Executive Summary

The Palm Beach Transportation Planning Agency (TPA) conducted a Health Impact Assessment (HIA) to assess health effects of a no-build scenario compared with proposed multimodal alternatives as part of the Okeechobee Boulevard and SR-7 Multimodal Corridor Study in Palm Beach County, Florida.

Health Impact Assessment

A HIA is a process that analyzes and quantifies how a policy or investment influences people's health. The HIA process consists of six main components: screening, scoping, assessment, recommendations, reporting, and monitoring and evaluation. Use of evidence-based approaches to predict potential health risks and benefits within a community, supported the HIA as a valuable source of evidence that facilitates the process to develop and select alternative systems focused on health promotion and risk mitigation.

1. **Screening**: Determine the HIA's value to the TPA's decision-making process; Assess timeliness & feasibility of the HIA; Evaluate the project based on TPA's Performance Measures.
2. **Scoping**: Define scope of investigation; Develop assessment plan using the Transportation-Alternative Health Analysis framework
3. **Assessment**: Evaluate health impacts of the no-build scenario and proposed multimodal alternatives in terms of air quality and resilience, physical activity, and road safety.
4. **Recommendations**: Use assessment findings to develop recommendations that align with the TPA's Performance Measures and optimize health promotions for each proposed scenario.
5. **Reporting**: Present HIA finds to the community.
6. **Monitoring & Evaluation**: Track the impact of HIA findings on the TPA's selection of a multimodal alternative.

Transportation-Alternative Health Analysis

The Transportation-Alternative Health Analysis scale was used to weigh health outcomes associated with specific design elements for each of the alternatives considered by the TPA. Categories deemed most relevant in evaluating the multimodal alternatives considered by the TPA were air quality and resilience, physical activity, and road safety. The Transportation-Alternative Health Analysis criteria categories were composed of factors that were individually assessed across the various alternatives. Impacts of an alternative's design were assigned value, based on their resulting effects on health using a likert scale system from -2 (impact on health is negative) to 2 (impact on health is positive).

Integrated Transport and Health Impact Model

As part of the larger Transportation-Alternative Health Analysis score, the Integrated Transport and Health Impact Model (ITHIM) is a modeling tool that quantifies the impact of changes to active travel behavior patterns on health. Depending on the design features included within the proposed scenarios considered by the Palm Beach TPA, the ITHIM predicts shifts in the number of vehicle miles traveled (VMT) to personal miles traveled (PMT).

Assuming transportation scenarios will increase bus ridership and active travel (e.g., biking), there was an expected redistribution from personal driving miles to miles traveled in active travel behaviors. As such, the ITHIM modeled health impacts across baseline (no-build) and three (3) scenarios. Scenarios shift 5, 10, or 15-percentage of overall miles traveled (vehicle and personal) from VMT to PMT. Projected ridership, informed by technical expertise and literature review, was utilized as a measure of such shifts in travel behavior. Proposed alternatives were categorized into one of the three scenarios based on their estimated changes in ridership.

Quantitative & Qualitative Analyses

A literature review, feedback provided during two Working Group meetings and public workshops, and results from polling activities informed the research questions and methodology established for assessment. These collaborative efforts helped to ensure the relevance of research objectives to the focus of the HIA. In response, the Transportation-Alternative Health Analysis was developed as a particularly effective approach to promote positive health impacts while also developing strategies to combat negative health impacts experienced within each of the proposed scenarios. Incorporating both qualitative and quantitative data elements, the Transportation-Alternative Health Analysis scale value quantifies the impact of each measure on health.

Working Group Engagement

Relevant interest groups were identified for their involvement in the HIA based on their expertise and value in the decision-making process. The project team assembled a Technical Steering Committee composed of field experts from the Palm Beach County TPA, FDOT, Palm Tran, and the City of West Palm Beach. Technical Steering Committee members offer content knowledge about planning, engineering, and health. Together with the technical team, public engagement and key informant interviews provided an opportunity to facilitate discussions with the community, thereby incorporating the public voice in guiding the HIA.

Findings & Recommendations by Alternative

No-Build

If selected, the no-build scenario would have a somewhat negative impact on health within the study area (Overall Transportation-Alternative Health Composite Score= -0.83). Compared with other proposed multimodal alternatives, the transportation health analysis predicts the no-build scenario would have the most negative implications on air quality and resilience, as well as physical activity. Features such as 6' wide sidewalks, existing multimodal facilities, higher vehicle speeds associated with 12' wide travel lanes, and narrow bicycle lanes do little to encourage public transit ridership, and pedestrian or bicycle activity. Existing emission trends, combined with the highest rates of air-quality and physical activity-related diseases, contribute toward the no-action scenario as the worst overall for health.

However, the no-build alternative possesses several health benefits that must be balanced with potentially negative health outcomes. While the lack of a bicycle lane buffer and limited width increase ambient stress and risk amongst bicyclists, those features are also associated with increased attentiveness on part of vehicle operators. The limited construction impacts involved with the no-build scenario bolster the aesthetic appeal along the corridor, an important consideration when assessing both short- and long-term impacts during the implementation phase of this project.

Under current transportation infrastructure, active travel behaviors (i.e. walking and bicycling) remain low, meaning fewer individuals are less likely to be involved in a crash resulting in injury or death. Although reduced activity levels positively influence road safety outcomes, discouraging pedestrian and bicycle engagement is not a suitable response. Instead, countermeasures such as enhancements to bicycle and pedestrian facilities (i.e., increased lighting, landscaping, tree canopy, and/or wider bicycle lanes and sidewalks) may help to reduce the negative health impacts experienced under the no-build scenario.

Mixed Traffic with Limited Bus Stops

The mixed traffic alternative with limited stops scored as the second highest alternative in terms of negative health impacts (Overall Transportation-Alternative Health Composite Score= -0.13). Given the slight increase in ridership from an added service route, this alternative may raise the convenience for residents to utilize multimodal options without the significant construction impacts characteristic of some other alternatives (i.e., center platforms for BRT or LRT uses). The mixed traffic alternative retains the potential for green space seen in the no-build scenario, while also enjoying a reduction in air quality and physical activity related diseases. Furthermore, perceived safety is positively impacted under proposed conditions, arising from wider sidewalks (uniform over all alternatives except no-build), wider, designated bicycle lanes, and slower traffic speeds (a byproduct of narrower travel lanes).

If selected, additional strategies should be developed to address areas of concern among bicyclists and roadway efficiency. In spite of equivalent risks of injury, designated bicycle lanes lack the physical barrier attributed to separated bicycle lanes. As a result, bicyclists may experience elevated levels of ambient stress than alternatives which include plans for separated bicycle lanes. From an air quality perspective, the mixed traffic option does not present the most efficient strategy to promote public-transportation use. Though rises in public transit ridership are predicted, the convenience and efficiency afforded by bus-dedicated lanes seen in the BAT curbside lane, and curbside BRT alternatives, are missing in the mixed traffic scenario. Mitigation strategies to ameliorate public transit efficiency, should aim to reduce the time spent in traffic among bus service routes, and in turn, encourage more users to use public transportation options.

Business Access and Transit Curbside Lane

The Business Access and Transit (BAT) curbside lane option falls ahead of the mixed traffic alternative according to the overall Transportation-Alternative Health Analysis score (0.45). Unsurprisingly, both alternatives share similar health benefits, such as wider sidewalks, equidistant buffer setbacks, designated bicycle lanes, availability of green space, and comparable ridership rates. Unlike the mixed traffic alternative, the BAT curbside option is unique in its integration of dedicated BAT lanes and some elements of BRT into design plans. Dedicated curbside lanes possess several health benefits. In addition to reducing pedestrian exposures when boarding and deboarding buses, exclusive bus lanes help to reduce travel times when utilizing public-transit services. As a consequence of enhanced efficiency, the BAT curbside lane enjoys increased ridership than the mixed traffic alternative, while averting an increased risk of road traffic fatalities and injury. A further health benefit of the BAT curbside lane is the width of individual travel lanes. As the alternative with the narrowest travel lanes (11' wide), the BAT curbside lane scenario entails the greatest reduction in vehicle speeds associated with such metrics.

Curbside Dedicated Lane Bus Rapid Transit

As the best rated alternative in the Transportation-Alternative Health Analysis, the curbside dedicated lane BRT alternative has some of the most positive overall health impacts of all the proposed scenarios (overall Transportation-Alternative Health Composite Score = 0.78). Despite its scoring in the Transportation-Alternative Health Analysis, the potential for greatest health impacts relate to LRT alternatives for reasons that will be discussed in greater depth within their specific recommendations.

BRT is a highly efficient and cost-effective transportation system that is similar to LRT. BRT is less burdensome from an operational and maintenance approach, even though the capacity for riders is somewhat diminished compared to LRT. In contrast to the BAT curbside lane option, the curbside BRT boasts enhanced efficiency through use of off-board fare collection and traffic signal priority, in addition to dedicated bus lanes. Supplementing it's appeal from an emissions and convenience standpoint, BRT is considered more accessible than traditional bus services, due to features such as elevated platforms, which may aid in addressing disparities in transportation access among the disabled or aging populations. Improvements to ridership also assist in modifying travel behaviors and thus alleviate the burden of chronic diseases related to poor air quality and lack of physical activity.

However, fewer travel lanes may increase congestion and in turn slow traffic speeds, reducing the risk of a crash. The smaller buffer setback between the roadway and sidewalk may negatively impact the perceived safety of pedestrians (although this is mitigated by the outer lanes being dedicated to transit-related travel), as well as their exposure to traffic-related pollutants. Further attention should also be paid to the increased risk of injury resulting from wider traffic lanes (12' wide) and heightened vehicle speeds.

Center Platform Bus Rapid Transit

The center platform BRT alternative is one of two alternatives that involve converting the existing median space into two (2) separated lanes dedicated for public-transit use. Overall, the center platform BRT lags behind the curbside dedicated lane BRT with regard to positive health impacts associated with air quality, physical activity, and road safety (overall Transportation-Alternative Health Composite Score = 0.56). Key differences between this alternative and the others considered by the TPA, center on the construction of a center platform. Positive health impacts of this alternative surround the rise in ridership, wherein physical activity is increased, and emissions of environmental pollutants are cut back from the reduction in personal vehicle travel. Bicyclists are similarly benefitted to other alternatives that incorporate a separated buffer lane design.

There exists several potentially negative health outcomes as a result of the center platform BRT option, many of which pertain to construction impacts. Given the significant effort and investment required to build the center platform, existing health disparities along the study corridor may worsen over time. Construction may discourage residents from engaging in active travel modes by compromising the aesthetic appeal of the roadway. By developing the median, health benefits related to the presence of green spaces (i.e., reducing exposures to vehicle emissions, ambient stress, and lower home values) are lost. If selected, this alternative should make effective use of the buffer setback from the roadway to the sidewalk as an area for landscaping and vegetation in order to offset the consequences of converting the median.

Center Platform Light Rail Transit

The center platform dedicated LRT alternative is one of two proposed designs that incorporate LRT technology. Despite being a highly sophisticated and modern transportation mode, LRT requires substantial financial investment to construct and maintain over time. As such, the center platform LRT option does not positively impact health to the same extent as previous designs that supply accessible, efficient, and connected transportation services. The Transportation-Alternative Health Analysis score identifies the center platform LRT as an alternative that has a somewhat positive health impact related to air quality and resilience, physical activity, and road safety (overall Transportation-Alternative Health Composite Score = 0.57).

LRT systems provide several distinct advantages in terms of health. As an electric technology with a high capacity for ridership, LRT use may significantly reduce roadway emissions produced by personal vehicle use. In a ten-year follow up study, Valley Metro found that implementation of LRT in Maricopa County, Arizona, triggered significant improvements to quality of life in the affected communities. Over 35,000 jobs have since been created in ½ mie of the Valley Metro's LRT (Valley Metro, n.d.). Other benefits include improved access to education and areas of interest in a single trip, a reduction in bicycle and pedestrian crashes, and increased affordability within the LRT corridor when compared with the average for Maricopa County (Valley Metro, n.d.). Increased public-transit use is also associated with a greater number of individuals satisfying their daily exercise requirements.

Despite its advantages, LRT is not the best suited option for all metropolitan areas. The sizable cost and construction required to build a center platform, may quell the positive effects of the alternative on emissions and physical health. However, these potentially negative impacts must be balanced for long-term outcomes as demonstrated by Valley Metro, wherein public transit ridership soared 487%, and 81% of users walk ¼ mile or less to access transit options since the implementation of LRT in 2008 (n.d.).

This specific alternative shares in some negative aspects experienced as result of limited available green spaces, fewer travel lanes for public and general roadway-use, and risk of higher vehicle speeds associated with wider travel lanes. Similar to recommendations formulated toward the center-platform BRT design, strategies to mitigate adverse health impacts aim to make active travel modes more desirable. Primarily, use of landscaping as a means to improve aesthetic appeal, help to reduce ambient stress caused by increased vehicle speeds and/or traffic congestion, and encourage walking or bicycling.

Elevated Grade-Separated Light Rail Transit

Much like the center platform design, the elevated grade-separated LRT has similar health impacts. A distinct feature of this alternative is the elevated and separated design for the LRT system, which would minimize obstructions to the roadway and alleviate traffic congestion. As a consequence, the elevated LRT option allows for four (4) travel lanes, as opposed to the three (3) lanes proposed in other alternatives (*e.g.*, center platform LRT and BRT). Decreased frustration among vehicle operators, congestion, and time spent in traffic are among some of the benefits experienced by the elevated LRT design, however from the perspective of road safety, these factors are negative in their effects on road traffic speeds and crash risk.

While four travel lanes may be advantageous for drivers along the study corridor, pedestrians are not so fortunate. In contrast, the greater distance across the roadway increases pedestrian's exposure and risk of injury when crossing the street. This issue is compounded by the frequency at which LRT users may need to cross the roadway in order to access the platform. Similarly, a reduction in buffer setback space between the roadway and sidewalk could diminish the sense of safety among pedestrians and discourage walking as a travel mode. Mitigation strategies to improve pedestrian safety and crash risk include plans for crosswalk enhancements, and integration of greenery in the available spaces below the LRT platform.

General Recommendations

In addition to the alternative-specific recommendations, this HIA formulated further evidence-based considerations that should be considered by the TPA, regardless of the selected alternative. The following is an abbreviated list of the aforementioned recommendations:

1. **Prioritize transportation infrastructure aimed at connectivity, in order to bolster equitable access to healthy living.**
    a. Minority populations, older adults, low income, and people living with disabilities are disproportionately impacted by limited transportation systems (Institute of Medicine, 2007; Shrestha et al., 2017).
2. **Prioritize projects using Performance Measures to achieve health equity.**
3. **Facilitate appropriate investments in efficient public transit infrastructure improvements that increase ridership and achieve health equity.**

   a. Infrastructure like BRT are advantageous in that they produce fewer emissions than traditional buses, and reduce travel times through off-board fare collection and traffic-signal priority (FTA, 2015).

4. **Consider transportation design elements that promote pedestrian activity.**
   a. Sidewalks that are 12 feet wide, further away from vehicular traffic, and slower roadway speeds are among the features discussed between proposed alternatives that can effectively encourage pedestrian activity (Clarke & George, 2005; Heinrich et al., 2008; Galea et al., 2005).
5. **Prioritize crosswalk enhancements to increase health and safety.**
6. **Consider transportation design elements that promote bicyclist activity.**
   a. Separated bicycle lanes substantially improve the perceived safety of bicyclists, which may in turn bolster existing modeshare splits for bicycling.
7. **Develop an architectural ITHIM to be used in corridor-level analysis that emphasizes equity, gathers environmental inputs from TPA Performance Measures, and informs a regional travel-demand ITHIM mechanism.**
8. **Collaborate with FDOT to develop a monitoring plan for each of the main corridors/throughout the County.**
9. **Consider short-term changes that enhance facilities and build a culture to support a Safe System approach.**
   a. Though crashes are inevitable, the Safe System approach attempts to reduce the risk of human error, and also minimize the severity of injury in the event of such incidents (Federal Highway Administration, 2021).
10. **Encourage an environment of conscious construction practices.**
   a. Sustainable construction projects may integrate solar technologies, source biodegradable materials, recycle existing materials during any demolition process (i.e., steel and/or concrete), utilize locally sourced materials, and ensure the availability of green spaces (Construction World, 2019).
11. **Incorporate landscaping and green space considerations into future transportation projects.**
   a. Availability of green spaces is supported by an array of literature for its beneficial effects in reducing ambient stress, slower traffic speeds, enhanced bicycle and pedestrian activity, minimized exposure to air pollutants, mitigation of urban heat island effects, and increased perceived safety for those walking or bicycling in the area of interest (de Hartog et al., 2010; Dijkstra et al., 2008; Dill et al., 2010; McDonald et al., 2006; Rabl & Nazelle, 2012; Safe Routes to School National Partnership, 2012).

12. **Consider investing in an air monitor system to measure air quality.**
    a. States are responsible for developing their own monitoring plans that ensure the ambient air monitoring networks meet minimum requirements set by the Clean Air Act. By situating an air monitoring system along the study corridor, decision makers can better aim interventions in highlighted areas of need.

