69	1.0353	0.0096	0.0088	0.0032	0.0229
75	987.32	1.1178	0.0101	0.0093	0.0033	0.0250

Emission by Pollutant (grams/mile)

	CO2	NOX	PM10	PM2.5	SO2	VOC
2020	1296.324	3.512	0.100	0.092	0.004	0.152
2030	1091.176	2.160	0.027	0.025	0.004	0.055
2040	1006.787	1.936	0.017	0.015	0.003	0.038
2050	993.028	1.897	0.015	0.014	0.003	0.036
2060	991.271	1.878	0.014	0.013	0.003	0.034
2020	1296.324	3.512	0.100	0.092	0.0044	0.152
2021	1275.809	3.377	0.093	0.085	0.0043	0.143
2022	1255.295	3.242	0.086	0.079	0.0042	0.133
2023	1234.780	3.107	0.078	0.072	0.0041	0.123
2024	1214.265	2.971	0.071	0.065	0.0041	0.113
2025	1193.750	2.836	0.064	0.059	0.0040	0.104
2026	1173.235	2.701	0.056	0.052	0.0039	0.094
2027	1152.721	2.566	0.049	0.045	0.0039	0.084
2028	1132.206	2.431	0.042	0.039	0.0038	0.075
2029	1111.691	2.295	0.035	0.032	0.0037	0.065
2030	1091.176	2.160	0.027	0.025	0.0036	0.055
2031	1082.737	2.138	0.026	0.024	0.0036	0.053
2032	1074.298	2.115	0.025	0.023	0.0036	0.052
2033	1065.859	2.093	0.024	0.022	0.0036	0.050
2034	1057.420	2.071	0.023	0.021	0.0035	0.048
2035	1048.981	2.048	0.022	0.020	0.0035	0.047
2036	1040.543	2.026	0.021	0.019	0.0035	0.045
2037	1032.104	2.003	0.020	0.018	0.0034	0.043
2038	1023.665	1.981	0.019	0.017	0.0034	0.041
2039	1015.226	1.959	0.018	0.016	0.0034	0.040
2040	1006.787	1.936	0.017	0.015	0.0034	0.038
2041	1005.411	1.932	0.016	0.015	0.0034	0.038
2042	1004.035	1.929	0.016	0.015	0.0033	0.038
2043	1002.659	1.925	0.016	0.015	0.0033	0.037
2044	1001.283	1.921	0.016	0.015	0.0033	0.037
2045	999.907	1.917	0.016	0.015	0.0033	0.037
2046	998.532	1.913	0.016	0.014	0.0033	0.037
2047	997.156	1.909	0.016	0.014	0.0033	0.036
2048	995.780	1.905	0.015	0.014	0.0033	0.036
2049	994.404	1.901	0.015	0.014	0.0033	0.036
2050	993.028	1.897	0.015	0.014	0.0033	0.036
2051	992.852	1.895	0.015	0.014	0.0033	0.036
2052	992.677	1.893	0.015	0.014	0.0033	0.035
2053	992.501	1.891	0.015	0.013	0.0033	0.035
2054	992.325	1.889	0.015	0.013	0.0033	0.035
2055	992.150	1.887	0.014	0.013	0.0033	0.035
2056	991.974	1.885	0.014	0.013	0.0033	0.035
2057	991.798	1.883	0.014	0.013	0.0033	0.035

Speed **Default** 50 **Default Speed Assumption**

Project Speed

Value Used 40

The average speed of trucks on selected interstate highways is between 50 and 60 miles per hour(mph). The average operating speed of trucks is typically below 55 mph in major urban areas, border crossings, and in

Source: https://www.energy.gov/eere/vehicles/fact-671-april-18-2011-average-truck-speeds

Idling Speed Equivalent 5

55mph

	CO2	NOX	PM10	PM2.5	SO2	VOC
2020	1191.105	2.687	0.074	0.068	0.0040	0.121
2030	988.758	1.297	0.020	0.018	0.0033	0.041
2040	904.741	1.071	0.011	0.010	0.0030	0.026
2050	890.898	1.032	0.010	0.009	0.0030	0.024
2060	889.264	0.999	0.009	0.009	0.0030	0.023
2020	1191.105	2.687	0.074	0.068	0.0040	0.121
2021	1170.870	2.548	0.068	0.063	0.0039	0.113
2022	1150.635	2.409	0.063	0.058	0.0039	0.105
2023	1130.401	2.270	0.057	0.053	0.0038	0.097
2024	1110.166	2.131	0.052	0.048	0.0037	0.089
2025	1089.932	1.992	0.047	0.043	0.0037	0.081
2026	1069.697	1.853	0.041	0.038	0.0036	0.073
2027	1049.462	1.714	0.036	0.033	0.0035	0.065
2028	1029.228	1.575	0.030	0.028	0.0034	0.057
2029	1008.993	1.436	0.025	0.023	0.0034	0.049
2030	988.758	1.297	0.020	0.018	0.0033	0.041
2031	980.357	1.275	0.019	0.017	0.0033	0.039
2032	971.955	1.252	0.018	0.016	0.0032	0.038
2033	963.553	1.229	0.017	0.016	0.0032	0.036
2034	955.152	1.207	0.016	0.015	0.0032	0.035
2035	946.750	1.184	0.015	0.014	0.0032	0.033
2036	938.348	1.161	0.015	0.013	0.0031	0.032
2037	929.947	1.139	0.014	0.013	0.0031	0.031
2038	921.545	1.116	0.013	0.012	0.0031	0.029
2039	913.143	1.094	0.012	0.011	0.0030	0.028
2040	904.741	1.071	0.011	0.010	0.0030	0.026
2041	903.357	1.067	0.011	0.010	0.0030	0.026
2042	901.973	1.063	0.011	0.010	0.0030	0.026
2043	900.589	1.059	0.011	0.010	0.0030	0.026
2044	899.204	1.055	0.011	0.010	0.0030	0.025
2045	897.820	1.051	0.011	0.010	0.0030	0.025
2046	896.436	1.047	0.011	0.010	0.0030	0.025
2047	895.051	1.043	0.011	0.010	0.0030	0.025
2048	893.667	1.039	0.010	0.010	0.0030	0.024
2049	892.283	1.035	0.010	0.010	0.0030	0.024
2050	890.898	1.032	0.010	0.009	0.0030	0.024
2051	890.735	1.028	0.010	0.009	0.0030	0.024
2052	890.572	1.025	0.010	0.009	0.0030	0.024
2053	890.408	1.022	0.010	0.009	0.0030	0.024
2054	890.245	1.019	0.010	0.009	0.0030	0.023
2055	890.081	1.015	0.010	0.009	0.0030	0.023
2056	889.918	1.012	0.010	0.009	0.0030	0.023
2057	889.754	1.009	0.010	0.009	0.0030	0.023