Future Considerations

As mentioned in relation to the curbside dedicated lane BRT recommendations, this HIA may underscore the full potential of LRT alternatives in affecting the community's health. Reports such as the quality of life study published by Valley Metro, and results from Commute Seattle's 2019 Center City Commuter Mode Split Survey point toward investments in LRT systems as a significant source of commuter mode split, reduction in single occupancy vehicle trips, in face of increasing employment. In Seattle, transit-related investments such as LRT have led to a 9% reduction in single-occupancy vehicle commutes despite an increase of 90,000 jobs in the downtown Seattle area from 2010-2019 (Commute Seattle, 2019). Limitations experienced in this HIA to fully capture the magnitude of LRT on health factors could be addressed in future studies through use of a Cost-Benefit Analysis and forecasting of long-term health impacts. Considering the substantial upfront costs of LRT systems, it is necessary for subsequent analyses to evaluate changes in health over an extended period of time, to not miss potential developments that may significantly affect health, as supported by findings by Valley Metro (n.d.) and Commute Seattle (2019).

Housing affordability is an additional area for future investigations to measure the impact of transportation alternatives on health. Given the demonstrated need for affordable housing in the greater Palm Beach area, the Okeechobee Blvd and SR7 corridor could benefit from the expansion of high-capacity transit systems that incentivize public and private investment in the development of affordable housing options. In a large-scale study of four metropolitan hubs (Atlanta, Denver, Seattle, and Washington D.C.), Enterprise Community Partners built on previous research by AARP, the National Housing Trust, and Reconnecting America, wherein more than 250,000 privately owned, federally subsidized apartments were within walking distance to quality transit services across 20 metropolitan areas (2010). Two third of which were covered by federal housing contracts (AARP, 2010). Similar opportunities exist in the Okeechobee Blvd and SR7 study corridor. Implementation of transit services with high ridership capacity, such as LRT, should be evaluated for their ability to encourage the development of additional affordable housing options and expand transit-oriented development.

INTRODUCTION

The Palm Beach Transportation Planning Agency (TPA) conducted a Health Impact Assessment (HIA) on the proposed multimodal alternatives for the Okeechobee Boulevard and SR-7 Multimodal Corridor Study in Palm Beach County. A HIA is a process that analyzes and quantifies how a policy or investment influences people's health. The purpose of this memorandum is to document the HIA process, how the study could potentially impact health from the perspective of mitigating disparities while optimizing air quality, physical activity, and road safety.

As one of the five components of the larger Okeechobee Blvd & SR7 Multimodal Corridor Study, the intent of the HIA was to consider health outcomes in evaluating the no-build and proposed multimodal alternatives. Performance of the HIA, in conjunction with other aspects of the planning study, specifically the roadway and transit alternatives analysis, and Land Use & Economic Development Analysis, demonstrated an interest in balancing optimal transit alternatives with those that produce the most beneficial health outcomes in the study area population.

About the HIA Process

HIAs are performed assuming a holistic approach to health, acknowledging that many factors may directly or indirectly influence the health of the community (Human Impact Partners, 2011). This HIA intended to evaluate the potential impact of multimodal alternatives on the state of health and equity along the corridor, and to provide recommendations to facilitate the TPA's intended outcomes or mitigate unintended outcomes.

HIAs are developed under a highly collaborative and democratic process. Through listening to feedback from those that live, play, and work, in the study area, the HIA approach values engagement from affected populations. In combining evidence-based strategies with commentary from stakeholders, policy makers, and community members, HIAs help to foster a broader understanding of the unique challenges communities face, particularly for vulnerable groups (Human Impact Partners, 2011). Collaborative efforts enable all involved parties to increase their competencies between various sectors, in addition to strengthening the contents of policies or projects that account for opinions across different areas of expertise (Bourcier et al., 2015). In doing so, HIAs possess potential for increased credibility and empowerment within their impacted communities.

The HIA process consists of six main components: screening, scoping, assessment, recommendations, reporting, and monitoring, detailed in Figure 1. Each stage is to be expanded upon further in its relation to the Okeechobee Boulevard and SR-7 Multimodal Corridor Study.

Figure 1. Health Impact Assessment Stages and Purpose

Screening	• Determine HIA's value to the TPA's decision-making process • Assess timeliness and feasibility of the HIA • Evaluate the project based on TPA's performance measures
Scoping	• Define the scope of investigation • Develop plan for assessment using the Transportation-Alternative Health Analysis
Assessment	• Assess impacts of proposed alternatives in terms of air quality & resilience, physical activity, and road safety • Specify direction and magnitude of potential impacts
Recommendations	• Use findings from assessment to develop recommendations that align with the TPA's performance measures • Optimize health promotion strategies for each alternative
Reporting	• Present HIA findings to the community as part of the the Okeechobee Blvd & SR7 Multimodal Corridor Study
Monitoring & Evaluation	• Track the impact of the HIA findings on the TPA's selection of a multimodal alternative • Detail the effects of the investment on determinants of health

Screening

In the first stage of a Health Impact Assessment (HIA), Screening, the project team aimed to establish the value and feasibility of the assessment. Data about the proposed project, measurement of potential health impacts, the existence of a demonstrated need for such a change, and evidence that the proposed project would result in substantial effects on public health were documented.

Timing

For the multimodal analysis along the Okeechobee Blvd and SR-7 study corridor, the project team determined that the HIA time frame is June 2021 to February 2022. A total of four (4) Technical Steering Committee meetings were conducted, a series of key informant interviews, a community-wide survey, and three (3) public meetings.

Health Impacts

As part of the Palm Beach TPA's 2045 Long Range Transportation Plan (LRTP), the 561 Plan identified the Okeechobee Blvd and SR-7 as one of six east-west and five north-south priority transit corridors respectively (Palm Beach Transportation and Planning Agency [TPA], 2020a). In addition to its significance as a major transit corridor, the 561 Plan also expects the Okeechobee Boulevard corridor to increase by 70,000 residents and 14,000 jobs by 2045. With such considerable growth anticipated in the future, present concerns related to commuter mode split within the study corridor and surrounding areas may worsen over time (TPA, 2020a). Specific performance measures set forth by the TPA describe desired reductions in single-occupancy vehicle trips, improved mode shares for walking, bicycling, and public-transit use, in addition to the development of infrastructure conducive for enhanced movement of freight throughout the county (TPA, 2020b). For the purposes of this HIA, multimodal alternatives to address current transportation-related improvements along the Okeechobee Blvd and SR7 study corridor were considered in terms of their potential impacts on the health of the surrounding community.

Population Characteristics of Okeechobee Blvd & SR-7

Passing through the Village of Wellington, Royal Palm Beach, and the City of West Palm Beach, the study corridor contains several distinct character areas each facing its individual needs and challenges, as detailed in the "Okeechobee Boulevard Transit-Supportive Land Use and Economic Development Analysis: Existing Conditions Report" performed by the Palm Beach TPA (2020a). Baseline conditions described in the Existing Conditions Report justified use of the HIA as a tool to assess multimodal alternatives for revised pedestrian, bicycle, public transportation, and freight designs to address discrepancies in health outcomes across the distinct sub-sections within the study area.

Population. The target population of interest for this HIA were the people that live, work, and play within the study corridor of Okeechobee Blvd and SR7. Of particular interest were segments of the population disproportionately affected by poor health outcomes and social vulnerability. Special considerations were made to socially vulnerable groups with specific transportation needs, such as aging adults, people living with disabilities, and low-income subsets of the population.

Baseline Conditions. Findings established in the "Existing Conditions Report" contextualize the study corridor as an area that could be substantially impacted by enhanced multimodal transportation options (TPA, 2020a). Transportation enhancement strategies consider a multitude of factors such as the availability of pedestrian and bicycle-friendly facilities, sidewalk or crosswalk improvements, and close gaps in transit coverage, with the greater goal of creating transportation systems that are accessible, efficient, and help to strengthen connection with communities (Todd, 2006). Indicators of particular relevance in the study area include:

- The demographic breakdown of the study population indicates groups that have unique transportation needs or may be underserved by current transportation infrastructure along the corridor:
  - Among the study population, 35% are either under 18 or over 65 years old, both of which entail special considerations in terms of transportation access and connectivity.
  - Less than 10% of workers live and work in the study area
  - There is a considerably higher concentration of the population living in the study area living at or below the federal poverty level (21%) as opposed to the county average rate (12%).
  - Indicators of housing and transportation affordability suggest the study area is more likely to be cost-burdened by housing and transportation-related costs.
- Some tracts within the corridor exceed county averages by more than double the rates for heart disease, stroke, nutritional deficiencies, diabetes, disability, and homicides.
- Only 11.3% of the study area is considered walkable.
- Between 2013-2018, 79% of bicycle and pedestrian crashes on the study corridor roadway resulted in injuries or fatalities

The conditions depict several demographic characteristics of the target population that justified further exploration into the potential impact of proposed multimodal alternatives on the state of health disparities in the study corridor.

Social Vulnerability & Areas of Greatest Concern

The CDC and Agency for Toxic Substances and Disease Registry's (ATSDR) Social Vulnerability Index (SVI) measures the impact of external stressors on health during times of emergency. Importantly, social vulnerability is a measure of community resilience. The social vulnerability index is composed of 15 factors from the US Census that identify subsets of a population with increased susceptibility to human suffering and economic losses in event of an emergency. Overall, there are four primary themes that affect social vulnerability, which are:

housing and transportation, race/ethnicity/language, socioeconomic status, and household composition (Centers for Disease Control and Prevention [CDC], 2020).

Using data from the American Community Survey 5-year estimates, the total population within the study corridor included 86,736 residents (2019). The total population of the study area represents 61% of the total population of all census tracts, including those that intersect the region of interest. The Project Team looked closer at different elements of health at the corridor-level, specifically social vulnerability (see Figure 2, page 5), life expectancy (see Figure 3, page 6), converging health outcomes (see Figure 4, page 7), and social vulnerability overlayed with converging health outcomes (see Figure 5, page 8).

Figure 2. Overall Social Vulnerability in the Okeechobee Blvd & SR7 Study Corridor, CDC/ATSDR Social Vulnerability Index 2020

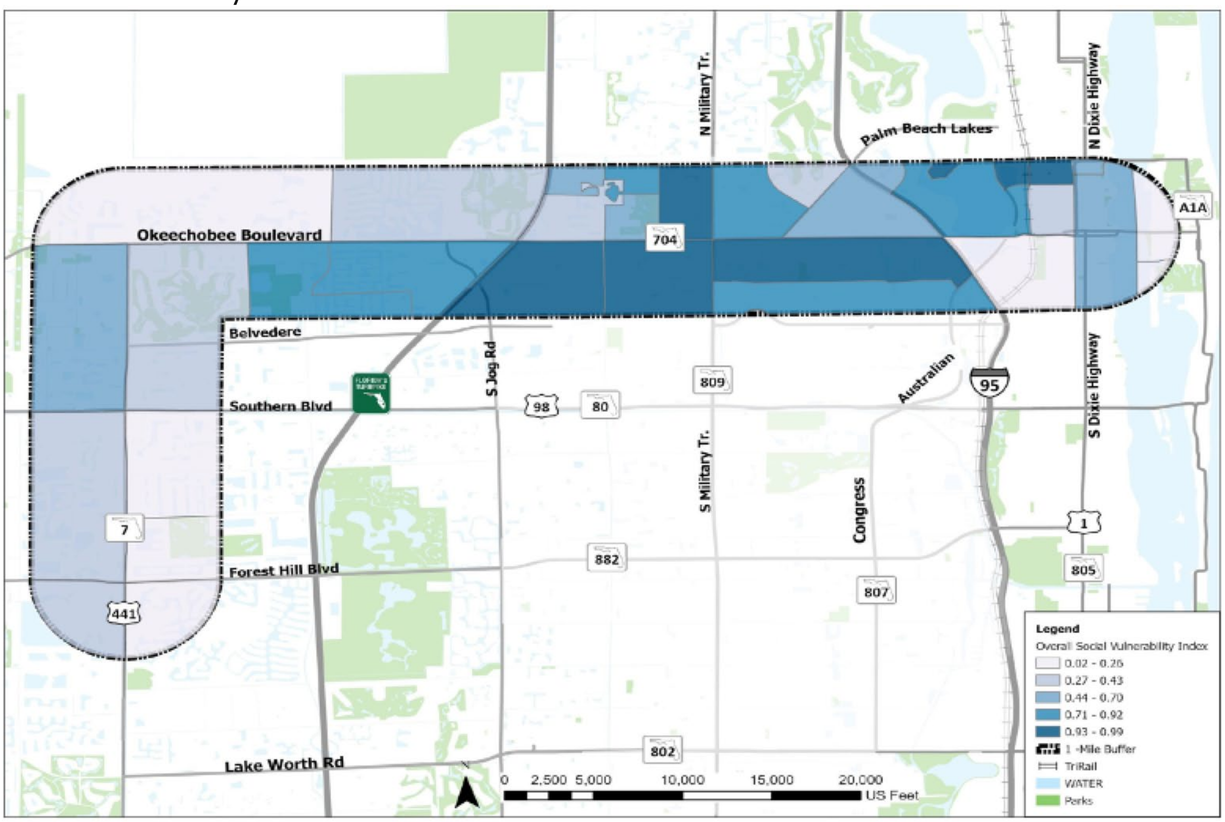


Figure 3. Life Expectancy in the Okeechobee Blvd & SR7 Study Corridor, Florida CHARTS, 2019

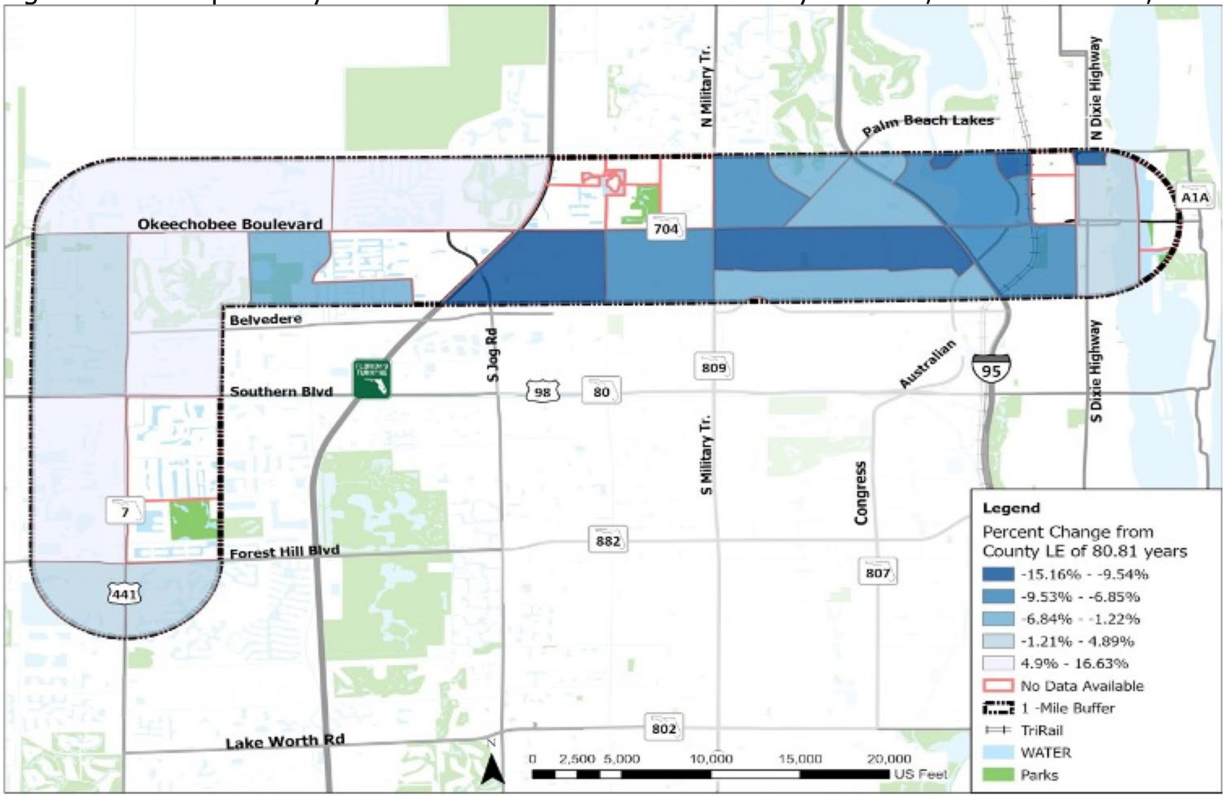


Figure 4. Percent of Converging Health Outcomes* in the Okeechobee Blvd & SR7 Study Corridor, PLACES Project, Centers for Disease Control and Prevention 2020