Bus Emissions

MOVES Average Annual Emissions Factors for Trucks

MOVES run conducted on February 6, 2024, Pima County, Arizona

2020

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	6304.57	31.2775	0.3696	0.3400	0.0212	1.8494
5	3598.73	16.3342	0.2013	0.1852	0.0121	0.9452
10	2496.18	9.9998	0.1271	0.1169	0.0084	0.5251
15	2163.54	7.7286	0.1035	0.0952	0.0073	0.3760
20	1926.29	6.3558	0.0893	0.0822	0.0065	0.2979
25	1747.35	5.3462	0.0785	0.0722	0.0059	0.2461
30	1661.87	4.7261	0.0706	0.0649	0.0056	0.2165
35	1516.18	4.0114	0.0595	0.0548	0.0051	0.1948
40	1460.43	3.5668	0.0540	0.0496	0.0049	0.1771
45	1417.61	3.2204	0.0496	0.0456	0.0048	0.1633
50	1387.68	2.9378	0.0457	0.0421	0.0047	0.1521
55	1363.19	2.7066	0.0426	0.0392	0.0046	0.1429
60	1343.60	2.5306	0.0396	0.0364	0.0045	0.1330
65	1427.77	2.7328	0.0396	0.0364	0.0048	0.1280
70	1508.04	2.9343	0.0397	0.0366	0.0051	0.1240
75	1597.50	3.2020	0.0404	0.0371	0.0054	0.1225

2030

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	5549.03	27.9373	0.0988	0.0909	0.0185	0.6997
5	3223.90	14.6770	0.0558	0.0514	0.0108	0.3534
10	2234.11	8.7517	0.0359	0.0330	0.0075	0.1952
15	1943.57	6.5522	0.0293	0.0269	0.0065	0.1397
20	1735.82	5.2382	0.0249	0.0229	0.0058	0.1110
25	1574.34	4.2442	0.0216	0.0199	0.0053	0.0898
30	1499.47	3.6022	0.0194	0.0179	0.0050	0.0779
35	1370.96	2.9186	0.0164	0.0151	0.0046	0.0667
40	1321.06	2.4460	0.0149	0.0137	0.0044	0.0581
45	1282.85	2.0778	0.0137	0.0126	0.0043	0.0514
50	1257.18	1.7785	0.0127	0.0117	0.0042	0.0459
55	1236.18	1.5336	0.0119	0.0109	0.0041	0.0414
60	1218.03	1.3551	0.0111	0.0102	0.0041	0.0383
65	1298.69	1.5153	0.0113	0.0104	0.0043	0.0392
70	1375.58	1.6775	0.0115	0.0106	0.0046	0.0401
75	1459.82	1.8879	0.0119	0.0109	0.0049	0.0428

2040

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	5115.09	26.7060	0.0235	0.0216	0.0171	0.3835
5	2992.41	14.0377	0.0153	0.0141	0.0100	0.1909
10	2073.02	8.2787	0.0106	0.0098	0.0069	0.1046
15	1807.47	6.1289	0.0088	0.0081	0.0060	0.0749
20	1613.48	4.8414	0.0073	0.0067	0.0054	0.0597
25	1463.85	3.8691	0.0060	0.0055	0.0049	0.0471
30	1392.78	3.2223	0.0054	0.0050	0.0046	0.0400
35	1273.96	2.5556	0.0046	0.0042	0.0042	0.0318
40	1226.70	2.0802	0.0041	0.0038	0.0041	0.0257
45	1190.58	1.7099	0.0037	0.0034	0.0040	0.0210
50	1166.78	1.4093	0.0035	0.0032	0.0039	0.0171
55	1147.32	1.1633	0.0033	0.0030	0.0038	0.0138
60	1131.22	0.9896	0.0032	0.0029	0.0038	0.0128
65	1208.54	1.1366	0.0035	0.0032	0.0040	0.0152
70	1282.15	1.2862	0.0037	0.0034	0.0043	0.0175
75	1360.51	1.4747	0.0040	0.0037	0.0045	0.0214

2050

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	4973.43	26.5142	0.0224	0.0206	0.0166	0.3665
5	2911.90	13.9261	0.0148	0.0136	0.0097	0.1809
10	2017.49	8.1814	0.0103	0.0095	0.0067	0.0976
15	1760.47	6.0442	0.0086	0.0079	0.0059	0.0689
20	1570.74	4.7635	0.0071	0.0065	0.0052	0.0544
25	1425.39	3.8009	0.0059	0.0054	0.0048	0.0424
30	1355.05	3.1561	0.0053	0.0049	0.0045	0.0359
35	1238.83	2.4933	0.0044	0.0041	0.0041	0.0284
40	1192.16	2.0201	0.0040	0.0036	0.0040	0.0228
45	1156.48	1.6516	0.0036	0.0033	0.0039	0.0184
50	1133.00	1.3529	0.0034	0.0031	0.0038	0.0147
55	1113.79	1.1085	0.0032	0.0029	0.0037	0.0118
60	1098.47	0.9383	0.0030	0.0028	0.0037	0.0110
65	1174.34	1.0860	0.0034	0.0031	0.0039	0.0132
70	1246.55	1.2360	0.0037	0.0034	0.0042	0.0153
75	1322.68	1.4234	0.0039	0.0036	0.0044	0.0190