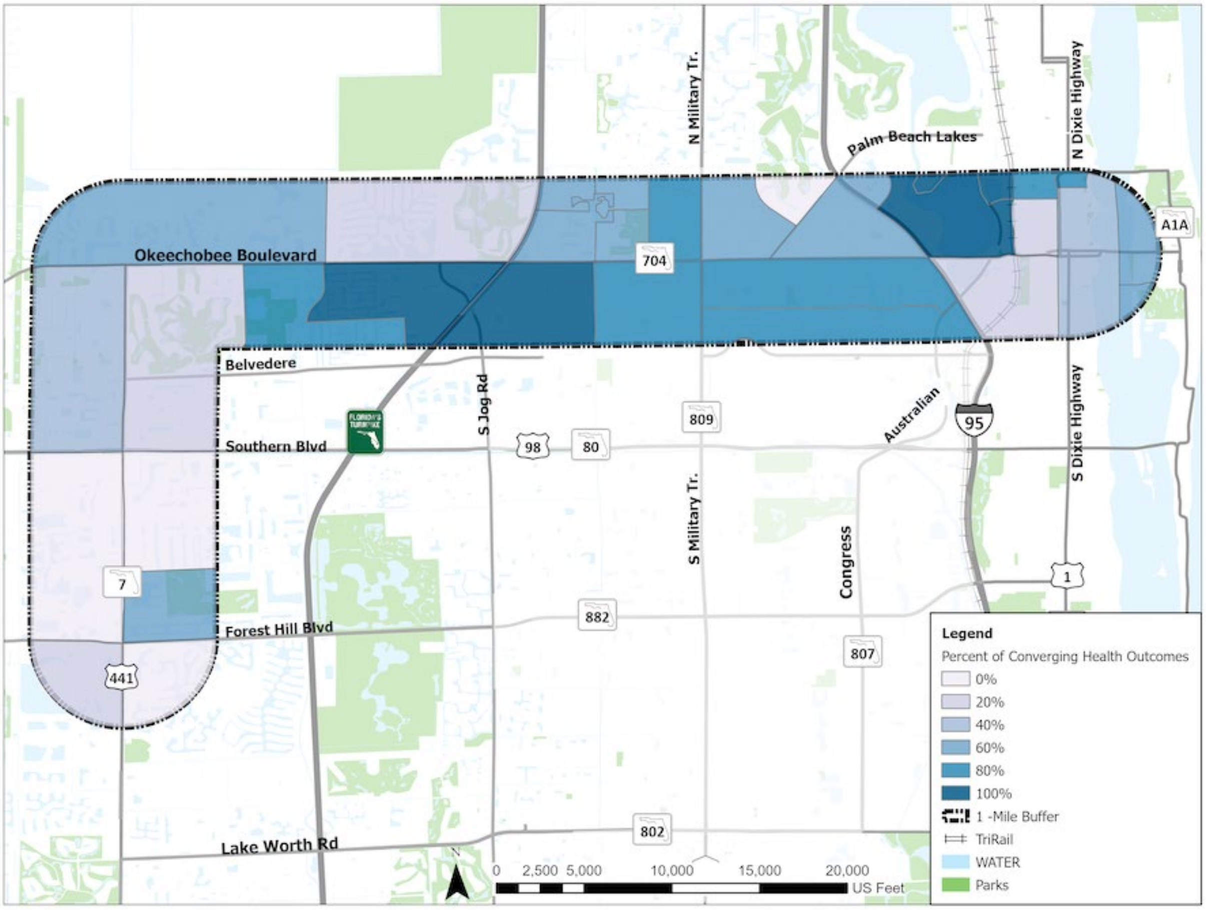


Figure 5. Areas with High Social Vulnerability Index & High Rates of Converging Health Outcomes* in the Okeechobee Blvd & SR7 Study Corridor, CDC 2020

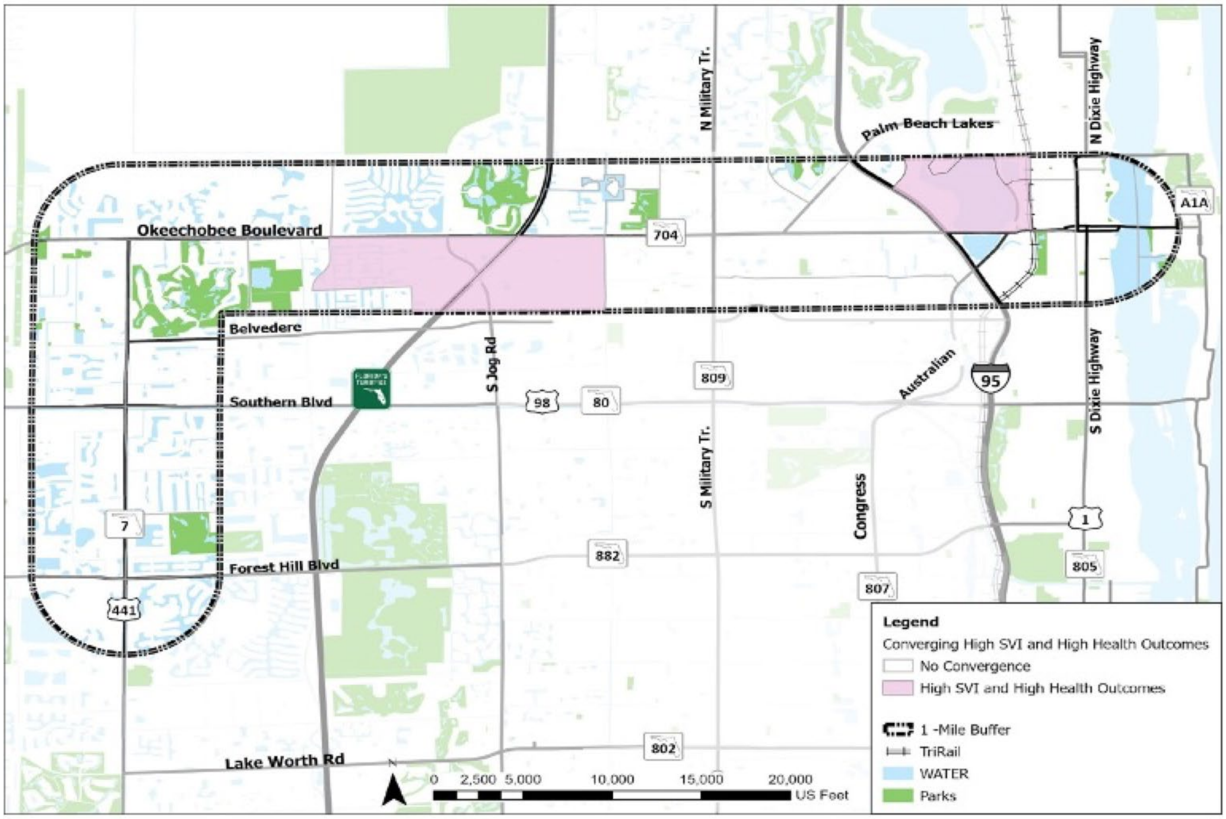


Figure 2 illustrates a sizable proportion of the census tracts along Okeechobee Blvd experiencing higher rates of social vulnerability than tracts on SR7 (darker blue shades are representative of increasing SVI). Similarly, census tracts along Okeechobee Blvd shared similar trends in life expectancy (darker blue shades indicate negative decreases in life expectancy) and poor health outcomes (Figure 3, page 6, and Figure 4, page 7). While the majority of census tracts had either elevated rates of health disparities or social vulnerability, four (4) tracts were found to have high scores for social vulnerability and poor health outcomes (see Figure 5, above). These tracts were concentrated near the Tri-Rail and southern portion of the Turnpike transect. Considerations were made toward these areas of greatest concern during the recommendations phase of the HIA, discussed on page _. *Converging Health Outcomes are representative of the four health outcomes in the study area that exceed the Palm Beach County rates: asthma, diabetes, cancer, poor mental health.*

Potential Impacts of HIA Process and Findings

Health has been identified as a consideration in the TPA's selection of no-build or multimodal alternatives. As mentioned previously, the decision to perform the HIA was intended to evaluate the no-build scenario and proposed alternatives in terms of their potential impact on health indicators within the community. Such a consideration, in conjunction with other aspects of the multimodal corridor study, specifically the roadway and transit alternatives analysis, and Land Use & Economic Development Analysis, prove an interest in balancing optimal transportation alternatives with those that produce the most beneficial health outcomes in the study area population. Utilizing previous studies, such as the "Okeechobee Boulevard Transit-Supportive Land Use and Economic Development Analysis: Existing Conditions Report," baseline conditions are well documented and support the use of the HIA as a tool to assess differences in premature morbidity and mortality across the no-build and multimodal alternatives in terms of their impact on air quality and resilience, physical activity and road safety.

In addition to its influence on existing health conditions, the HIA process was identified for its potential to help evaluate existing goals, and achieve the TPA's vision of a "safe, efficient, and connected multimodal transportation system." (TPA, 2020b). Evidence-based recommendations developed through the HIA phases, possess great potential to inform the TPA which alternatives or approaches may help to achieve existing desired outcomes within their performance measures, and aid in the selection of alternatives that most closely align with industry standards.

Existing variability in transportation infrastructure and access implies variable needs for multimodal options. One of the strengths of the HIA, is to weigh identified areas of concern and to recommend strategies that strengthen the selected alternative for the greatest magnitude and breadth of impact on overall health. Findings from the HIA could enhance collaboration and cohesion among community members through the implementation of multimodal alternatives aimed at reducing the health inequities identified in previous studies of the area.

Stakeholder Interest & Capacity

Vast differences in demographic trends exist from portion-portion of the study area. Stark contrasts in health determinants are linked to a variety of poor health outcomes, which may contribute to a divide in the communities along the study corridor (Thornton et al., 2016). With knowledge of the distinct character areas along the corridor, it is especially important to incorporate community feedback on the proposed scenarios, some of which if implemented, may have differing effects on residents and community members along the 13.8-mile-long study corridor. For example, communities utilizing the eastern segment of the study area enjoy improved walkability, bicycle infrastructure, and transportation coverage, whereas areas of the study corridor along SR7 (particularly in the north-western segment) have a higher prevalence of narrow (4'-7' feet wide) sidewalks, and gaps in bus route coverage (TPA, 2020a).

Relevant interest groups were identified for their involvement in the HIA based on their expertise and value in the decision-making process. The project team assembled a Technical Steering Committee composed of field experts from the Palm Beach County TPA, FDOT, Palm Tran, and the City of West Palm Beach. Technical Steering Committee members offer content knowledge about planning, engineering, and health. Together with the technical team, public engagement and key informant interviews provided an opportunity to facilitate discussions with the community, thereby incorporating the public voice in guiding the HIA. Concerns regarding current state of health outcomes along the study corridor have been documented prior to the HIA, as stated in the "Okeechobee Boulevard Transit-Supportive Land Use and Economic Development Analysis: Existing Conditions Report" (TPA, 2020a).

During the evaluation meeting for the HIA's approval, stakeholders noted existing needs within the study corridor that could benefit from the HIA process and expressed their interest to participate. Of the 30 individuals that attended and approved the use of the HIA, a significant amount (16, 53%) had previously participated in HIAs and detailed their priority health considerations.

Stakeholder Feedback in Screening

One (1) meeting was held by the Project Team to accomplish the tasks outlined in the screening phase. As mentioned earlier, Working Group members were invited to participate interactively, using a Mentimeter platform. Mentimeter allowed the Project Team to receive real-time feedback in various formats (e.g. multiple choice answers, ranking and polling, word clouds/open-ended responses) submitted by virtually stakeholders (Mentimeter, n.d.).

Figure 6. Health Considerations Shared by the HIA Corridor Working Group at Meeting #1, June 2021

There were 26 participants that provided open-ended responses highlighting their primary areas of interest for investigation within the HIA. Word cloud terms appear larger, the more a specific response was submitted. Notably, access, walkability, safety, proximity to services, air quality, and equity were among the most popular considerations established by the technical team during the June 29th meeting.

SCOPING

During the scoping phase of the Okeechobee Blvd and SR7 HIA, the project team determined project roles, scope of investigation, and detailed methodology to be employed during the assessment.

Determining Roles

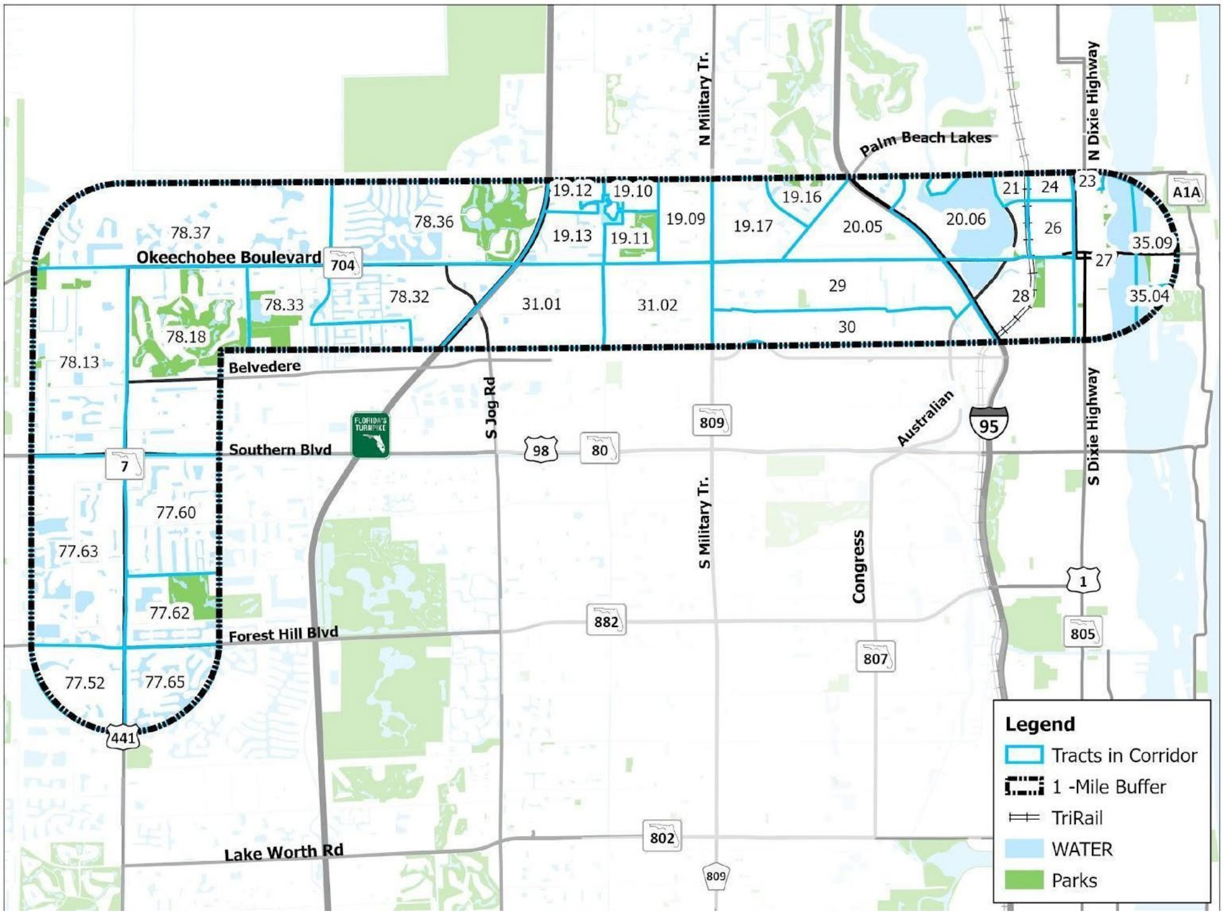
Roles for the HIA were determined by the project team, and the HIA Working Group Members. The project Working Group met bi-monthly to discuss project developments and provide feedback that informed the direction of the HIA. During Working Group meetings, members were provided a presentation describing the purpose of each HIA stage, reviewed materials, and participated in discussions on HIA findings for each of the respective steps. Working Group members also engaged in an interactive polling platform that captured both open-ended and multiple-choice responses.

In addition to the project Working Group, feedback from the community brought forth key insights on the priority areas to be addressed during the HIA. Through the public workshops, community members were provided a platform that informed the HIA in a different manner from the project Working Group. As opposed to technical discussions, public workshops allowed the Project Team to incorporate the first-hand experiences of the community into the HIA. By incorporating both technical and community-based perspectives, the scoping stage of this HIA developed an assessment plan that accurately reflected the conditions and needs specific to the study corridor.

Defining the Scope of Inquiry

Geographic Boundaries. The geographic boundaries evaluated in this HIA adhere to previous definitions established by the TPA in the "Existing Conditions Report" (2020a). Such boundaries are also replicated in other components of the Okeechobee Blvd & SR7 Multimodal Corridor Study. Most population data was collected at the census tract level. Within the study corridor, there were 32 census tracts, representing 61% of the intersection tract total population (United States [U.S.] Census Bureau, 2015-2019).

Figure 7. Census Tracts in the Okeechobee Blvd & SR7 Study Corridor, U.S. Census Bureau, 2015-2019



Qualitative Analysis. A literature review, feedback provided during both Working Group meetings and public workshops, and results from polling activities informed the research questions and methodology established for assessment. These collaborative efforts helped to ensure the relevance of research objectives to the focus of the HIA. Three (3) pathways arose from such interactions. Pathways were selected based on the areas with the greatest potential to impact health and equity in considering the proposed multimodal alternatives, which were: air quality and resilience, physical activity, and road safety.

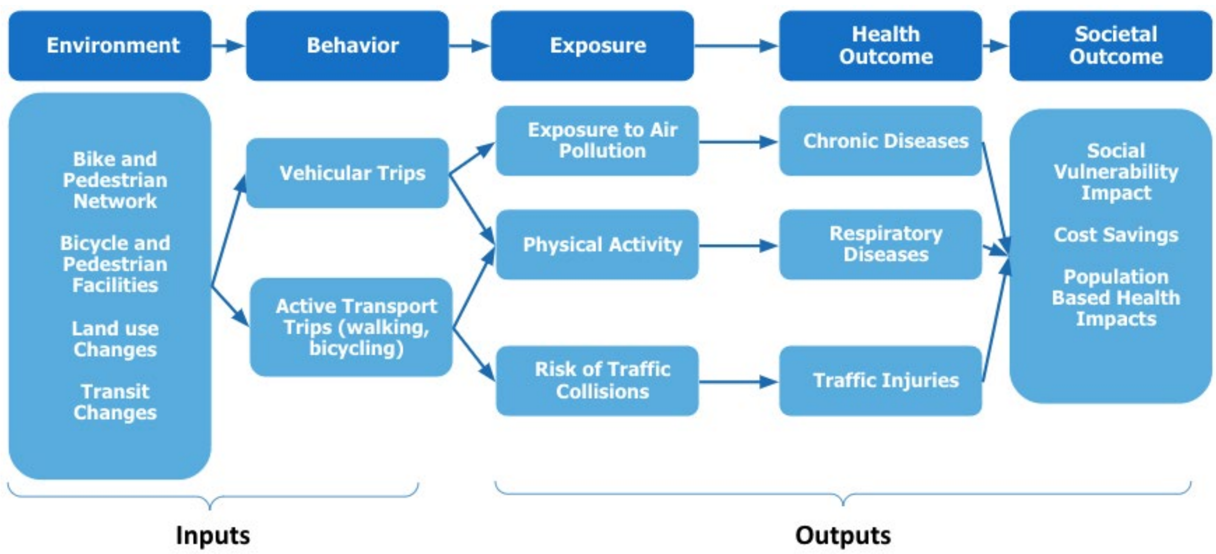
In response, the Transportation-Alternative Health Analysis was developed as a particularly effective approach to promote positive health impacts while also developing strategies to combat negative health impacts experienced within each of the proposed scenarios. Incorporating both qualitative and quantitative data elements, the Transportation-Alternative Health Analysis scale value quantifies the impact of each measure on health for each of the listed scenarios. Qualitative values are assigned based on literature review as well as professional and technical expertise.

Quantitative Analysis. Combined with the Transportation-Alternative Health Analysis, the Integrated Transport and Health Impact Model, or ITHIM, captured quantitative measures of physical activity, air pollution, and road traffic injuries. Statistical analyses of the ITHIM utilized R Software to run the modeling tool, adapted from California Integrated Transport and Health Impact Model (University of California, Davis, 2019). Data sources used to run the ITHIM tool are listed in Appendix A, on page __.

Pathways & Health Indicators

Within a HIA, pathways are a visual tool that help illustrate associations between environmental factors and health outcomes. As part of the iterative process, several pathways were presented to Working Group members and the public and underwent revisions during the scoping phase. In concluding scoping, it was determined that the pathways of air quality and resilience, physical activity, and road safety were the most pertinent subject areas to assess when comparing the alternatives considered by the TPA. Figure 8 outlines the pathways through which factors of air quality and resilience, physical activity, and road safety impact health.

Figure 8. Okeechobee Blvd & SR7 Corridor Study HIA Pathways, Adapted from Center for Health Impact Evaluation & County of Los Angeles Public Health Department, 2018



The pathways shown in Figure 8 provide a guide for the inputs and potential outputs of this HIA. Environmental inputs for the ITHIM would include the bike and pedestrian network, facilities, changes in land use, vehicle parking, and transportation. Behavioral inputs are impacted by the environmental inputs, specifically related to the number of vehicle trips taken in the study area, and the modes of active transportation engagement (walking or bicycling). Interactions between environmental and behavioral inputs determine outputs of the ITHIM tool, namely exposures, health outcomes, and societal outcomes for the study corridor population along Okeechobee Blvd and SR7.

Research Question

The scope of investigation for this HIA aimed to compare the no-build scenario and various proposed alternatives in terms of their potential health impacts. As such, the Project Team established the following research question:

1. How will the no-build and proposed transportation alternatives along Okeechobee Blvd and SR7 impact health in terms of air quality and resilience, physical activity, and road safety?

Transportation-Alternative Health Analysis

The Transportation-Alternative Health Analysis scale was used to weigh health outcomes associated with specific design elements for each of the alternatives considered by the TPA. Previous HIAs evaluated proposed transportation projects using a similar scoring framework to measure potential health impacts, like the Public Health Assessment performed by the Massachusetts Department of Transportation (MassDOT) Office of Transportation Planning (2020). To develop their project scoring framework, information was compiled through literature review and key informant interviews with transportation and public health officials from seven (7) states. Categories considered by ten (10) previous health prioritization frameworks are listed in Table 1, below.

Table 1. Previous HIAs Utilizing Health Criteria in Project Prioritization Frameworks, adapted from MassDOT, 2020

State/MPO	Air-Quality & Resiliency	Physical Activity	Road Safety	Accessibility	Health Equity
Department of Transportation (State-level)					
California	✓	✓	✓	✓	
Minnesota		✓	✓	✓	✓
Massachusetts	✓	✓	✓	✓	✓
Maryland	✓	✓	✓	✓	✓
North Carolina		✓	✓	✓	
Ohio	✓		✓	✓	
Tennessee		✓	✓	✓	✓
Virginia	✓		✓	✓	✓
Metropolitan Planning Organization (MPO) (Regional)					

Nashville	✓	✓	✓	✓	
Sacramento Area Council of Governments	✓	✓	✓		

Based on prior frameworks nationally employed by various MPOs, as well as state departments of transportation and departments of public health to evaluate proposed transportation alternatives, the Transportation-Alternative Health Analysis deployed in this HIA is similarly aligned. The categories deemed most relevant in evaluating the multimodal alternatives considered by the TPA were air quality and resilience, physical activity, and road safety. In contrast to the MassDOT categories, health equity and accessibility were assessed from a qualitative perspective and referred to in the recommendations. Further modifications were made to the MassDOT scoring framework wherein each health-related criteria category was assigned a weight. Though the weighing system remains relevant to emphasize areas with the greatest potential to impact health, the methodology employed in the MassDOT evaluation and similar reports, such as the Virginia DOT's SmartScale, was not in context for this HIA. Within these studies, weights represented values generated from public engagement. Though public engagement in the form of public workshops was an important factor in guiding the HIA, such interactions did not inform this aspect of the project. As a result, this should be considered a limitation of the assessment, and remains a potential strategy to be deployed in future studies.

The Transportation-Alternative Health Analysis criteria categories were composed of factors that were individually assessed across the various alternatives. Factors were unique to each category, as displayed in Table 2 (below).

Table 2. Okeechobee Blvd & SR7 Corridor Study Transportation-Alternative Health Analysis Factors by Category

Category	Transportation-Alternative Health Analysis Factors
Air Quality	• Chronic diseases associated with air quality • PM2.5 and NO2 concentration ○ Green technology ○ Buffers for pedestrian exposure to emissions • Integrated Transport and Health Impact Model
Physical Activity	• Chronic diseases (CHD, cancer, dementia, diabetes, stroke) associated with physical activity ○ Enhanced ped/bike facilities ○ Connectivity • Integrated Transport and Health Impact Model

Safety	• Ped/bike crashes • Ped/bike fatalities • Integrated Transport and Health Impact Model
Accessibility	• Access to jobs • Access to other goods & services through active transport modes • Transportation access for socially vulnerable populations
Health Equity	• Construction impacts • Aging-in place • Distribution of diseases • Social vulnerability

A likert scale, similar to the grading systems established in the MassDOT grading framework, was established to indicate the magnitude and direction of health impacts for each of the factors. Impacts of an alternative's design were assigned value, based on their resulting effects on health. Those with negative health effects received either a -2 or -1 score, depending on the severity of the impact. Likewise, health promoting features were assigned positive values. The scoring system and specified values are defined in Table 3, below.

Table 3. Okeechobee Blvd & SR7 Corridor Study Transportation-Alternative Health Analysis Scale

Transportation-Alternatives Health Analysis Scale Value	**-2**	**-1**	**0**	**1**	**2**
Transportation - Alternatives Health Analysis Scale Description	Impact on health is negative - -	Impact on health is somewhat negative -	Impact on health is neutral -/+	Impact on health is somewhat positive +	Impact on health is positive + +

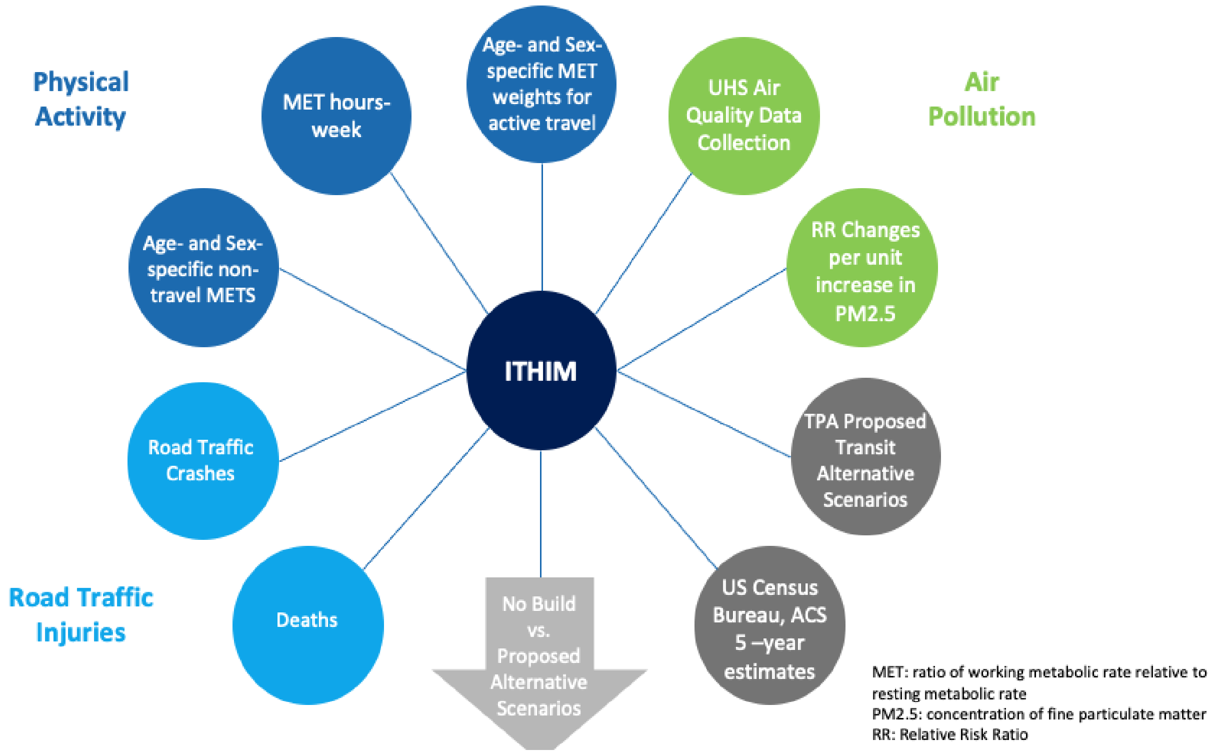
A detailed review of the specific rationale and sub score values assigned to each indicator is described in Appendix C (page _). The composite scores (also seen in Appendix C, page __) were calculated by averaging the sub-score values assigned to each Transportation-Alternative Health Analysis indicator.

Integrated Transport and Health Impact Model

As part of the larger Transportation-Alternative Health Analysis score, the ITHIM is a modeling tool that quantifies the impact of changes to active travel behavior patterns on health. Depending on the design features included within the multimodal alternatives considered by the Palm Beach Transportation and Planning Agency (TPA), the **ITHIM predicts shifts disease burden (air quality and physical activity-related chronic diseases, and road traffic crashes) as a result of changes in the number of vehicle miles traveled (VMT) redistributed to Personal miles traveled (PMT).**

Utilizing data sources across 3 levels of government (federal, state, and local sources), the model requires 14 calibration items. Data inputs within the ITHIM tool include existing travel patterns (pedestrian, bicycle, vehicular transport), physical activity levels, air pollution concentration (as defined by fine particulate matter), in addition to the burden of disease and injuries within the study population and various travel scenarios (University of Wisconsin-Madison Global Health Institute, 2021; Whitfield et al., 2017). Figure 9 below shows the specific inputs and output of the ITHIM.

Figure 9. Overview of the Okeechobee Blvd & SR7 Corridor Study Integrated Transport and Health Impact Model, Adapted from University of California, Davis, 2019



Use of the ITHIM tool in a HIA is well established for its ability to quantify the impact of transportation infrastructure on health, specifically by looking at physical activity, road traffic injury risk, and exposure to fine particulate matter (PM2.5) air pollution. The Office of Research and Development within the United States Environmental Protection Agency endorsed the ITHIM Tool in 2016. Global applications of the ITHIM tool are documented in England, Wales, India, the Netherlands, Switzerland, and Brazil (Götschi et al., 2015; Sá et al., 2017; Woodcock et al., 2009, 2013, 2014). Nationally, Metropolitan Planning Organizations (MPOs) in Nashville, Tennessee, Oregon, and California have successfully implemented the ITHIM tool as part of a growing interest in the field of health-integrated transportation planning (Iroz-Elardo et al., 2014; Mazlish et al., 2013; Whitfield et al., 2017; Wu et al., 2019).

Similar interest in the ITHIM tool is echoed locally in the South Florida region. A recent study commissioned by the Florida Department of Transportation (FDOT) assessed health integration in transportation planning, which identified the ITHIM tool as a best practice and provided guidance on localized applications of the ITHIM, which are adhered to in this HIA. Additionally, the FDOT study recommended a framework that combined regional travel demand modeling with ITHIM, to effectively consider health within a transportation planning process that could be endorsed by the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) (Lee & Jin, 2020). The Project Team has taken these models and frameworks to devise an ITHIM methodology specific to the Okeechobee Blvd and SR7 corridor study.

ITHIM Methodology

Methodology in this HIA was guided by the California Integrated Transport and Health Impact Model (University of California, Davis, 2019). Assuming transportation scenarios will increase bus ridership and active travel (e.g., biking), there was an expected redistribution from vehicle miles traveled (VMT) to personal miles traveled (PMT). As such, the ITHIM modeled health impacts across baseline (no-build) and three (3) scenarios. Scenarios shift 5, 10, or 15-percentage of overall miles traveled (vehicle and personal) from VMT to PMT. Projected ridership, informed by technical expertise and literature review, was utilized as a measure of such shifts in travel behavior. Proposed alternatives were categorized into one of the three scenarios, as seen in Table 4.

Table 4. Okeechobee Blvd & SR7 Corridor Study Categorization of Alternatives by ITHIM Scenarios

Category	Baseline	5% Shift in VMT to PMT	10% Shift in VMT to PMT	15% Shift in VMT to PMT
Alternative	• No-Build /No-Action Alternative	• Mixed Traffic Bus w/ Limited Stops • Business Access and Transit (BAT) Lane	• Curbside Dedicated Lane BRT* • Center Platform Dedicated Lane BRT*	• Center Platform Dedicated Lane LRT** • Elevated Grade LRT**
Projected Corridor Boardings*	3,200	2,800 - 3,800	3,900 - 6,000	6,300 - 10,300

Data elements consisted of Okeechobee Corridor census tract-level data combined with California estimates and percentage shift changes (*i.e.,* average, minimum, maximum for non-travel Metabolic Equivalent Task hours (METS), and baseline PMT and VMT). Formula coefficients and unit-change values are based on previous meta-analysis research. Baseline was defined as Okeechobee Corridor's current state of health. Death and road traffic data were averaged over 2018-2020 to increase reliability due to probable fluctuations due to the 2020 pandemic. Changes in vehicle and personal miles traveled based on transportation scenarios were hypothesized by UHS based on literature reviews.

Although previous ITHIM applications resort to Disability Adjusted Life Years (DALYs) as a measure of health impacts, this HIA makes use of a similar metric, the Population Attributable Fraction (PAF). DALYs, unlike PAFs, is a measure of the burden of a disease over an individual's lifetime, equating the years of life lost due to premature mortality and years lost living in a suboptimal state of health (WHO, n.d.-a). Instead, the PAF **indicates the proportion of a disease in a population that is attributable to a certain exposure** (WHO, n.d.-b). Additionally, the PAF assumes a causal relationship, where the disease burden could be avoided by adding or eliminating the exposure, presuming no other changes. Use of the PAF, as opposed

*Bus Rapid Transit (BRT)
**Light Rail Transit (LRT)

to DALYs, was justified given the availability of corridor-level data and the similarities between both metrics.

To understand the magnitude of deaths prevented in the corridor, cause-specific deaths for Palm Beach County (i.e., three-year average from the Florida CHARTS) were divided by the corridor's population and multiplied by the respective PAF. Diseases without well-defined death estimates were omitted from these transformations (i.e., acute respiratory infections, depression). Scenario health impacts were ranked by an overall composite score of mean PAFs summed across diseases. Disease-specific PAFs included acute respiratory infection, breast cancer, colon cancer, lung cancer, dementia, depression, diabetes, heart disease, stroke, and road traffic injuries. Scores were then multiplied by 100. A higher relative score corresponded to great positive impacts on health.

Air Quality. Changes in air quality were impacted by the concentration of fine particulate matter (PM2.5) in the study corridor. More specifically, shifts in VMT across each of the modeled scenarios, projected differences in future PM2.5 concentration and the relative risk of developing an air-quality-related illness. The association between certain exposure levels of fine particulate matter and risk of heart disease, stroke, acute respiratory infections, and lung cancer was established by Woodcock et al. and required by the ITHIM to estimate health impacts affected by air quality changes (2010). Data regarding the concentration of PM2.5 was not previously available at the corridor-level prior to this HIA. As a response, a field collection of PM2.5, 0.3MuM, 10MuM, percent Relative Humidity, and temperature (°F) using a PerfectPrime AQ9600, PM 0.3/2.5/10 Mm Air Quality Particle/Dust Detector/Counter at transit station stops located within the study corridor was performed.

Physical Activity. Physical activity levels were measured by shifts in PMT affecting the prevalence of heart disease, diabetes, stroke, dementia, depression, colon cancer, and breast cancer. Baseline data for disease states were obtained from the Florida CHARTS (2019). Active travel time, or PMT, was multiplied by weights in order to generate the Metabolic Equivalent Task (MET) hours (University of California Los Angeles, 2009). The ITHIM outputs (Population Attributable Fractions, or PAFs) related to physical activity account for age- and sex- specific differences in metabolic rates for active travel, as set forth by Woodcock et al.(2011). Existing literature on the relationship between the relative risk and health conditions support health outcome estimates modeled by the ITHIM (Krewski et al., 2009).