2060

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	4937.46	26.5468	0.0224	0.0206	0.0165	0.3667
5	2890.75	13.9440	0.0148	0.0136	0.0096	0.1810
10	2002.69	8.1912	0.0103	0.0095	0.0067	0.0976
15	1747.72	6.0525	0.0086	0.0079	0.0058	0.0690
20	1558.82	4.7687	0.0071	0.0065	0.0052	0.0544
25	1414.64	3.8055	0.0059	0.0054	0.0047	0.0424
30	1344.38	3.1587	0.0053	0.0049	0.0045	0.0359
35	1228.96	2.4948	0.0044	0.0041	0.0041	0.0284
40	1182.43	2.0207	0.0040	0.0036	0.0039	0.0227
45	1146.86	1.6515	0.0036	0.0033	0.0038	0.0184
50	1123.48	1.3523	0.0034	0.0031	0.0037	0.0147
55	1104.34	1.1075	0.0032	0.0029	0.0037	0.0117
60	1089.31	0.9375	0.0030	0.0028	0.0036	0.0110
65	1164.71	1.0853	0.0034	0.0031	0.0039	0.0132
70	1236.45	1.2352	0.0037	0.0034	0.0041	0.0153
75	1311.78	1.4221	0.0039	0.0036	0.0044	0.0190

Speed		
Default	50	**Default Speed Assumption**
Project Speed		The average speed of trucks on selected interstate highways is between 50 and 60 miles per hour(mph). The average operating speed of trucks is typically below 55 mph in major urban areas, border crossings, and in
Value Used	40	Source: https://www.energy.gov/eere/vehicles/fact-671-april-18-2011-average-truck-speeds
Idling Speed Equivalent	5	

Emission by Pollutant (grams/mile) - No-Build

	CO2	NOX	PM10	PM2.5	SO2	VOC
2020	1460.430	3.567	0.054	0.050	0.005	0.177
2030	1321.060	2.446	0.015	0.014	0.004	0.058
2040	1226.700	2.080	0.004	0.004	0.004	0.026
2050	1192.160	2.020	0.004	0.004	0.004	0.023
2060	1182.430	2.021	0.004	0.004	0.004	0.023
2020	1460.430	3.567	0.054	0.050	0.0049	0.177
2021	1446.493	3.455	0.050	0.046	0.0049	0.165
2022	1432.556	3.343	0.046	0.042	0.0048	0.153
2023	1418.619	3.231	0.042	0.039	0.0048	0.141
2024	1404.682	3.119	0.038	0.035	0.0047	0.130
2025	1390.745	3.006	0.034	0.032	0.0047	0.118
2026	1376.808	2.894	0.031	0.028	0.0046	0.106
2027	1362.871	2.782	0.027	0.024	0.0046	0.094
2028	1348.934	2.670	0.023	0.021	0.0045	0.082
2029	1334.997	2.558	0.019	0.017	0.0045	0.070
2030	1321.060	2.446	0.015	0.014	0.0044	0.058
2031	1311.624	2.409	0.014	0.013	0.0044	0.055
2032	1302.188	2.373	0.013	0.012	0.0043	0.052
2033	1292.752	2.336	0.012	0.011	0.0043	0.048
2034	1283.316	2.300	0.011	0.010	0.0043	0.045
2035	1273.880	2.263	0.009	0.009	0.0043	0.042
2036	1264.444	2.227	0.008	0.008	0.0042	0.039
2037	1255.008	2.190	0.007	0.007	0.0042	0.035
2038	1245.572	2.153	0.006	0.006	0.0042	0.032
2039	1236.136	2.117	0.005	0.005	0.0041	0.029
2040	1226.700	2.080	0.004	0.004	0.0041	0.026
2041	1223.246	2.074	0.004	0.004	0.0041	0.025
2042	1219.792	2.068	0.004	0.004	0.0041	0.025
2043	1216.338	2.062	0.004	0.004	0.0041	0.025
2044	1212.884	2.056	0.004	0.004	0.0040	0.025
2045	1209.430	2.050	0.004	0.004	0.0040	0.024
2046	1205.976	2.044	0.004	0.004	0.0040	0.024
2047	1202.522	2.038	0.004	0.004	0.0040	0.024
2048	1199.068	2.032	0.004	0.004	0.0040	0.023
2049	1195.614	2.026	0.004	0.004	0.0040	0.023
2050	1192.160	2.020	0.004	0.004	0.0040	0.023
2051	1191.187	2.020	0.004	0.004	0.0040	0.023
2052	1190.214	2.020	0.004	0.004	0.0040	0.023
2053	1189.241	2.020	0.004	0.004	0.0040	0.023
2054	1188.268	2.020	0.004	0.004	0.0040	0.023
2055	1187.295	2.020	0.004	0.004	0.0040	0.023
2056	1186.322	2.020	0.004	0.004	0.0040	0.023
2057	1185.349	2.021	0.004	0.004	0.0040	0.023

55mph

	CO2	NOX	PM10	PM2.5	SO2	VOC
2020	1191.105	2.687	0.074	0.068	0.0040	0.121
2030	988.758	1.297	0.020	0.018	0.0033	0.041
2040	904.741	1.071	0.011	0.010	0.0030	0.026
2050	890.898	1.032	0.010	0.009	0.0030	0.024
2060	889.264	0.999	0.009	0.009	0.0030	0.023
2020	1191.105	2.687	0.074	0.068	0.0040	0.121
2021	1170.870	2.548	0.068	0.063	0.0039	0.113
2022	1150.635	2.409	0.063	0.058	0.0039	0.105
2023	1130.401	2.270	0.057	0.053	0.0038	0.097
2024	1110.166	2.131	0.052	0.048	0.0037	0.089
2025	1089.932	1.992	0.047	0.043	0.0037	0.081
2026	1069.697	1.853	0.041	0.038	0.0036	0.073
2027	1049.462	1.714	0.036	0.033	0.0035	0.065
2028	1029.228	1.575	0.030	0.028	0.0034	0.057
2029	1008.993	1.436	0.025	0.023	0.0034	0.049
2030	988.758	1.297	0.020	0.018	0.0033	0.041
2031	980.357	1.275	0.019	0.017	0.0033	0.039
2032	971.955	1.252	0.018	0.016	0.0032	0.038
2033	963.553	1.229	0.017	0.016	0.0032	0.036
2034	955.152	1.207	0.016	0.015	0.0032	0.035
2035	946.750	1.184	0.015	0.014	0.0032	0.033
2036	938.348	1.161	0.015	0.013	0.0031	0.032
2037	929.947	1.139	0.014	0.013	0.0031	0.031
2038	921.545	1.116	0.013	0.012	0.0031	0.029
2039	913.143	1.094	0.012	0.011	0.0030	0.028
2040	904.741	1.071	0.011	0.010	0.0030	0.026
2041	903.357	1.067	0.011	0.010	0.0030	0.026
2042	901.973	1.063	0.011	0.010	0.0030	0.026
2043	900.589	1.059	0.011	0.010	0.0030	0.026
2044	899.204	1.055	0.011	0.010	0.0030	0.025
2045	897.820	1.051	0.011	0.010	0.0030	0.025
2046	896.436	1.047	0.011	0.010	0.0030	0.025
2047	895.051	1.043	0.011	0.010	0.0030	0.025
2048	893.667	1.039	0.010	0.010	0.0030	0.024
2049	892.283	1.035	0.010	0.010	0.0030	0.024
2050	890.898	1.032	0.010	0.009	0.0030	0.024
2051	890.735	1.028	0.010	0.009	0.0030	0.024
2052	890.572	1.025	0.010	0.009	0.0030	0.024
2053	890.408	1.022	0.010	0.009	0.0030	0.024
2054	890.245	1.019	0.010	0.009	0.0030	0.023
2055	890.081	1.015	0.010	0.009	0.0030	0.023
2056	889.918	1.012	0.010	0.009	0.0030	0.023
2057	889.754	1.009	0.010	0.009	0.0030	0.023