Road Safety. Road traffic crash data was obtained from the Signal Four Analytics System (2020). The data was averaged across three years (2018-2020) due to probable pandemic impacts on travel behaviors. Rates of road traffic crashes were based on the PAF and multiplied by baseline road traffic fatalities with the corridor population denominator. Road safety outcomes are expressed as potential road traffic fatalities.

ITHIM Limitations

Florida specific travel behavior was not available to serve as baselines for vehicle and personal miles traveled. In the absence of this measure a range of values (*i.e.,* mean, minimum, and maximum to calculate non-travel METs; Baseline PMT and VMT for Florida) were used from California's travel survey estimates. Future ITHIM applications could benefit from the availability of region-specific data of VMT and PMT measures, which could be administered in the form of a Travel Survey similar to the version used in California (University of California Los Angeles, Center for Health Policy Research, 2012).

In addition, corridor census tract-level deaths were not available. To combat this limitation, the mortality per 100,000 residents was used, based on a Palm Beach County death numerator and a corridor population denominator. Future work may consider gathering tract-specific deaths by cause for more precise estimation of the Corridor's health impact.

While road traffic estimates do account for mode of striking vehicle or pedestrian, and severity of incident, the ITHIM was unable to account for the protection conferred by additional safety measures within each of the modeled scenarios. Countermeasures may include improvements to lighting, curb extensions (as seen in several of the proposed designs, such as the Curbside dedicated lane BRT, which has the shortest roadway distance of all the alternatives), high visibility markings for crosswalks at midblock crossings or uncontrolled intersections, and additional "YIELD" or "STOP" signage leading up to crosswalks. Given this significant limitation, caution is urged in interpreting ITHIM outputs related to road safety, as they are likely a substantial overestimation of crash risk. Inclusion of such safety measures are expected to counteract the frequency and severity of traffic-related crashes. Therefore, the ITHIM's road safety outputs should be understood as areas where such safety countermeasures are essential considerations. Future research could benefit through the development of constants, coefficients, or formulas to be applied in the ITHIM in order to project the effects of road safety countermeasures.

Changes in mortality were chosen as this study's primary outcome given our methodology was adapted from California's Integrated Transport and Health Impact Model (ITHIM). California's ITHIM incorporated relative risk change in mortality per unit increase/decrease in air particulate matter and physical activity exposure. Additional areas for future investigations may include estimating changes to corridor morbidity (e.g., non-fatal outcomes) upon appropriate changes in methodology and data elements. Currently within the corridor, road traffic injuries (as opposed to road-traffic fatalities) are the one measure that provided insight on road-safety related morbidity. Such a recalibration of the ITHIM mechanism could help provide an alternative form of analysis and better capture the current state of health within the Okeechobee Blvd & SR7 corridor.

Assessment

For assessment, the Project Team evaluated the direction and magnitude of potential health impacts related to air quality and resilience, physical activity, and road safety.

Design Elements & Health Outcomes

The associations between transportation design and health outcomes are well established in literature. Differences across the proposed alternatives in terms of sidewalks, bicycle lanes, travel lanes, buffer zones, median, and transportation types are compared across the Transportation-Alternative Health Analysis categories. Features unique to each of the proposed alternatives can differentially impact areas of focus within this HIA. Oftentimes, certain design elements impact health in similar ways, a point that is illustrated in Table 5 (below).

Table 5. Okeechobee Blvd & SR7 Corridor Study Design Elements by Transportation-Alternative Health Analysis Categories

Design Element	Air Quality & Resilience	Physical Activity	Road Safety	Accessibility	Health Equity
Sidewalk Width	✓	✓	✓	✓	✓
Bicycle Lane Width	✓	✓	✓		✓
Travel Lane Width			✓		
Buffer Zone Width	✓	✓	✓	✓	✓
Type of Bicycle Lane	✓	✓	✓		✓
Median Green Space	✓	✓	✓		
Type of Transit	✓			✓	✓
Construction Impacts	✓	✓	✓		

One example are the health effects resulting from designs that encourage walking or bicycling, as opposed to driving a car. Wider sidewalks and buffered bicycle lanes promote pedestrian and bicyclist activity through related mechanisms (Appendix B). Both design features (i.e. broader walkways, and a physical barrier between oncoming traffic and bicyclists) increase the perceived safety of walking or bicycling along such areas, and may in turn promote physical activity (Appendix B). As such, design elements that increase active transportation engagement will also improve rates of physical activity, air quality, and their related diseases. The relationship between transportation designs and some of their related health outcomes are featured in Table 6.

Table 6. Okeechobee Blvd & SR7 Corridor Study Transportation Design Elements & Health-Related Outcomes*

Design Element	Behavioral Outcomes	Associated Health Outcomes
Sidewalk Width	Wider sidewalks are associated with … Increased perceived safety [1,6,7] Greater pedestrian activity when sidewalks are considered more desirable [3,6,7,20,21] Enhanced walkability from sidewalks is associated with higher land values [12, 13] Improved air quality (fewer vehicle emissions) [15,17]	• Enhanced business activities (e.g., shopping, access to goods & services) [4,11,20, 27] • Increase in spending at businesses [11,27] • Increase in the number of individuals meeting daily exercise requirements [14,26] • Reduce burden of chronic diseases associated with physical activity [21,23,25] • Improve mental health [22] • Risk of exposure to air pollution [15,16,17,18,19] • Risk of respiratory illnesses linked to poor air quality [15,16,17,18,19]
Bicycle Lane Width	Wider bicycle lanes are associated with … Increased perceived safety for bicyclists [36] Decreased attentiveness by vehicle operators [10]	• Increase in the number of individuals meeting daily exercise requirements [14,26] • Reduce the burden of chronic diseases associated with physical activity [21,23,25] • No significant association with green spaces and mixed land uses [30] • Risk of vehicle and bicycle crash increases [10] • Risk of exposure to air pollution [31**]
Travel Lane Width	Lane widths measuring 10 feet positively impact street safety without compromising traffic capacity [41,42,43] Narrower travel lanes promote slower traffic speeds [44,45]	• Narrower lanes reduce pedestrian exposure at crossings and intersections [44,46] • Crash rates are reduced or unchanged between 10 ft and 12 ft wide travel lanes [47,48] • Higher traffic speeds increase the risk of more severe crashes, with serious injuries and fatalities [49]
Buffer Zone Width	Wider buffer zones between roadway and sidewalk are associated with … Increased perceived safety [1,8] Increased pedestrian activity [8] Enhanced aesthetic appeal and opportunity for green spaces [50]	• Greater buffer widths reduce risk of pedestrian exposure to air pollution (PM2.5 NO2) [51,52] • Risk of respiratory illnesses linked to poor air quality [15,16,17,18,19] • Increased protection for

*The corresponding numbered reference list is included in Appendix B, on page ___.
**Within this specific study, vehicle operators experienced elevated levels of PM2.5 exposure as compared to bicyclist exposure.

		pedestrians from out-of-control motorists [50]
Type of Bicycle Lane	Increased perceived safety [36,37] Buffered bicycle lanes provide increased safety as opposed to wider bike lanes [9] Increased bicyclist activity [38,39] Fewer vehicle emissions & traffic congestion [40]	• Decrease in crash odds across all types of bicycle lane (separated, designated) [32] • Improve mental and physical health [33,34,35] • Lessened air and noise pollution exposure in surrounding communities [40]
Median Green Space	Presence of green spaces is associated with … Increased perceived safety for pedestrians and bicyclists [1,24] Increased pedestrian and bicycle activity [1,2,55] Slower traffic speeds [5] Enhanced aesthetic appeal and opportunity for green spaces [50] Reduced greenhouse gas emissions [53]	• Reduce ambient stress [24] • Reduce the risk of pedestrian exposure to air pollution (PM2.5 NO2) [51,52] • Risk of respiratory illnesses linked to poor air quality [15,16,17,18,19] • Mitigate urban heat island effects [53] • Presence of tree canopy is linked with elevated property values [54]
Type of Transit	Availability of enhanced, multimodal transit options relates to … Sustainable infrastructure in the form of green technology investments [56] Reduction in greenhouse gas emissions [61]	• Improve functional capacity in performing daily activities [23] • Increase the number of individuals meeting daily exercise requirements [26] • Lower BMI [28,29] • Increase social interactions within the community [60] • Reduce vehicle crashes [59] • Equitable access to employment opportunities, and goods and services, especially for low-income individuals, older adults, or people living with disabilities [57,58]
Construction Impacts	Construction efforts are often associated with changes to daily living. The intensity and duration of such projects are linked with impacts such as … Aesthetic appearance [68] Increased noise pollution [62] Construction-related emittance of air pollutants [66] Disruption of existing traffic patterns [64]	• Risk of ambient stress, sleep disturbances, and high blood pressure, typically associated with noise pollution [62,63] • Traffic delays may increase frustration among vehicle operators [64,65] • Compromised quality of life due to noise and air pollutants [66,67] • Discourage physical activity [68] • Increase in exposure to air pollutants [68]

*The corresponding numbered reference list is included in Appendix B, on page ___.
**Within this specific study, vehicle operators experienced elevated levels of PM2.5 exposure as compared to bicyclist exposure.

		• Risk of bicycle and pedestrian crashes increase [68]

*The corresponding numbered reference list is included in Appendix B, on page ___.
**Within this specific study, vehicle operators experienced elevated levels of PM2.5 exposure as compared to bicyclist exposure.

Air Quality & Resilience

Background

Reliance on personal vehicles as a primary mode of transportation presents several challenges to health. Within the larger Palm Beach County, the percentage of commuters driving to work alone (80%) exceeded the national average (75%), whereas less than 2% utilized public-transit alternatives (TPA, n.d.-a). Nationally, the transportation sector contributes to 29% of the United States' greenhouse gas emissions, passenger cars being one of the main sources of emissions (United States Environmental Protection Agency, 2021b). Increases in greenhouse gasses are associated with a multitude of negative health outcomes including heat-related illnesses, lung cancer, asthma, displacement, and increased prevalence of communicable disease (National Institute for Environmental Health Sciences, 2019).

Aims to reduce greenhouse gas emissions caused by personal vehicle travel may be accomplished through upgraded multimodal alternatives that may diminish health impacts linked to climate change. Such are aligned with established goals within the Palm Beach TPA. The TPA, alongside the Broward Metropolitan Planning Organization (MPO), and the Miami-Dade Transportation Planning Organization (TPO), led the "South Florida Climate Change Vulnerability and Adaptation Pilot Project," intended to "conduct climate change and extreme weather vulnerability assessments of transportation infrastructure and to analyze options for adapting and improving resiliency." As a result, the final report concludes that southeast Florida (including Palm Beach County) is one of the most vulnerable areas in the country to extreme weather events and future impacts of climate change (Broward Metropolitan Planning Organization & Parsons Brinckerhoff, Inc., 2015). By promoting the use of alternative forms of multimodal transportation that emit less greenhouse gasses, this HIA explored the resulting impacts of proposed measures on mitigating negative health outcomes rooted from a warming climate.

Features of Proposed Alternatives Affecting Air Quality & Resiliency

Specific design elements within each of the alternatives possessed potential to differ in their impact on air quality and resiliency factors. The factors of interest within this HIA were adapted from the MassDOT project scoring criteria and include the burden of chronic diseases associated with air quality, use of eco-friendly technology, and buffers for pedestrian and bicyclist exposure to emissions (2020).

Table 7. Transportation-Alternative Health Analysis Factors Related to Air Quality & Resiliency

Transportation-Alternative Health Analysis Factors Related to Air Quality & Resiliency		
Burden of chronic diseases associated with air quality - Heart Disease - Stroke - Lung cancer	Use of eco-friendly technology - Vehicle Emissions - Electric forms of energy	Buffers for pedestrian exposure to emissions - Green space - Landscaping - Tree canopy

A comparison between design specifications of each of the alternatives are listed in Table 8 (below). Design elements listed are those that may impact the Transportation-Alternative Health Analysis factors of interest. The specific health factors within air quality and resilience are later discussed in relation to their impact on health.

Table 8. Okeechobee Blvd & SR7 Corridor Study Design Elements Affecting Air Quality & Resilience

Design Elements	No Build	Mixed Traffic with Limited Bus Stops	Business Access and Transit (BAT) Curbside Lane	Curbside Dedicated Lane BRT	Center Platform Dedicated BRT	Center Platform Dedicated LRT	Elevated Grade Separated LRT
Total width of the sidewalk (per side)	6 ft width	12 ft width	12 ft width	12 ft width	12 ft width	12 ft width	12 ft width
Total width of the bicycle lane (per side)	5 ft width	7 ft width	7 ft width	10 ft width	10 ft width	10 ft width	10 ft width
Type of bicycle lane buffer	Designated No marked buffer)	Designated 2 ft buffer	Designated 2 ft buffer	Separated 2ft and 3ft buffers on either side	Separated 2ft and 3ft buffers on either side	Separated 2ft and 3ft buffers on either side	Separated 2ft and 3ft buffers on either side
Median Green Space	Green space available	Green space available	Green space available	Green space available	Center platform for BRT	Center platform for LRT	Elevated platform, some green space available
Width of Left/Right sidewalk buffer	Left: 45.5 ft Right: 43.5 ft	Left: 39.5 ft Right: 37.5 ft	Left: 39.5 ft Right: 37.5 ft	Left: 32.5 ft Right: 30.5 ft	Left: 44 ft Right: 42 ft	Left: 39.5 ft Right: 37.5 ft	Left: 32.5 ft Right: 30.5 ft
Eco-friendly Technology	No	Possible	Possible	Yes	Yes	Yes	Yes

Health Outcomes Associated with Air Quality & Resiliency Factors

Chronic Diseases Associated with Air Quality & Resiliency. The Integrated Transport and Health Impact Model (ITHIM) projected health effects of PM2.5 concentration on the following outcomes: heart disease, stroke, and lung cancer. The mortality rates (per 10,000 corridor residents) at baseline and 5%/10%/15% scenarios are illustrated in Table 9.

Table 9. Mortality Rate per 10,000 Corridor Residents due to Air-Quality-Related Diseases

Cause of Mortality	Baseline	5% Shift in VMT to PMT	10% Shift in VMT to PMT	15% Shift in VMT to PMT
Heart Disease	452	431	411	393
Stroke	138	131	125	120
Lung Cancer	83	<83	<83	<83

Based on findings shown in Table 10, there is a clear reduction across all chronic conditions associated with air quality with increasing shifts in VMT to PMT. Though the 15% shift represents the most significant difference in mortality rates, it is important to note ITHIM outputs must also be considered in conjunction with the broader Transportation-Alternative Health Analysis. More specifically, the two alternatives: center platform dedicated LRT and elevated LRT, do not necessarily represent the alternatives with the most beneficial impacts on health even though they represent the greatest shift in active travel behavior. Such is due to the fact that the 5%/10%/15% scenarios are defined by their estimated ridership and lack measured shifts in walking and bicycling patterns. Similar considerations must be considered when interpreting ITHIM findings related to physical activity and road safety.

Use of Eco-friendly technology. From an environmental perspective, alternatives that alter travel behaviors, namely, a reduction in single-occupancy vehicle trips, directly influence the amount of carbon dioxide emissions released into the air resulting from the combustion of petroleum-based products, most commonly gasoline and diesel (United States Environmental Protection Agency, 2021). Namely, the reduction in vehicle emissions that result from engaging in walking, bicycling, and public transportation are outcomes of particular interest that affect air quality and resilience. Within public transportation, the prioritization of multimodal options that make use of green technology (*e.g,* electric fleets, LRT), or more efficient transit routes that reduce time spent in traffic may significantly impact emission levels along the study corridor.

A key difference between the alternative designs is the impact each scenario may have on air quality. Traditional bus routes are generally regarded as less efficient than services like BRT. For context within this HIA, it is important to note that there is potential for Palm Tran to electrify their fleet of buses. If so, there would be a great impact on the air quality and resilience scoring, particularly among the no-build, mixed-traffic with limited bus stops, and Business Access and Transit (BAT) lane alternatives. Existing scores for these scenarios rely on the assumption that buses are not electric.

BRT services are often characterized by dedicated bus lanes, off-board fare collection, traffic signal priority, elevated platforms, and expanded station facilities compared to more conventional bus stations. Investments in BRT have been endorsed by the Federal Transit Administration (FTA) as appropriate, and affordable transit alternatives suitable for application in big cities and mid-sized metropolitan areas, like the study corridor (FTA, 2015). Mimicking elements of light rail transit (LRT), BRT alternatives are regarded as more reliable and efficient than regular bus systems. Dedicated bus lanes and traffic signal priority reduce the amount of time spent in traffic, making the alternative a more desirable transportation option over single-occupancy vehicles, while also lessening the amount of emissions released into the atmosphere.

LRTs best suited within the context of Okeechobee Blvd and SR7 are capable of high capacity, long haul trips. Powered by a catenary system, LRT systems are fully electric and possess substantial impact to reduce emissions resulting from vehicles and other forms of public transportation. Challenges to LRT require an appropriate balancing between the design of a comfortable and efficient service, without spending excessive capital on an alternative that exceeds the need of the study area and affected communities (RailSystem, n.d.). At the same time, in a 10-year follow-up study of their LRT system, findings from Valley Metro in Maricopa County, Arizona, indicate that the potential for long-term health benefits of LRT implementation may warrant the substantial up-front costs. Since its implementation, over 35,000 jobs have since been created in ½ mie of the Valley Metro's LRT (Valley Metro, n.d.). Other benefits include improved access to education and areas of interest in a single trip, a reduction in bicycle and pedestrian crashes, and increased affordability within the LRT corridor when compared with the average for Maricopa County (Valley Metro, n.d.). As such, the lasting health impacts must also be weighed against the initial investment and construction efforts.