Auto Emissions

MOVES Average Annual Emissions Factors for Trucks

MOVES run conducted on February 6, 2024, Pima County, Arizona

2020

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	1814.0069	0.3173	0.0099	0.0088	0.0121	0.1885
5	1006.4726	0.2425	0.0063	0.0055	0.0067	0.1172
10	604.6391	0.2002	0.0043	0.0038	0.0040	0.0811
15	474.4329	0.1767	0.0034	0.0030	0.0032	0.0682
20	400.5978	0.1615	0.0028	0.0025	0.0027	0.0585
25	355.5191	0.1568	0.0024	0.0021	0.0024	0.0521
30	321.7899	0.1482	0.0024	0.0021	0.0021	0.0467
35	305.9058	0.1467	0.0023	0.0020	0.0020	0.0410
40	295.4409	0.1466	0.0023	0.0020	0.0020	0.0365
45	287.4218	0.1470	0.0022	0.0020	0.0019	0.0331
50	279.9554	0.1475	0.0022	0.0020	0.0019	0.0307
55	274.3130	0.1485	0.0022	0.0019	0.0018	0.0290
60	271.0600	0.1504	0.0022	0.0019	0.0018	0.0277
65	273.5472	0.1566	0.0023	0.0021	0.0018	0.0270
70	282.9931	0.1696	0.0026	0.0023	0.0019	0.0282
75	298.5573	0.1869	0.0032	0.0028	0.0020	0.0310

2030

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	1432.0050	0.0476	0.0076	0.0067	0.0095	0.0431
5	794.2244	0.0389	0.0045	0.0040	0.0053	0.0280
10	476.8880	0.0337	0.0029	0.0026	0.0032	0.0203
15	374.1166	0.0301	0.0022	0.0020	0.0025	0.0172
20	316.0099	0.0275	0.0019	0.0017	0.0021	0.0148
25	280.4810	0.0270	0.0016	0.0014	0.0019	0.0133
30	253.8796	0.0257	0.0016	0.0014	0.0017	0.0121
35	241.3908	0.0259	0.0015	0.0013	0.0016	0.0108
40	233.1717	0.0262	0.0014	0.0013	0.0015	0.0098
45	226.8720	0.0266	0.0014	0.0012	0.0015	0.0091
50	220.9974	0.0268	0.0014	0.0012	0.0015	0.0086
55	216.5609	0.0271	0.0013	0.0012	0.0014	0.0082
60	214.0106	0.0275	0.0013	0.0012	0.0014	0.0080
65	215.9990	0.0288	0.0014	0.0012	0.0014	0.0080
70	223.4879	0.0311	0.0016	0.0014	0.0015	0.0085
75	235.8358	0.0343	0.0019	0.0017	0.0016	0.0095

2040

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	1293.5375	0.0088	0.0065	0.0057	0.0086	0.0258
5	717.1670	0.0072	0.0038	0.0033	0.0048	0.0168
10	430.4031	0.0062	0.0023	0.0021	0.0029	0.0121
15	337.5659	0.0056	0.0018	0.0016	0.0022	0.0103
20	285.1596	0.0051	0.0015	0.0013	0.0019	0.0089
25	253.0951	0.0050	0.0013	0.0012	0.0017	0.0080
30	229.0886	0.0048	0.0012	0.0011	0.0015	0.0072
35	217.8414	0.0048	0.0012	0.0011	0.0014	0.0065
40	210.4453	0.0049	0.0012	0.0010	0.0014	0.0059
45	204.7754	0.0049	0.0012	0.0010	0.0014	0.0054
50	199.4818	0.0050	0.0011	0.0010	0.0013	0.0051
55	195.4835	0.0050	0.0011	0.0010	0.0013	0.0049
60	193.1883	0.0051	0.0011	0.0010	0.0013	0.0048
65	194.9915	0.0053	0.0011	0.0010	0.0013	0.0048
70	201.7537	0.0058	0.0013	0.0011	0.0013	0.0051
75	212.9010	0.0064	0.0015	0.0013	0.0014	0.0057

2050

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	1266.9600	0.0056	0.0063	0.0056	0.0084	0.0238
5	702.4310	0.0045	0.0037	0.0032	0.0047	0.0155
10	421.5583	0.0039	0.0023	0.0020	0.0028	0.0112
15	330.6281	0.0035	0.0017	0.0015	0.0022	0.0095
20	279.2987	0.0032	0.0014	0.0013	0.0019	0.0082
25	247.8930	0.0031	0.0013	0.0011	0.0016	0.0074
30	224.3797	0.0030	0.0012	0.0011	0.0015	0.0067
35	213.3636	0.0030	0.0012	0.0010	0.0014	0.0060
40	206.1193	0.0031	0.0011	0.0010	0.0014	0.0054
45	200.5657	0.0031	0.0011	0.0010	0.0013	0.0050
50	195.3811	0.0031	0.0011	0.0010	0.0013	0.0047
55	191.4649	0.0032	0.0011	0.0010	0.0013	0.0045
60	189.2167	0.0032	0.0011	0.0009	0.0013	0.0044
65	190.9825	0.0034	0.0011	0.0010	0.0013	0.0044
70	197.6057	0.0036	0.0012	0.0011	0.0013	0.0047
75	208.5243	0.0040	0.0015	0.0013	0.0014	0.0053

2060

Speed	CO2	NOX	PM10	PM2.5	SO2	VOC
2.5	1264.33	0.0050	0.0063	0.0056	0.0084	0.0235
5	700.97	0.0041	0.0037	0.0033	0.0047	0.0153
10	420.69	0.0035	0.0023	0.0020	0.0028	0.0110
15	329.94	0.0031	0.0017	0.0015	0.0022	0.0093
20	278.72	0.0029	0.0014	0.0013	0.0019	0.0081
25	247.38	0.0028	0.0013	0.0011	0.0016	0.0073
30	223.92	0.0027	0.0012	0.0011	0.0015	0.0066
35	212.92	0.0027	0.0012	0.0010	0.0014	0.0059
40	205.69	0.0027	0.0011	0.0010	0.0014	0.0054
45	200.15	0.0028	0.0011	0.0010	0.0013	0.0050
50	194.98	0.0028	0.0011	0.0010	0.0013	0.0047
55	191.07	0.0028	0.0011	0.0010	0.0013	0.0045
60	188.83	0.0029	0.0011	0.0010	0.0013	0.0043
65	190.59	0.0030	0.0011	0.0010	0.0013	0.0043
70	197.20	0.0032	0.0012	0.0011	0.0013	0.0046
75	208.09	0.0036	0.0015	0.0013	0.0014	0.0052

Emission by Pollutant (grams/mile)

	CO2	NOX	PM10	PM2.5	SO2	VOC
2020	295.441	0.147	0.002	0.002	0.0020	0.037
2030	233.172	0.026	0.001	0.001	0.0015	0.010
2040	210.445	0.005	0.001	0.001	0.0014	0.006
2050	206.119	0.003	0.001	0.001	0.0014	0.005
2060	205.694	0.003	0.001	0.001	0.0014	0.005
2020	295.441	0.147	0.002	0.002	0.0020	0.037
2021	289.214	0.135	0.002	0.002	0.0019	0.034
2022	282.987	0.123	0.002	0.002	0.0019	0.031
2023	276.760	0.110	0.002	0.002	0.0018	0.029
2024	270.533	0.098	0.002	0.002	0.0018	0.026
2025	264.306	0.086	0.002	0.002	0.0018	0.023
2026	258.079	0.074	0.002	0.002	0.0017	0.021
2027	251.852	0.062	0.002	0.001	0.0017	0.018
2028	245.626	0.050	0.002	0.001	0.0016	0.015
2029	239.399	0.038	0.002	0.001	0.0016	0.013
2030	233.172	0.026	0.001	0.001	0.0015	0.010
2031	230.899	0.024	0.001	0.001	0.0015	0.009
2032	228.626	0.022	0.001	0.001	0.0015	0.009
2033	226.354	0.020	0.001	0.001	0.0015	0.009
2034	224.081	0.018	0.001	0.001	0.0015	0.008
2035	221.809	0.016	0.001	0.001	0.0015	0.008
2036	219.536	0.013	0.001	0.001	0.0015	0.007
2037	217.263	0.011	0.001	0.001	0.0014	0.007
2038	214.991	0.009	0.001	0.001	0.0014	0.007
2039	212.718	0.007	0.001	0.001	0.0014	0.006
2040	210.445	0.005	0.001	0.001	0.0014	0.006
2041	210.013	0.005	0.001	0.001	0.0014	0.006
2042	209.580	0.004	0.001	0.001	0.0014	0.006
2043	209.148	0.004	0.001	0.001	0.0014	0.006
2044	208.715	0.004	0.001	0.001	0.0014	0.006
2045	208.282	0.004	0.001	0.001	0.0014	0.006
2046	207.850	0.004	0.001	0.001	0.0014	0.006
2047	207.417	0.004	0.001	0.001	0.0014	0.006
2048	206.985	0.003	0.001	0.001	0.0014	0.006
2049	206.552	0.003	0.001	0.001	0.0014	0.005
2050	206.119	0.003	0.001	0.001	0.0014	0.005
2051	206.077	0.003	0.001	0.001	0.0014	0.005
2052	206.034	0.003	0.001	0.001	0.0014	0.005
2053	205.992	0.003	0.001	0.001	0.0014	0.005
2054	205.949	0.003	0.001	0.001	0.0014	0.005
2055	205.907	0.003	0.001	0.001	0.0014	0.005
2056	205.864	0.003	0.001	0.001	0.0014	0.005
2057	205.822	0.003	0.001	0.001	0.0014	0.005

Speed	**Default**	50	**Default Speed Assumption**
	Project Speed	50	The average speed of trucks on selected interstate highways is between 50 and 60 miles per hour(mph). The
	Value Used	40	average operating speed of trucks is typically below 55 mph in major urban areas, border crossings, and in
			Source: https://www.energy.gov/eere/vehicles/fact-671-april-18-2011-average-truck-speeds