Buffers for pedestrian exposure to emissions. Availability of green space is associated with several positive health impacts. Not only do green spaces increase perceived safety among pedestrians and bicyclists, they also play a role in reducing greenhouse gasses, mitigating urban heat island effects, elevate property values, and provide a buffer between pedestrians and vehicular traffic emissions (Bowker et al., 2007; Dijkstra et al., 2008; Dill et al., 2010; Kweon et al., 2021; Netusil et al., 2010; Safe Routes to School National Partnership, 2010). As a result, exposures to air pollutants like PM2.5 and NO_2 are minimized, accompanied by a diminished risk of contracting a respiratory illness associated with poor air quality. Alternatives that develop the median green space, or reduce the buffer between the roadway and sidewalk, must weigh the potential benefits of increased public transit ridership with the decreased potential for green space and landscaping.

Table 10. Air Quality & Resilience-Related Health Outcomes by Alternative According to References Listed in Appendix B

Alternative	Potential Health Outcomes
No-Build*	• Existing pedestrian and bicycle activity levels [69] • Perceived safety without a bicycle buffer [36,38,39] • Green space is available along some corridor sections [69] • Buffer set-back from roadway to sidewalk, that provides increased sense of safety for pedestrians & protection from vehicle emissions [69,70] • Persistent emission trends [70,74] • Estimated ridership [73] • Rates of heart disease, stroke, and lung cancer [70,72,73,74,75,76,77]

Mixed Traffic with Limited Bus Stops	• Minimal increase in public transit ridership from an added service route (Mall at Wellington Green and Intermodal Transit Center) & BRT option [73] • Mixed traffic lanes may impact efficiency of the alternative in reducing emissions/ time spent in traffic [15,17,40,56,61] • Increase in pedestrian activity from wider sidewalks (equal across all alternatives except no-build) [3,6,7,20,21] • Minimal reduction in mortality from heart disease, stroke, and lung cancer [70,72,73,74,75,76,77] • Minimal increase in perceived safety for bicyclists due to wider bicycle lanes and designated buffer [36,38,39] • Green space is available along some corridor sections [69] • Minimal reduction in perceived safety for pedestrians & protection from vehicle emissions due to smaller buffer set-back from roadway to sidewalk [3,8,51,52]
BAT Curbside Lane	• Minimal increase in ridership from implementation of Business Access and Transit Lane (reduce travel times) [73] • Minimal potential reduction in emissions (> Mixed Traffic with Limited Bus stops) [15,17,40,56,61,78] • Increase in pedestrian activity from wider sidewalks (equal across all alternatives except no-build) [3,6,7,20,21] • Minimal reduction in perceived safety for pedestrians & protection from vehicle emissions due to smaller buffer set-back from roadway to sidewalk (= Mixed Traffic with Limited Bus stops) [3,8,51,52] • Minimal reduction in mortality from heart disease, stroke, and lung cancer [70,72,73,74,75,76,77] • Minimal increase in perceived safety for bicyclists due to wider bicycle lanes and designated buffer [36,38,39] • Green space is available along some corridor sections [69]
Curbside Dedicated Lane BRT	• Moderate increase in ridership from implementation of dedicated BRT lane & BRT option [73] • Increase in pedestrian activity from wider sidewalks (equal across all alternatives except no-build) [3,6,7,20,21] • Separated buffer provides the maximum increase in perceived safety for bicyclists [36,38,39] • Small buffer area between roadway and sidewalk, leading to a decreased sense of safety and increased exposure to emissions for pedestrians [3,8,51,52] • Reduction in emissions due to BRT usage, and increases in bicycle activity [15,17,40,56,61] • Moderate reduction in mortality from heart disease, stroke, and lung cancer [70,72,73,74,75,76,77] • Green space is available along some corridor sections [69]

Center Platform Dedicated BRT	• Moderate increase in ridership by having dedicated BRT lanes (< travel time than curbside dedicated BRT lane alternative due to elimination of non-transit vehicles) [73] • Increase in pedestrian activity from wider sidewalks (equal across all alternatives except no-build) [3,6,7,20,21] • Separated buffer provides the maximum increase in perceived safety for bicyclists [36,38,39] • Minimal reduction buffer area between roadway and sidewalk compared to no-build scenario, impacting the sense of safety and exposure to emissions for pedestrians [3,8,51,52] • Moderate reduction in emissions from increases in ridership & bicycle activity [15,17,40,56,61] • Moderate reduction in mortality from heart disease, stroke, and lung cancer [70,72,73,74,75,76,77] • Less green space is available because of converting the median [69]
Center Platform Dedicated LRT	• LRT is powered by electricity and has a high ridership capacity, leading to a significant reduction in emissions [73] • Increase in pedestrian activity from wider sidewalks (equal across all alternatives except no-build) [3,6,7,20,21] • Separated buffer provides the maximum increase in perceived safety for bicyclists [36,38,39] • Moderate reduction in buffer area between roadway and sidewalk compared to no-build scenario, impacting the sense of safety and increased exposure to emissions for pedestrians [3,8,51,52] • Maximum reduction in emissions from increases in ridership & bicycle activity [15,17,40,56,61] • Significant reduction in mortality from heart disease, stroke, and lung cancer [70,72,73,74,75,76,77] • Less green space is available because of converting the median [69]
Elevated Grade Separated LRT	• LRT is powered by electricity and has a high ridership capacity, leading to a significant reduction in emissions (> ridership than Center platform LRT) [73] • Increase in pedestrian activity from wider sidewalks (equal across all alternatives except no-build) [3,6,7,20,21] • Separated buffer provides the maximum increase in perceived safety for bicyclists [36,38,39] • Small buffer area between roadway and sidewalk, leading to a decreased sense of safety and increased exposure to emissions for pedestrians [3,8,51,52] • Maximum reduction in emissions from increases in ridership & bicycle activity [15,17,40,56,61] • Significant reduction in mortality from heart disease, stroke, and lung cancer [70,72,73,74,75,76,77] • Green space is available underneath the elevated platform [69]

Transportation-Alternative Health Analysis Scores for Air Quality & Resiliency Factors

The composite score was an average of all the scores assigned to each potential health outcome listed in Table 10 (above). A detailed table for individual scores by alternative can be found in Appendix C, on page __.

Table 11. Composite Transportation-Alternative Health Analysis Scores for Air Quality & Resiliency

Composite Score	No Build	Mixed Traffic with Limited Bus Stops	BAT Curbside Lane	Curbside Lane BRT	Center Platform Dedicated BRT	Center Platform Dedicated LRT	Elevated Grade Separated LRT
Air Quality & Resiliency	-1.14	-1	0	1	0.86	1	1.57

In light of the aforementioned considerations related to air quality and resilience, the elevated grade separated LRT scored the highest in terms of its potential health impacts. Similar to many of the proposed alternatives, wider sidewalks and separated bicycle lanes were two components that positively impacted air quality and resilience by encouraging pedestrian and bicycle activity. The availability of green spaces was maintained in this alternative underneath the elevated platform, whereas the center platform BRT and LRT options traded the median space for a decreased impact on traffic flow.

Though the elevated LRT scored the highest according to the Transportation -Alternative Health framework, there remains a need to analyze each alternative in terms of health promotion and mitigation of disparities based on findings across the areas of air-quality, physical activity, and road safety. In the Recommendations section on page __, these strategies are outlined in greater detail.

Physical Activity

Background

Multimodal alternatives proposed in the Okeechobee Blvd and SR7 may contribute toward individual level health via increases in physical activity. Such a phenomenon may be accomplished by encouraging residents to walk and bicycle, as opposed to driving. Increasing the proportion of individuals who walk or bike to get places are also identified as an important component of Healthy People 2030's Transportation Objectives, and TPA performance measures (Health.gov., n.d.-c; TPA, 2020b). Like Healthy People 2030, the TPA aims to accomplish a target objective of 5% for those walking to work, and 3% of commuters that bike by 2030 (TPA, n.d.-a). Regular physical activity is one of the most important strategies for people of all ages to improve their health. The built environment plays an essential role in determining pedestrian and bicycle activity (Ferrari et al., 2020). On this note, safe and continuous multimodal facilities for bicyclists, as well as pedestrian crossing opportunities are identified needs within the "Okeechobee Boulevard Transit-Supportive Land Use and Economic Development Analysis: Existing Conditions Report" (2020).

Features of Proposed Alternatives Affecting Physical Activity

Factors with relevance to physical activity within each of the proposed alternative designs include the prevalence of chronic diseases such as heart disease, cancer, dementia, diabetes, and stroke, availability of enhanced pedestrian and bicycle facilities, and connectivity. Like factors of air quality and resilience, measures associated with physical activity were also adapted from the MassDOT project scoring framework and modified to reflect the priorities of this HIA.

Table 12. Transportation-Alternative Health Analysis Factors Related to Physical Activity

Transportation-Alternative Health Analysis Factors Related to Physical Activity		
Burden of chronic diseases associated with physical activity - Heart Disease - Cancer - Diabetes - Dementia - Stroke	Availability of bicycle and pedestrian facilities - Appealing environment	Connectivity - Daily exercise requirements

The design elements with the most potential to impact physical activity are seen in Table 13, below. The specific health outcomes associated with each of the design alternatives are discussed later in this section.

Table 13. Okeechobee Blvd & SR7 Corridor Study Design Elements Affecting Physical Activity

Design Elements	No Build	Mixed Traffic with Limited Bus Stops	BAT Curbside Lane	Curbside Dedicated Lane BRT	Center Platform Dedicated BRT	Center Platform Dedicated LRT	Elevated Grade Separated LRT
Total width of the sidewalk (per side)	6 ft width	12 ft width	12 ft width	12 ft width	12 ft width	12 ft width	12 ft width
Total width of the bicycle lane (per side)	5 ft width	7 ft width	7 ft width	10 ft width	10 ft width	10 ft width	10 ft width
Type of bicycle lane buffer	Designated No marked buffer)	Designated 2 ft buffer	Designated 2 ft buffer	Separated 2ft and 3ft buffers on either side	Separated 2ft and 3ft buffers on either side	Separated 2ft and 3ft buffers on either side	Separated 2ft and 3ft buffers on either side
Width of Left/Right sidewalk buffer	Left: 45.5 ft Right: 43.5 ft	Left: 39.5 ft Right: 37.5 ft	Left: 39.5 ft Right: 37.5 ft	Left: 32.5 ft Right: 30.5 ft	Left: 44 ft Right: 42 ft	Left: 39.5 ft Right: 37.5 ft	Left: 32.5 ft Right: 30.5 ft

Health Outcomes Associated with Physical Activity Factors

Chronic Diseases Associated with Physical Activity. The health effects of increased active travel were measured on the following outcomes: heart disease, breast cancer, colon cancer, dementia, diabetes, and stroke. The mortality rates (per 10,000 corridor residents) at baseline and 5%/10%/15% scenarios are illustrated in Table 14.

Table 14. Mortality Rate per 10,000 Corridor Residents due to Physical Activity-Related Diseases

Cause of Mortality	Baseline	5% Shift in VMT to PMT	10% Shift in VMT to PMT	15% Shift in VMT to PMT
Heart Disease	452	431	411	393
Breast Cancer	31	<31	<31	<31
Colon Cancer	31	30	29	28
Dementia	38	35	33	31
Diabetes	39	37	36	34
Stroke	138	131	125	120

As shown in Table 14, increases in active transportation was shown to have an inverse effect on the mortality rate of all measured diseases associated with physical activity. Per earlier discussions on limitations of the ITHIM, it is not necessarily true that the 15% shift in VMT to PMT alternatives (both LRT options) are the most beneficial to improve rates of physical activity, but rather are more reflective of ridership.

Despite ITHIM limitations, the availability of enhanced multimodal options relates to a greater proportion of individuals meeting daily exercise requirements (Li et al., 2008). Design elements that engage and promote active travel behaviors will have a positive impact on reducing chronic conditions associated with reduced levels of physical activity.

Availability of Bicycle and Pedestrian Facilities. Many elements of a built environment may help to encourage physical activity participation. Most often, facilities such as sidewalks, and bicycle lanes can either promote or discourage such activities by enhancing the perceived safety to either walk or bicycle along the area of interest. Facilities that improve safety are also those that increase a sense of comfort. As mentioned previously, an area’s desirability is often associated with a greater willingness to participate in active travel behaviors. Structural improvements, trees/landscaping, and sufficient sidewalk space are among the considerations that can improve pedestrian and bicyclist engagement within the proposed scenarios.

Connectivity. When places are more connected, individuals are more likely to opt for active travel modes when traveling shorter distances. In place of analyzing gaps in pedestrian and bicycle networks across the alternatives, this HIA measures connectivity as the number of individuals meeting daily exercise requirements by means of active travel. The likelihood of satisfying daily exercise requirements are estimated using design elements such as sidewalk and bicycle lane width, as well as public transportation use. Though not traditionally associated with physical activity, literature supports a positive relationship between public transit use and fulfilling daily exercise requirements. Alternatives with enhanced bicycle and pedestrian facilities, and increased public transit ridership were considered the most connected.

Table 15. Physical Activity-Related Health Outcomes by Alternative According to References Listed in Appendix B

Alternative	Potential Health Outcomes
No-Build	• Existing number of individuals meeting daily exercise requirements [14,26,73] • Sidewalk width [3,6,7,20,21,69] • High ambient stress among bicyclists and pedestrians due to narrow lanes [36,37,69] • Aesthetic appeal given lack of construction impacts [68,69] • Aesthetic appeal is not compromised over an extended period of time [69,79] • Large buffer set-back from roadway to sidewalk, that provides increased sense of safety for pedestrians [3,8,50,69] • Rates of heart disease, cancers, dementia, diabetes, and stroke [69,72,73,75]
Mixed Traffic with Limited Bus Stops	• Minimal increase in the number of individuals meeting daily exercise requirements related to public transit use [14,26,73] • Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build) [3,6,7,20,21,69] • Aesthetic appeal given lack of construction impacts [62,68,69] • Aesthetic appeal is not compromised over an extended period of time required to implement the transportation alternative [69,79] • Minimal reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke [69,72,73,75] • Ambient stress for bicyclists that have wider lanes, but no physical barrier [36,37,69] • Some reduction in perceived safety for pedestrians due to smaller buffer set-back from roadway to sidewalk [3,8,50,69]
BAT Curbside Lane	• Minimal increase in the number of individuals meeting daily exercise requirements related to public transit use [14,26,73] • Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build) [3,6,7,20,21,69] • Aesthetic appeal is maintained given limited construction required to implement a BAT curbside lane [62,68,69] • Aesthetic appeal is not compromised over an extended period of time required to implement the transportation alternative [69,79] • Minimal reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke [69,72,73,75] • Ambient stress for bicyclists that have wider lanes, but no physical barrier [36,37,69] • Moderate reduction in perceived safety for pedestrians due to small buffer set-back from roadway to sidewalk [3,8,50,69]
Curbside Dedicated Lane BRT	• Moderate increase in the number of individuals meeting daily exercise requirements associated with increased public transit use & ridership (BRT) [14,26,73] • Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build) [3,6,7,20,21,69]

	• Aesthetic appeal is maintained given limited construction required to implement a BRT curbside lane [62,68,69] • Aesthetic appeal is not compromised over an extended period of time required to implement the transportation alternative [69,79] • Moderate reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke [69,72,73,75] • Minimal amount ambient stress for bicyclists that have wider lanes, and a physical barrier [36,37,69] • Small buffer setback in combination with a dedicated bus lane provides minimal reduction in perceived safety [3,8,50,69]
Center Platform Dedicated BRT	• Moderate increase in the number of individuals meeting daily exercise requirements associated with increased public transit use & ridership (BRT) (>Curbside Dedicated BRT) [14,26,73] • Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build) [3,6,7,20,21,69] • Aesthetic appeal is compromised due to significant construction efforts required to build a center platform dedicated lane [62,68,69] • Negative aesthetic impacts experienced over a longer period given the extensiveness of the project [69,79] • Moderate reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke [69,72,73,75] • Minimal amount ambient stress for bicyclists that have wider lanes, and a physical barrier [36,37,69] • Minimal increase in perceived safety among pedestrians due to small buffer setback from roadway to sidewalk as compared to no build, yet pedestrian dedicated onboarding area in the center platform promotes slower traffic speeds [3,8,50,69]
Center Platform Dedicated LRT	• Maximum increase in the number of individuals meeting daily exercise requirements associated with increased public transit use & ridership (LRT has a high ridership) [14,26,73] • Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build) [3,6,7,20,21,69] • Aesthetic appeal is compromised due to significant construction efforts required to build a center platform dedicated lane [62,68,69] • Negative aesthetic impacts experienced over a longer period given the extensiveness of the project [69,79] • Significant reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke [69,72,73,75] • Minimal amount ambient stress for bicyclists that have wider lanes, and a physical barrier [36,37,69] • Minimal increase in perceived safety among pedestrians due to small buffer setback from roadway to sidewalk as compared to no build, yet pedestrian dedicated onboarding area in the center platform promotes slower traffic speeds [3,8,50,69]
Elevated Grade Separated LRT	• Maximum increase in the number of individuals meeting daily exercise requirements associated with increased public transit use & ridership (Elevated LRT has the highest ridership) [14,26,73]

	• Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build) [3,6,7,20,21] • Aesthetic appeal is compromised due to significant construction efforts required to build an elevated platform dedicated lane [62,68,69] • Negative aesthetic impacts experienced over a longer period given the extensiveness of the project [69,79] • Significant reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke [69,72,73,75] • Minimal amount ambient stress for bicyclists that have wider lanes, and a physical barrier [36,37,69] • Increase in perceived safety among pedestrians due to buffer setback from roadway to sidewalk as compared to no build, yet pedestrian dedicated onboarding area on the elevated platform and below the LRT space, promotes slower traffic speeds [3,8,50,69]

Transportation-Alternative Health Analysis Scores for Physical Activity Factors

The composite score was an average of all the scores assigned to each potential health outcome listed in Table 15 (above). A detailed table for individual scores by alternative can be found in Appendix C, on page __.

Table 16. Composite Transportation-Alternative Health Analysis Scores for Physical Activity

Composite Score	No Build	Mixed Traffic with Limited Bus Stops	BAT Curbside Lane	Curbside Dedicated Lane BRT	Center Platform Dedicated BRT	Center Platform Dedicated LRT	Elevated Grade Separated LRT
Physical Activity	-0.86	-0.14	-0.14	0.71	0.43	0.71	0.86

The transportation alternatives with the best scores in terms of physical activity-related factors were the elevated grade LRT, followed by the center platform dedicated LRT and the curbside dedicated BRT options. All of which possess significant increases in ridership capacity compared to the no-build scenario, and promote an environment of perceived safety and decreased ambient stress for pedestrians and bicyclists with wider lanes.

Notably, the most substantial differences across alternatives exist due to the impact of construction on aesthetic appeal. While the elevated and separated LRT transportation alternatives require substantial construction efforts, their ridership capacity enables an added reduction in vehicle emissions, similar to the curbside BRT. The highest scoring alternatives also address some design flaws in the no-build scenario that do not effectively promote physical activity (*i.e.*, narrow sidewalks and bicycle lanes, and reduced ridership).

Additional considerations for each of the multimodal transportation alternatives are made in the Recommendations section, on page __.

Road Safety

Background

With respect to road traffic safety, the Palm Beach TPA established a goal for a combined walking, biking, and transit mode share of 15% by 2030, also part of their performance objectives. At present, just under 2% of Palm Beach County residents walk as a means of accessing their employment centers, and fewer than 1% elect to ride a bicycle (TPA, n.d.-a). In response, the need to assess alternatives that create an environment that facilitates efficient and safe active transportation options became apparent, particularly for those walking and bicycling along the study corridor. In the United States, unintentional injuries are the leading cause of death in children, adolescents, and adults under 45 (Herron, 2019). Preventing crashes is a priority of the TPA's vision for safer, efficient, and connected multimodal transportation systems. Similarly, the TPA's "Vision Zero Plan" describes the mechanisms through which they hope to achieve zero traffic-related fatalities and serious injuries (TPA, n.d.-b). Between 2013 and 2018, there were a total of 281 bicycle and pedestrian crashes on the study corridor roadway, 79% of which, resulting in fatalities or injuries (TPA, 2020a). Of which more than half of the bicycle and pedestrian crashes were not intersection related. With a majority of bicycle and pedestrian crashes occurring along the study corridor roadway, and not at intersections, there may be a significant opportunity to reduce unintentional injury and death in the study area through increased safety precautions in the design of bicycle and pedestrian routes.

Features of Proposed Alternatives Affecting Road Safety

Design elements within each of the alternatives possessed potential to differ in their impact on road safety factors. The factors of interest within this HIA include the rate of pedestrian and bicycle crashes, as well as fatalities. Proposed alternatives were assessed based on their potential to impact traffic-related injuries and fatalities.

Table 17. Transportation-Alternative Health Analysis Factors Related to Road Safety

Transportation-Alternative Health Analysis Factors Related to Road Safety	
Pedestrian & Bicycle Crashes	Pedestrian & Bicycle Fatalities

The design elements with the most potential to impact road safety are seen in Table 18, below. The specific health outcomes associated with each of the design alternatives are discussed later in this section.

Table 18. Okeechobee Blvd & SR7 Corridor Study Design Elements Affecting Road Safety

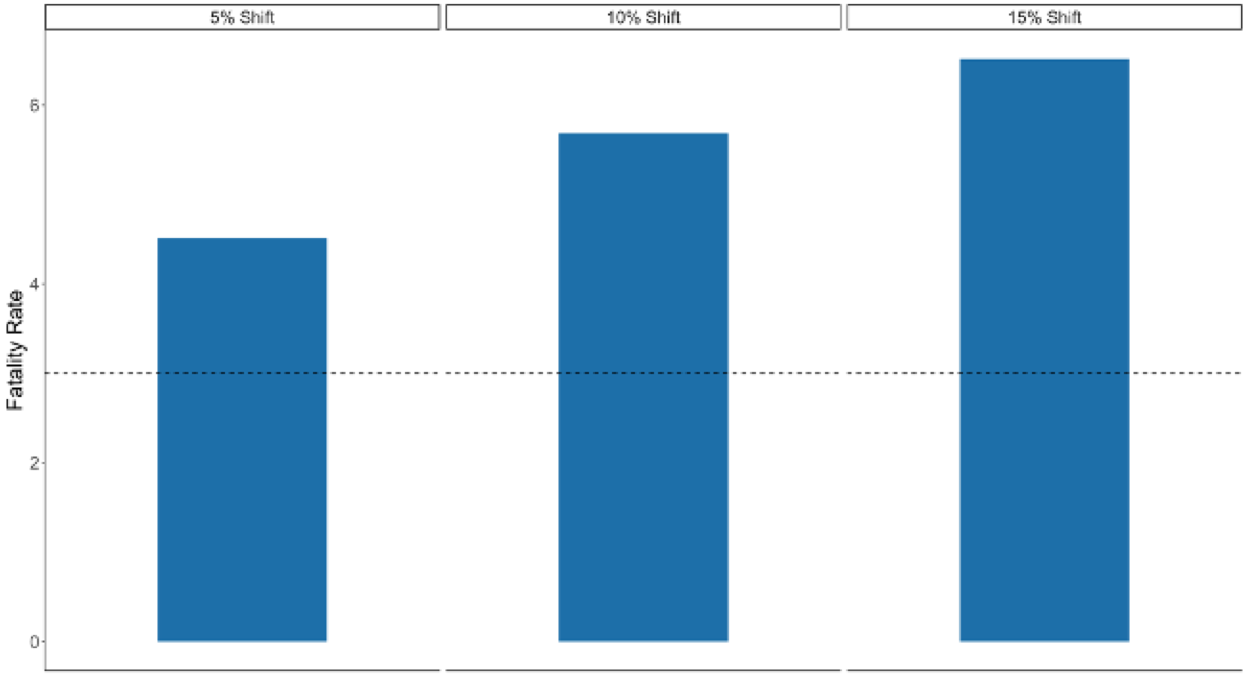
Design Elements	No Build	Mixed Traffic with Limited Bus Stops	BAT Curbside Lane	Curbside Dedicated Lane BRT	Center Platform Dedicated BRT	Center Platform Dedicate d LRT	Elevated Grade Separate d LRT
Total width of the bicycle lane (per side)	5 ft width	7 ft width	7 ft width	10 ft width	10 ft width	10 ft width	10 ft width
Type of bicycle lane buffer	Designate d No marked buffer)	Designate d 2 ft buffer	Designated 2 ft buffer	Separated 2ft and 3ft buffers on either side	Separated 2ft and 3ft buffers on either side	Separated 2ft and 3ft buffers on either side	Separated 2ft and 3ft buffers on either side
Width of Left/Right sidewalk buffer	Left:45.5 ft Right: 43.5 ft	Left: 39.5 ft Right: 37.5 ft	Left: 39.5 ft Right: 37.5 ft	Left: 32.5 ft Right: 30.5 ft	Left: 44 ft Right: 42 ft	Left: 39.5 ft Right: 37.5 ft	Left: 32.5 ft Right: 30.5 ft
Total width of Travel Lanes per side	48 ft width	46 ft width	44 ft width	36 ft width	36 ft width	36 ft width	48 ft width
Width of Individual Travel Lane	12 ft width	11.5 ft width	11 ft width	12 ft width	12 ft width	12 ft width	12 ft width
Total Number of Non-Transit Exclusive Lanes	8 lanes	8 lanes	6 lanes	6 lanes	6 lanes	6 lanes	8 lanes

Health Outcomes Associated with Road Safety Factors

Pedestrian & Bicycle Crashes. Baseline conditions point toward road traffic injuries as a consistent cause of morbidity in the study corridor. Within the study area alone, there was an average of 519 road traffic injuries annually (3-Year Average). As mentioned previously, the 3-year average was calculated from the periods of 2018 through 2020, to mitigate potential fluctuations in travel-related behavior resulting from the COVID-19 pandemic in 2020.

Pedestrian and Bicycle Fatalities. Potential road traffic fatalities were modeled using the ITHIM tool. Under the no-build, or baseline scenario, there are an estimated three (3) road traffic fatalities per 100,000 corridor residents. Baseline fatalities are shown in Figure 10 as a dotted line within each of the 5%, 10%, and 15% shift scenarios in VMT to PMT. The estimates shown in Figure 10 are based on mean starting values for personal and vehicle miles traveled. The number of traffic fatalities was calculated by multiplying road traffic injury-specific attributable fractions by corresponding 3-year average road traffic fatality rate (*i.e.,* fatality numerator and corridor population denominator). Traffic fatalities per 100,000 corridor residents are rounded to the nearest whole number. Notably, ITHIM outputs for road safety should consider that road traffic estimates do not account for additional safety measures that may be incorporated into transportation-alternative designs.

Figure 10. Potential Road Traffic Fatalities per 100,0000 Corridor Residents in the Okeechobee Blvd & SR7 Study Corridor



Rises in road traffic injuries and fatalities are consistent with previous findings, due to the increased presence of active travelers as opposed to personal-vehicle occupants. While the mean estimates for traffic fatalities increase under the 10% and 15% scenarios, the 5% shift may yield the same, if not reduced burden of road traffic deaths. The decreased risk is likely due to the *safety in numbers* phenomenon. The safety in numbers concept is a phenomenon where rates of traffic injuries slow in response to higher activity levels among pedestrians and bicyclists, though it appears some threshold exists whereby the safety in numbers concept concedes some of its protective effects (Jacobsen, 2003). Such, is used with reference to ITHIM applications in Los Angeles and Nashville (Nicholas et al., 2018; Whitfield et al., 2017).

Limitations of the ITHIM discussed in previous sections also apply to road safety models. However, additional regard must be provided to potential road safety strategies when interpreting traffic fatality outputs modeled by the ITHIM, which are not integrated into the model's calculations. As a result, ITHIM outputs are likely an overestimation of crash risk. Given these additional factors in calculating crash risk, ITHIM outputs should be interpreted as areas where such safety countermeasures are essential considerations.

Table 19. Road Safety-Related Health Outcomes by Alternative According to References Listed in Appendix B

Alternative	Potential Health Outcomes
No-Build	• Narrow bicycle lane leads to maximum exposure to roadway traffic [9,36,37,69] • Risk of injury without a designated or separated buffer [32,69]

	• Large buffer set-back from roadway to sidewalk, that reduces pedestrian exposure to vehicular traffic [1,8,50,69] • Travel lane width of 12' is linked with high travel speeds and risk of severe injury and/or fatality [47,28,49,69] • Minimal risk of road traffic fatalities compared to other travel scenarios projected by ITHIM [69,71,73] • Maximum distance across travel lanes, increasing time and risk for pedestrians crossing the roadway [44,46,69] • Number of travel lanes for non-transit vehicles to meet road capacity (decrease congestion and increase traffic speeds) [69,80] • Minimal risk of road crashes among transit users with availability of curbside service (not necessary to cross the roadway for transit-access) [69,81]
Mixed Traffic with Limited Bus Stops	• Wide bicycle lane reduces bicyclist exposures to roadway traffic [9,36,37,69] • Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present [32,69] • Pedestrian exposure to vehicular traffic due to the buffer size from roadway to sidewalk [1,8,50,69] • Reduced travel lane widths promote slower traffic speed [41,42,43,44,45,69] • Minimal risk of road traffic fatalities projected by ITHIM (equal to BAT Curbside Lane) [69,71,73] • Minimal reduction in roadway width compared to no-build, similar time and exposure for pedestrians to cross the roadway [44,46,69] • Number of travel lanes for non-transit vehicles to meet road capacity (decrease congestion and increase traffic speeds) [69,80] • Minimal risk of road crashes among transit users with availability of curbside service (not necessary to cross the roadway for transit-access) [69,81]
BAT Curbside Lane	• Wide bicycle lane reduces bicyclist exposures to roadway traffic [9,36,37,69] • Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present [32,69] • Pedestrian exposure to vehicular traffic due to the buffer size from roadway to sidewalk [1,8,50,69] • Maximum reduction in vehicle speeds due to travel lane width [47,28,49,69] • Minimal risk of road traffic fatalities projected by ITHIM [69,71,73] • Moderate reduction in roadway width compared to no-build, less time and exposure for pedestrians to cross the roadway [44,46,69] • Reduced number of travel lanes for non-transit vehicles to meet road capacity (increase congestion and reduce traffic speeds) and dedicated bus lane provides an additional safety buffer for pedestrians and bicyclists [69,80] • Minimal risk of road crashes among transit users with availability of curbside service (not necessary to cross the roadway for transit-access) [69,81]
Curbside Dedicated Lane BRT	• Wide bicycle lane reduces bicyclist exposures to roadway traffic [9,36,37,69] • Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present [32,69] • Maximum pedestrian exposure to vehicular traffic due to the buffer size from roadway to sidewalk [1,8,50,69] • Travel lane widths of 12' are associated with increased travel speeds and increased risk of injury [47,28,49,69] • Moderate risk of road traffic fatalities projected by ITHIM [69,71,73] • Maximum reduction in roadway width compared to no-build, less time and exposure for pedestrians to cross the roadway [44,46,69]

	• Reduced number of travel lanes for non-transit vehicles to meet road capacity (increase congestion and reduce traffic speeds) and dedicated bus lane provides an additional safety buffer for pedestrians and bicyclists [69,80] • Minimal risk of road crashes among transit users with availability of curbside service (not necessary to cross the roadway for transit-access) [69,81]
Center Platform Dedicated BRT	• Wide bicycle lane reduces bicyclist exposures to roadway traffic [9,36,37,69] • Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present [32,69] • Pedestrian exposure to vehicular traffic is somewhat increased due to the buffer size from roadway to sidewalk [1,8,50,69] • Travel lane widths of 12' are associated with increased travel speeds and increased risk of injury [47,28,49,69] • Moderate risk of road traffic fatalities projected by ITHIM [69,71,73] • Maximum reduction in roadway width compared to no-build, less time and exposure for pedestrians to cross the roadway [44,46,69] • Reduced number of travel lanes for non-transit vehicles to meet road capacity (increase congestion and reduce traffic speeds) [69,80] • Maximum risk of road crashes for BRT users crossing the roadway from the center platform to the sidewalk [69,81]
Center Platform Dedicated LRT	• Wide bicycle lane reduces bicyclist exposures to roadway traffic [9,36,37,69] • Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present [32,69] • Pedestrian exposure to vehicular traffic is increased due to the buffer size from roadway to sidewalk (= Mixed Traffic alternative & BAT Curbside Lane) [1,8,50,69] • Travel lane widths of 12' are associated with increased travel speeds and increased risk of injury [47,28,49,69] • Significant risk of road traffic fatalities projected by ITHIM (equal to Elevated LRT) [69,71,73] • Maximum reduction in roadway width compared to no-build, less time and exposure for pedestrians to cross the roadway [44,46,69] • Reduced number of travel lanes for non-transit vehicles to meet road capacity (increase congestion and reduce traffic speeds) [69,80] • Maximum risk of road crashes among LRT users crossing the roadway from the center platform to the sidewalk [69,81]
Elevated Grade Separated LRT	• Wide bicycle lane reduces bicyclist exposures to roadway traffic [9,36,37,69] • Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present [32,69] • Maximum pedestrian exposure to vehicular traffic due to the buffer size from roadway to sidewalk [1,8,50,69] • Travel lane widths of 12' are associated with increased travel speeds and increased risk of injury [47,28,49,69] • Significant risk of road traffic fatalities projected by ITHIM (equal to Center Platform LRT) [69,71,73] • Greatest distance across travel lanes, increasing time and risk for pedestrians crossing the roadway [44,46,69] • Number of travel lanes for non-transit vehicles to meet road capacity (decrease congestion and increase traffic speeds) [69,80] • Maximum risk of road crashes among LRT users crossing the roadway from the elevated platform to the sidewalk [69,81]

Transportation-Alternative Health Analysis Scores for Road Safety Factors

The composite score was an average of all the scores assigned to each potential health outcome listed in Table 19 (above). A detailed table for individual scores by alternative can be found in Appendix C, on page __.

Table 20. Composite Transportation-Alternative Health Analysis Scores for Road Safety

Composite Score	No Build	Mixed Traffic with Limited Bus Stops	BAT Curbside Lane	Curbside Dedicated Lane BRT	Center Platform Dedicated BRT	Center Platform Dedicated LRT	Elevated Grade Separated LRT
Road Safety	-0.50	0.75	1.5	0.63	0.38	0	-1

The BAT curbside lane scored the highest in it's potential to positively impact road safety-related health outcomes. Elements of the BAT curbside lane alternative that promoted road safety included wider bicycle lanes, fewer travel lanes and reduced vehicle speeds, and like the Mixed traffic option, the lowest risk of road traffic fatalities projected by the ITHIM. In addition to slower roadway traffic speeds resulting from the number of travel lanes, the BAT curbside option and curbside BRT options are also advantageous to road safety given that exterior lanes are composed of slower-moving, dedicated bus lanes.