Idling Speed Equivalent 5

PIMA POPULATION PROJECTIONS: 2022 TO 2060, MEDIUM SERIES
TABLE 1: TOTAL POPULATION & COMPONENTS OF POPULATION CHANGE

Year	Population	Population Change	Population % Change	Births	Deaths	Natural Change[1]	Net Domestic Migration	Net Foreign Migration	Total Net Migration [2]	Special Population Change
2022	1,072,298	-----	-----	10,206	12,655	-2,449	15,217	1,212	16,429	-----
2023	1,079,998	7,700	0.7%	10,414	11,773	-1,359	7,101	1,721	8,822	237
2024	1,087,948	7,950	0.7%	10,520	11,427	-907	6,391	2,228	8,619	238
2025	1,095,834	7,886	0.7%	10,638	11,083	-445	5,359	2,733	8,092	239
2026	1,102,227	6,393	0.6%	10,755	11,353	-598	4,231	2,760	6,991	0
2027	1,108,795	6,568	0.6%	10,878	11,620	-741	4,539	2,770	7,309	0
2028	1,115,523	6,727	0.6%	11,005	11,904	-899	4,833	2,793	7,626	0
2029	1,122,384	6,862	0.6%	11,135	12,216	-1,081	5,130	2,813	7,943	0
2030	1,129,414	7,030	0.6%	11,268	12,498	-1,230	5,426	2,834	8,260	0
2031	1,136,634	7,220	0.6%	11,401	12,758	-1,357	5,723	2,854	8,577	0
2032	1,143,742	7,108	0.6%	11,530	12,999	-1,469	5,706	2,871	8,577	0
2033	1,150,621	6,878	0.6%	11,655	13,354	-1,699	5,689	2,888	8,577	0
2034	1,157,329	6,708	0.6%	11,770	13,639	-1,869	5,672	2,905	8,577	0
2035	1,163,913	6,585	0.6%	11,875	13,867	-1,993	5,655	2,922	8,577	0
2036	1,170,387	6,474	0.6%	11,965	14,069	-2,103	5,641	2,936	8,577	0
2037	1,176,755	6,368	0.5%	12,036	14,245	-2,209	5,627	2,950	8,577	0
2038	1,182,994	6,239	0.5%	12,085	14,423	-2,338	5,613	2,964	8,577	0
2039	1,189,098	6,104	0.5%	12,115	14,588	-2,473	5,602	2,975	8,577	0
2040	1,195,070	5,972	0.5%	12,127	14,733	-2,605	5,591	2,986	8,577	0
2041	1,200,928	5,858	0.5%	12,125	14,844	-2,719	5,581	2,996	8,577	0
2042	1,206,679	5,751	0.5%	12,110	14,935	-2,826	5,570	3,007	8,577	0
2043	1,212,319	5,639	0.5%	12,085	15,023	-2,938	5,560	3,017	8,577	0
2044	1,217,845	5,526	0.5%	12,054	15,105	-3,051	5,552	3,025	8,577	0
2045	1,223,286	5,441	0.4%	12,019	15,155	-3,136	5,544	3,033	8,577	0
2046	1,228,664	5,378	0.4%	11,984	15,183	-3,199	5,537	3,040	8,577	0
2047	1,233,987	5,324	0.4%	11,950	15,204	-3,253	5,529	3,048	8,577	0
2048	1,239,276	5,288	0.4%	11,920	15,209	-3,289	5,525	3,052	8,577	0
2049	1,244,550	5,274	0.4%	11,896	15,198	-3,303	5,518	3,059	8,577	0
2050	1,249,828	5,278	0.4%	11,879	15,178	-3,299	5,511	3,066	8,577	0
2051	1,255,136	5,308	0.4%	11,871	15,140	-3,269	5,506	3,071	8,577	0
2052	1,260,505	5,369	0.4%	11,873	15,081	-3,208	5,502	3,075	8,577	0
2053	1,265,935	5,430	0.4%	11,884	15,031	-3,147	5,495	3,082	8,577	0
2054	1,271,434	5,500	0.4%	11,909	14,986	-3,077	5,491	3,086	8,577	0
2055	1,276,988	5,553	0.4%	11,948	14,972	-3,024	5,485	3,092	8,577	0
2056	1,282,568	5,580	0.4%	11,999	14,996	-2,997	5,481	3,096	8,577	0
2057	1,288,147	5,580	0.4%	12,058	15,055	-2,997	5,474	3,103	8,577	0
2058	1,293,773	5,626	0.4%	12,122	15,073	-2,951	5,464	3,113	8,577	0
2059	1,299,464	5,691	0.4%	12,189	15,075	-2,886	5,458	3,119	8,577	0
2060	1,305,212	5,748	0.4%	12,257	15,086	-2,829	5,448	3,129	8,577	0

[1]Natural Change = Births - Deaths

[2]Total Net Migration = Net Domestic Migration + Net Foreign Migration

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Marginal External Costs

Table V-22. 2000 Marginal External Costs for Noise (cents per mile)									
	Rural Highways			Urban Highways			All Highways		
	High	Middle	Low	High	Middle	Low	High	Middle	Low
Automobiles	0.03	0.01	0.00	0.30	0.11	0.03	0.20	0.06	0.02
Pickups and Vans	0.03	0.01	0.00	0.27	0.10	0.03	0.17	0.06	0.02
Buses	0.35	0.13	0.04	4.55	1.72	0.48	2.79	1.06	0.30
Single Unit Trucks	0.27	0.10	0.03	3.14	1.19	0.33	1.85	0.70	0.20
Combination Trucks	0.68	0.26	0.07	9.86	3.73	1.05	4.24	1.61	0.45
All Vehicles	**0.08**	**0.03**	**0.01**	**0.64**	**0.24**	**0.07**	**0.42**	**0.16**	**0.05**

Table V-23. 2000 Marginal External Costs for Congestion (cents per mile)									
	Rural Highways			Urban Highways			All Highways		
	High	Middle	Low	High	Middle	Low	High	Middle	Low
Automobiles	3.76	1.28	0.34	18.27	6.21	1.64	13.17	4.48	1.19
Pickups and Vans	3.80	1.29	0.34	17.78	6.04	1.60	11.75	4.00	1.06
Buses	6.96	2.37	0.63	37.59	12.78	3.38	24.79	8.43	2.23
Single Unit Trucks	7.43	2.53	0.67	42.65	14.50	3.84	26.81	9.11	2.41
Combination Trucks	10.87	3.70	0.98	49.34	16.78	4.44	25.81	8.78	2.32
All Vehicles	**4.40**	**1.50**	**0.40**	**19.72**	**6.71**	**1.78**	**13.81**	**4.70**	**1.24**

Table V-24. 2000 Marginal External Costs for Crashes (cents per mile)									
	Rural Highways			Urban Highways			All Highways		
	High	Middle	Low	High	Middle	Low	High	Middle	Low
Automobiles	9.68	3.15	1.76	4.03	1.28	0.78	6.02	1.94	1.13
Pickups and Vans	10.21	3.31	1.75	4.05	1.27	0.74	6.70	2.15	1.17
Buses	14.15	4.40	2.36	6.25	1.89	1.08	9.55	2.94	1.62
Single Unit Trucks	5.97	2.00	0.97	2.21	0.71	0.40	3.90	1.29	0.65
Combination Trucks	6.90	2.20	1.02	3.67	1.16	0.56	5.65	1.79	0.84
All Vehicles	**9.52**	**3.09**	**1.68**	**3.98**	**1.26**	**0.76**	**6.12**	**1.97**	**1.11**

Source: Federal Highway Administration, 1997 Federal Highway Cost Allocation Study, Tables V-22, V-23, and V-24
https://www.fhwa.dot.gov/policy/otps/costallocation.cfm

Table II-11. Trends and Projections of VMT by Vehicle Class (millions)				
	1990	1994	2000	2000 perc.
Autos	1,997,283	1,595,869	1,818,461	67.5%
Pickups and Vans		587,284	669,198	24.8%
Single Unit Trucks	64,114	71,239	83,150	3.1%
Combination Trucks	89,257	99,176	115,639	4.3%
Buses	5,822	6,416	7,397	0.3%
TOTAL	**2,156,476**	**2,359,984**	**2,693,845**	**100.0%**

Source: Federal Highway Administration, 1997 Federal Highway Cost Allocation Study, Table II-11

Marginal External Costs - Additional Estimates used in some of our previous TIGER applications, in CENTS OF 2000 PER MILE

Table 13. 2000 Pavement, Congestion, Crash, Air Pollution, and Noise Costs for Illustrative Vehicles Under Specific Conditions

Vehicle Class/Highway Class	CENTS per Mile					
	Pavement	Congestion	Crash	Air Pollution	Noise	Total
Autos/Rural Interstate	0.00	0.78	0.98	1.14	0.01	2.91
Autos/Urban Interstate	0.10	7.70	1.19	1.33	0.09	10.41
40 kip 4-axle S.U. Truck/Rural Interstate	1.00	2.45	0.47	3.85	0.09	7.86
40 kip 4-axle S.U. Truck/Urban Interstate	3.10	24.48	0.86	4.49	1.50	34.43
60 kip 4-axle S.U. Truck/Rural Interstate	5.60	3.27	0.47	3.85	0.11	13.30
60 kip 4-axle S.U. Truck/Urban Interstate	18.10	32.64	0.86	4.49	1.68	57.77
60 kip 5-axle Comb/Rural Interstate	3.30	1.88	0.88	3.85	0.17	10.08
60 kip 5-axle Comb/Urban Interstate	10.50	18.39	1.15	4.49	2.75	37.28
80 kip 5-axle Comb/Rural Interstate	12.70	2.23	0.88	3.85	0.19	19.85
80 kip 5-axle Comb/Urban Interstate	40.90	20.06	1.15	4.49	3.04	69.64

Source: Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000
https://www.fhwa.dot.gov/policy/otps/costallocation.cfm

NOTE: S.U. = Single Unit, Comb. = Combination; Air pollution costs are averages of costs of travel on all rural and urban highway classes, not just Interstate. Available data do not allow differences in air pollution costs for heavy truck classes to be distinguished.

Recommendations for BUILD - Marginal Costs, in 2018 Dollars

		Units	Most Likely	Low	High	In Dollars of
External Costs of Additional Automobile Use						
	Congestion	$ per vmt	$ 0.063	$ 0.017	$ 0.185	2019
	Accidents	$ per vmt	$ 0.027	$ 0.016	$ 0.084	2019
	Noise	$ per vmt	$ 0.001	$ 0.000	$ 0.003	2019
External Costs of Additional Light-Truck Use (Pickups and Vans)						
	Congestion	$ per vmt	$ 0.056	$ 0.015	$ 0.165	2019
	Accidents	$ per vmt	$ 0.030	$ 0.016	$ 0.094	2019
	Noise	$ per vmt	$ 0.001	$ 0.000	$ 0.002	2019
External Costs of Additional Single Unit Truck Use						
	Congestion	$ per vmt	$ 0.128	$ 0.034	$ 0.376	2019
	Accidents	$ per vmt	$ 0.018	$ 0.009	$ 0.055	2019
	Noise	$ per vmt	$ 0.010	$ 0.003	$ 0.026	2019
External Costs of Additional Combination Truck Use						
	Congestion	$ per vmt	$ 0.123	$ 0.033	$ 0.362	2019
	Accidents	$ per vmt	$ 0.025	$ 0.012	$ 0.079	2019
	Noise	$ per vmt	$ 0.023	$ 0.006	$ 0.059	2019

Inflation Adjustment 2000 - 2019: 1.402

Notes

Use the percent VMT in table II-11 to estimate average marginal external costs from the above table if you have no information on the vehicle mix.

These are marginal cost estimates to be applied to changes in VMT (e.g., due to modal diversion), not to total VMT.

Also consider the following alternative sources:

Parry, Ian W. H., Margaret Walls, and Winston Harrington, “Automobile Externalities and Policies”, Resources For the Future, January 2007

Mark Delucchi and Don McCubbin, External Costs of Transport in the U.S., in Handbook of Transport Economics, ed. by A. de Palma, R. Lindsey, E. Quinet, and R. Vickerman, Edward Elgar Publishing Ltd., 2010

Table 1.1.9. Implicit Price Deflators for Gross Domestic Product

[Index numbers, 2017=100]

Bureau of Economic Analysis

Last Revised on: January 25, 2024 - Next Release Date February 28, 2024

2002-2022	1.62
2002-2019	1.40
2020-2022	1.12
2021-2022	1.07
2022-2021	0.93
2023-2022	0.96

Line		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Lin													
1	**Gross domestic product**	**72.722**	**74.36**	**75.515**	**77.006**	**79.077**	**81.556**	**84.071**	**86.349**	**88.013**	**88.556**	**89.632**	**91.481**
2	**Personal consumption expenditures**	**73.822**	**75.302**	**76.291**	**77.894**	**79.827**	**82.127**	**84.44**	**86.607**	**89.17**	**88.921**	**90.514**	**92.804**
3	Goods	94.089	94.018	93.122	93.003	94.311	96.203	97.494	98.576	101.524	99.084	100.533	104.325
4	Durable goods	140.293	137.545	134.074	129.173	126.647	125.332	123.187	120.564	118.304	116.081	113.946	113.023
5	Nondurable goods	76.084	76.893	76.898	78.488	81.206	84.319	86.946	89.505	94.506	92	94.791	100.417
6	Services	65.21	67.292	69.033	71.336	73.528	75.998	78.75	81.388	83.783	84.432	86.077	87.742
7	**Gross private domestic investment**	**83.374**	**83.854**	**84.383**	**84.943**	**87.506**	**91.104**	**94.179**	**95.6**	**96.621**	**95.278**	**93.782**	**94.699**
8	Fixed investment	82.486	83.206	83.453	84.183	86.642	90.223	93.428	94.857	95.658	94.494	93.026	93.991
9	Nonresidential	92.068	91.698	91.219	90.517	91.409	93.78	96.066	97.62	99.131	98.488	96.695	97.756
10	Structures	50.252	52.884	55.089	57.057	61.282	68.841	77.037	81.581	85.751	84.186	83.502	86.244
11	Equipment	117.751	114.281	111.883	108.99	108.078	107.828	106.758	106.377	105.708	106.354	102.543	102.518
12	Intellectual property products	98.1	97.969	96.657	95.927	95.613	96.232	97.372	98.571	100.125	98.877	98.593	99.807
13	Residential	60.758	63.642	65.218	68.308	73.102	78.338	82.914	84.01	82.828	79.93	79.643	80.236
14	Change in private inventories	---	---	---	---	---	---	---	---	---	---	---	---
15	**Net exports of goods and services**	---	---	---	---	---	---	---	---	---	---	---	---
16	Exports	82.873	82.223	81.507	82.8	85.818	88.784	91.604	95.059	99.387	93.484	97.378	103.508
17	Goods	89.024	88.502	87.581	88.405	91.512	94.418	97.332	101.139	106.345	98.82	103.284	110.868
18	Services	71.501	70.578	70.264	72.493	75.363	78.478	81.141	83.933	86.595	83.622	86.495	89.957
19	Imports	85.236	83.031	82.042	84.524	88.553	93.764	97.393	100.791	110.783	98.532	104.108	112.041
20	Goods	88.912	86.413	84.921	86.73	90.869	96.638	100.511	103.903	115.245	100.768	107.081	116.289
21	Services	70.017	69.057	70.147	75.515	79.097	81.85	84.412	87.864	92.235	88.378	91.228	94.172
22	**Government consumption expenditures and g**	**64.059**	**65.909**	**67.61**	**70.091**	**73.016**	**76.726**	**80.063**	**83.653**	**87.221**	**86.836**	**89.149**	**91.861**
23	Federal	69.115	70.395	72.669	75.849	78.458	81.723	84.327	86.83	89.494	89.279	91.394	93.9
24	National defense	69.056	70.365	72.712	76.317	78.965	82.562	85.452	88.071	90.999	90.352	92.273	94.979
25	Nondefense	69.339	70.576	72.735	75.221	77.77	80.461	82.573	84.882	87.084	87.637	90.094	92.262
26	State and local	61.03	63.128	64.538	66.646	69.726	73.667	77.406	81.603	85.692	85.201	87.642	90.494
	Addendum:												
27	Gross national product	72.743	74.38	75.535	77.027	79.098	81.58	84.096	86.377	88.046	88.581	89.66	91.514

Line		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Lin													
1	**Gross domestic product**	**93.185**	**94.771**	**96.421**	**97.316**	**98.241**	**100**	**102.291**	**104.008**	**105.381**	**110.213**	**117.973**	**122.262**
2	**Personal consumption expenditures**	**94.534**	**95.781**	**97.121**	**97.299**	**98.284**	**100**	**102.047**	**103.513**	**104.635**	**109.001**	**116.043**	**120.374**
3	Goods	105.62	105.049	104.542	101.35	99.71	100	100.811	100.427	99.646	104.572	113.548	114.883
4	Durable goods	111.595	109.551	106.771	104.617	102.337	100	98.633	97.679	96.782	102.112	108.621	107.687
5	Nondurable goods	102.831	102.895	103.409	99.735	98.405	100	101.935	101.853	101.137	105.826	116.245	118.933
6	Services	89.648	91.659	93.795	95.462	97.629	100	102.626	104.972	107.054	111.103	117.066	122.982
7	**Gross private domestic investment**	**95.85**	**96.586**	**98.242**	**98.95**	**98.737**	**100**	**101.545**	**102.965**	**104.049**	**107.711**	**115.936**	**119.575**
8	Fixed investment	95.241	96.16	97.923	98.582	98.55	100	101.568	103.014	104.292	108.162	116.754	120.852
9	Nonresidential	99.13	99.229	100.17	100.345	99.38	100	100.427	101.457	102.092	103.458	109.624	113.595
10	Structures	90.209	91.474	96.213	97.719	97.668	100	101.174	105.258	106.811	110.459	126.692	134.166
11	Equipment	103.088	102.857	102.124	101.499	100.206	100	99.921	99.98	99.502	100.066	106.238	110.889
12	Intellectual property products	100.292	99.948	100.326	100.626	99.453	100	100.582	100.882	102.208	103.235	104.978	106.88
13	Residential	81.006	85.095	89.986	92.454	95.699	100	105.64	108.656	112.28	124.605	141.785	146.218
14	Change in private inventories	---	---	---	---	---	---	---	---	---	---	---	---
15	**Net exports of goods and services**	---	---	---	---	---	---	---	---	---	---	---	---
16	Exports	104.298	104.457	104.515	99.455	97.457	100	103.325	102.814	100.247	111.801	122.767	120.836
17	Goods	111.092	110.344	109.207	101.423	97.467	100	103.545	101.851	97.87	111.693	124.796	119.616
18	Services	91.79	93.61	95.88	95.849	97.44	100	102.91	104.649	104.917	111.584	117.948	122.906
19	Imports	112.359	110.894	110.067	101.283	97.825	100	102.662	100.987	98.87	106.023	113.623	111.5
20	Goods	116.442	114.181	112.66	102.053	97.81	100	102.709	100.452	97.756	105.203	113.034	109.655
21	Services	95.134	96.886	98.954	97.966	97.888	100	102.464	103.341	103.972	109.539	115.945	119.62
22	**Government consumption expenditures and g**	**93.46**	**95.634**	**97.578**	**97.581**	**97.766**	**100**	**103.619**	**105.235**	**107.516**	**113.181**	**121.153**	**124.23**
23	Federal	94.783	95.597	97.215	97.609	98.205	100	102.775	104.56	105.599	109.024	115.108	119.638
24	National defense	95.99	96.459	97.85	98.053	98.419	100	102.642	104.312	105.458	109.181	116.038	120.165
25	Nondefense	92.927	94.307	96.287	96.968	97.897	100	102.968	104.923	105.806	108.835	113.924	118.97
26	State and local	92.579	95.654	97.804	97.567	97.505	100	104.126	105.64	108.689	115.792	124.97	127.127
	Addendum:												
27	Gross national product	93.217	94.801	96.452	97.339	98.262	100	102.225	103.937	105.309	110.13	117.885	---