Considering mortality estimates are similar if not elevated in the no-build scenario, and increase across the other alternatives as there is a greater shift in ridership, it is likely the 5% shift scenario experienced by the mixed traffic and BAT curbside lane alternatives yield the protective effects of the safety in number concept. Mitigation strategies are still needed to address increased risk of traffic-related injuries and fatalities resulting from reduced buffer sizes.

It is worth noting that the type of bicycle lane produces fewer health impacts associated with road safety than previous evaluations for air quality and resilience, or physical activity. Wider bicycle lanes confer the same reduced risk of traffic crashes regardless of whether the bicycle lane is designated or separated by a physical buffer (Hunter et al., 2005). Further examination is also required when considering vehicle operators in relation to the type of bicycle lane buffers. Some literature indicates that drivers may drive more attentively when the width of bicycle lanes are reduced. Despite the increased protection supported by these studies, closer analysis must also be made to the distracted driving behaviors, such as texting while driving, which present an increased crash risk (Atwood et al., 2018). In 2018 (the most recently available data), Palm Beach County experienced a total of 2,509 distracted driving crashes (Morse, 2019). With one of the highest county rates of distracted driving-related crashes in the State of Florida, the project team decided to exclude the driver attentiveness outcome in relation to bicycle lane widths (Morse, 2019).

Additional considerations for each of the multimodal alternatives are made in the Recommendations section, on page __.

Recommendations

Recommendations formulated by the HIA will not advocate one alternative for implementation by the TPA, but rather discuss potential strategies that promote health across the alternatives. The recommendations are evidence-based, utilizing findings from previous HIA stages to inform areas of air quality and resilience, physical activity, and road safety.

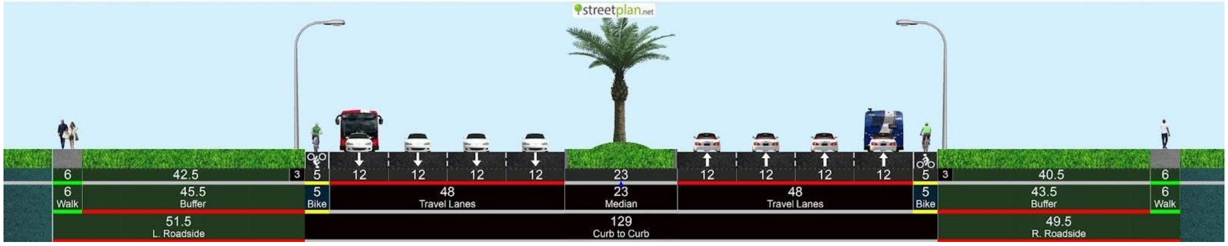
A brief summary of the Transportation-Alternative Health Analysis Scores by alternative are visualized in Table 21, below.

Table 21. Okeechobee Blvd & SR7 Corridor Study Composite Transportation-Alternative Health Analysis Scores

Category	No-Build	Mixed Traffic with Limited Bus Stops	BAT Curbside Lane	Curbside Dedicated Lane BRT	Center Platform Dedicated BRT	Center Platform Dedicated LRT	Elevated Grade Separated LRT
Air Quality & Resiliency	-1.14	-1	0	1	0.86	1	1.57
Physical Activity	-0.86	-0.14	-0.14	0.71	0.43	0.71	0.86
Road Safety	-0.50	0.75	1.5	0.63	0.38	0	-1
Overall	-0.83	-0.13	0.45	0.78	0.56	0.57	0.48

No-Build/ No-Action

Figure 11. No-Build Alternative Design Plan



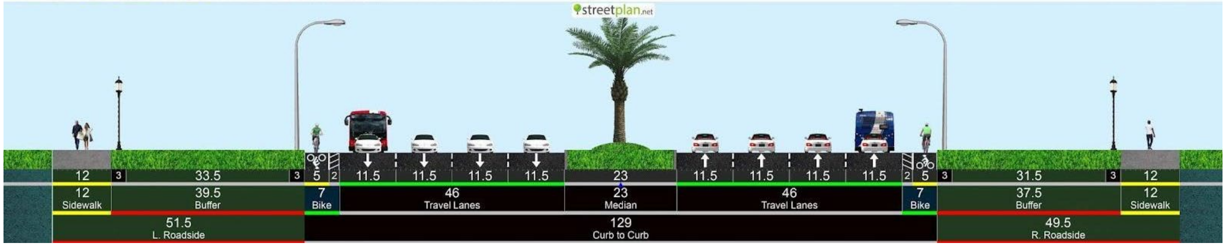
Under the no-build/action scenario, several considerations must be made toward health promotion and risk mitigation strategies. Though the no-build scenario encapsulates currently planned and funded projects, this HIA evaluated health based on the design specifications and traffic patterns currently in practice along the Okeechobee Blvd & SR7 corridor. If selected, the no-build scenario would have a somewhat negative impact on health within the study area (Overall Transportation-Alternative Health Composite Score= -0.83). Compared with other proposed multimodal alternatives, the transportation health analysis predicts the no-build scenario would have the most negative implications on air quality and resilience, as well as physical activity. Features such as 6′ wide sidewalks, existing multimodal facilities, higher vehicle speeds associated with 12′ wide travel lanes, and narrow bicycle lanes do little to encourage public transit ridership, and pedestrian or bicycle activity. Existing emission trends, combined with the highest rates of air-quality and physical activity-related diseases, contribute toward the no-action scenario as the worst overall for health.

Importantly, the no-build alternative possesses several health benefits that must be balanced with potentially negative health outcomes. While the lack of a bicycle lane buffer and limited width increase ambient stress and risk amongst bicyclists, those features are also associated with increased attentiveness on part of vehicle operators. Adverse effects on the perceived and physical safety among study corridor residents may be mitigated by use of available green space and large setbacks between the roadway and sidewalks. The limited construction impacts involved with the no-build scenario bolster the aesthetic appeal along the corridor, an important consideration when assessing both short- and long-term impacts during the implementation phase of this project.

The no-build scenario also boasts one of the lowest road-traffic fatality and injury rates relative to the other proposed alternatives. Under current transportation infrastructure, active travel behaviors (i.e. walking and bicycling) remain low, meaning fewer individuals are less likely to be involved in a crash resulting in injury or death. Although reduced activity levels positively influence road safety outcomes, discouraging pedestrian and bicycle engagement is not a suitable response. Instead, satisfying the safety in numbers threshold, and/or weighing the potentially positive health outcomes related to air quality and physical activity should also be evaluated.

Mixed Traffic with Limited Bus Stops

Figure 12. Mixed Traffic with Limited Bus Stops Design Plan



The mixed traffic alternative with limited stops scored as the second highest alternative in terms of negative health impacts (Overall Transportation-Alternative Health Composite Score= -0.13). With negative composite scores covering air quality, and physical activity, the mixed traffic alternative regains some positive health impacts related to road safety, compounded by improvements to the no-build plan. Though the mixed traffic scenario is not the highest ranking alternative in terms of ridership, it appears the increase in public transit users may trigger the protective effects of the safety in numbers phenomenon. Estimated ridership levels for both the mixed traffic and BAT curbside lane alternatives yield the same, if not reduced, risk of road traffic fatality, as projected by the ITHIM tool.

Given the slight increase in ridership from an added service route, this alternative may raise the convenience for residents to utilize multimodal options without the significant construction impacts characteristic of some other alternatives (i.e., center platforms for BRT or LRT uses). The mixed traffic alternative retains the potential for green space seen in the no-build scenario, while also enjoying a reduction in air quality and physical activity related diseases. Furthermore, perceived safety is positively impacted under proposed conditions, arising from wider sidewalks (uniform over all alternatives except no-build), wider, designated bicycle lanes, and slower traffic speeds (a byproduct of narrower travel lanes).

If selected, additional strategies should be developed to address areas of concern among bicyclists and roadway efficiency. In spite of equivalent risks of injury, designated bicycle lanes lack the physical barrier attributed to separated bicycle lanes. As a result, bicyclists may experience elevated levels of ambient stress than alternatives which include plans for separated bicycle lanes. From an air quality perspective, the mixed traffic option does not present the most efficient strategy to promote public-transportation use. Though rises in public transit ridership are predicted, the convenience and efficiency afforded by bus-dedicated lanes seen in the BAT curbside lane, and curbside BRT alternatives, are missing in the mixed traffic scenario. With a compromised ability to navigate through traffic, particularly during peak travel hours, the mixed traffic alternative may have negative impacts on air quality. Mitigation strategies to ameliorate public transit efficiency, should aim to reduce the time spent in traffic among bus service routes, and in turn, encourage more users to use public transportation options.

Business Access and Transit (BAT) Curbside Lane

Figure 13. BAT Curbside Lane Design Plan

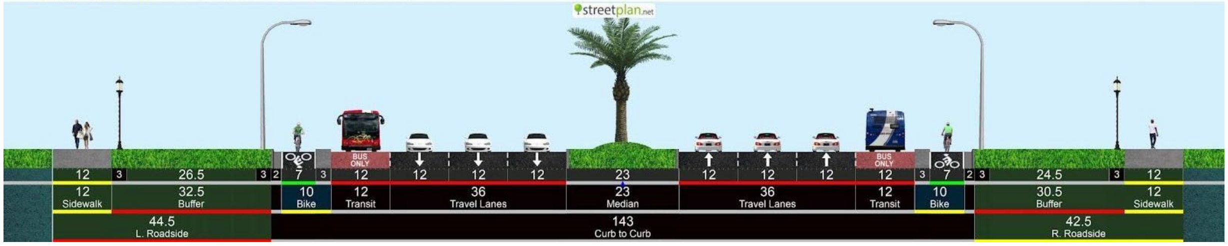
The Business Access and Transit (BAT) curbside lane option falls ahead of the mixed traffic alternative according to the overall Transportation-Alternative Health Analysis score (0.45). Unsurprisingly, both alternatives share similar health benefits, such as wider sidewalks, equidistant buffer setbacks, designated bicycle lanes, availability of green space, and comparable ridership rates. Given the ITHIM methodology, both the BAT curbside lane and the mixed traffic alternatives are included in the 5% shift in VMT to PMT scenario. Accordingly, both alternatives share the same outputs related to a reduction in heart disease, stroke, diabetes, dementia, and cancer.

Unlike the mixed traffic alternative, the BAT curbside option is unique in its integration of dedicated BAT lanes and some elements of BRT into design plans. Dedicated curbside lanes possess several health benefits. In addition to reducing pedestrian exposures when boarding and deboarding buses, exclusive bus lanes help to reduce travel times when utilizing public-transit services. As a consequence of enhanced efficiency, the BAT curbside lane enjoys increased ridership than the mixed traffic alternative, while averting an increased risk of road traffic fatalities and injury. Rises in ridership while maintaining the safety in numbers effect, mean that the mixed traffic and BAT curbside options enjoy the positive aspects with increases in active travel, such as increased physical activity and enhanced access and spending at businesses. A further health benefit of the BAT curbside lane is the width of individual travel lanes. As the alternative with the narrowest travel lanes (11’ wide), the BAT curbside lane scenario entails the greatest reduction in vehicle speeds associated with such metrics.

In order to acquire improved efficiency and ridership from a dedicated lane, the BAT curbside lane poses challenges to single-occupancy vehicle operators in the form of heightened traffic congestion. Resulting from the downgrade of four (4) travel lanes to three (3) travel lanes, drivers may be more vulnerable to frustration and risky driving behaviors. A distinguishing element of the BAT curbside lane, as opposed to the mixed traffic alternative, is the intensified need for construction. Though not nearly as intense as other proposed designs, the BAT curbside lane will require slightly more intensive construction efforts that may obstruct traffic patterns and dissuade active travel behaviors.

Curbside Dedicated Lane Bus Rapid Transit (BRT)

Figure 14. Curbside Dedicated BRT Design Plan



As the best rated alternative in the Transportation-Alternative Health Analysis, the curbside dedicated lane BRT alternative has some of the most positive overall health impacts of all the proposed scenarios (overall Transportation-Alternative Health Composite Score = 0.78). Benefits from the transit-exclusive lanes as seen in the BAT recommendations are also reflected in this option, however the integration of BRT systems pose a heightened advantage.

BRT is a highly efficient and cost-effective transportation system that is similar to LRT. BRT is less burdensome from an operational and maintenance approach, even though the capacity for riders is somewhat diminished compared to LRT. In contrast to the BAT curbside lane option, the curbside BRT boasts enhanced efficiency through use of off-board fare collection and traffic signal priority, in addition to dedicated bus lanes. Supplementing it's appeal from an emissions and convenience standpoint, BRT is considered more accessible than traditional bus services, due to features such as elevated platforms, which may aid in addressing disparities in transportation access among the disabled or aging populations. Improvements to ridership also assist in modifying travel behaviors and thus alleviate the burden of chronic diseases related to poor air quality and lack of physical activity.

Akin to the BAT alternative, the curbside lane design protects BRT-users during boarding and deboarding periods, where in other designs, they may face increased risk of road traffic crashes when crossing the roadway to access public-transportation facilities. The risk of injury to bicyclists in the BRT curbside lane is equivalent to the designated bicycle lanes, featured in the mixed traffic and BAT curbside lane alternatives. These options do however differ in terms of ambient stress levels and perceived safety among bicyclists, which may play a role in either encouraging or discouraging bicycle activity. Presence of physical barriers, as seen in the separated bicycle lanes planned in the curbside dedicated BRT alternative, help to address such safety concerns.

In contrast to previous options, the curbside BRT plan suffers slightly more negative outcomes from the perspective of road safety despite its strengths with regard to air quality and physical activity. However, fewer travel lanes may increase congestion and in turn slow traffic speeds, reducing the risk of a crash. The smaller buffer setback between the roadway and sidewalk may negatively impact the perceived safety of pedestrians (although this is mitigated by the outer lanes being dedicated to transit-related travel), as well as their exposure to traffic-related pollutants. Further attention should also be paid to the increased risk of injury resulting from wider traffic lanes (12' wide) and heightened vehicle speeds.

Center Platform BRT

Figure 15. Center Platform BRT Design Plan

The center platform BRT alternative is one of two alternatives that involve converting the existing median space into two (2) separated lanes dedicated for public-transit use. Overall, the center platform BRT lags behind the curbside dedicated lane BRT with regard to positive health impacts associated with air quality, physical activity, and road safety (overall Transportation-Alternative Health Composite Score = 0.56). Key differences between this alternative and the others considered by the TPA, center on the construction of a center platform.

Some similarities between the center platform BRT and alternatives like curbside lane BRT and BAT options are the traffic challenges that arise from the existence of fewer travel lanes for single-occupancy vehicles. In addition to these commonalities, the center platform BRT shares the same reduction in heart disease, stroke, cancer, diabetes and dementia, and advantages of the BRT system as established under the BRT curbside lane alternative.

Positive health impacts of this alternative surround the rise in ridership, wherein physical activity is increased, and emissions of environmental pollutants are cut back from the reduction in personal vehicle travel. Bicyclists are similarly benefitted to other alternatives that incorporate a separated buffer lane design.

There exists several potentially negative health outcomes as a result of the center platform BRT option, many of which pertain to construction impacts. Given the significant effort and investment required to build the center platform, existing health disparities along the study corridor may worsen over time. Construction may discourage residents from engaging in active travel modes by compromising the aesthetic appeal of the roadway. By developing the median, health benefits related to the presence of green spaces (i.e., reducing exposures to vehicle emissions, ambient stress, and lower home values) are lost. If selected, this alternative should make effective use of the buffer setback from the roadway to the sidewalk as an area for landscaping and vegetation in order to offset the consequences of converting the median.

In addition to the aforementioned concerns, the center platform BRT poses an increased motivation among public transit users to cross Okeechobee Blvd & SR7 in order to utilize the BRT service. As a consequence, the risk of road traffic crashes is substantially intensified with the increasing frequency at which pedestrians cross the roadway.

Center Platform Dedicated Light Rail Transit (LRT)

Figure 16. Center Platform Dedicated LRT Design Plan

The center platform dedicated LRT alternative is one of two proposed designs that incorporate LRT technology. Despite being a highly sophisticated and modern transportation mode, LRT requires substantial financial investment to construct and maintain over time. The Transportation-Alternative Health Analysis score identifies the center platform LRT as an alternative that has a somewhat positive health impact related to air quality and resilience, physical activity, and road safety (overall Transportation-Alternative Health Composite Score = 0.57).

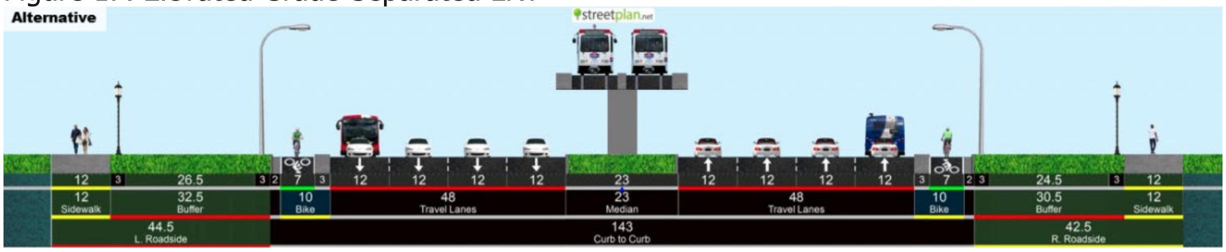
Comparable with alternatives already discussed in this report, this alternative provides an increased sense of safety among pedestrians and bicyclists due to wider, more separated lanes. LRT systems also provide several distinct advantages in terms of health. As an electric technology with a high capacity for ridership, LRT use may significantly reduce roadway emissions produced by personal vehicle use. As shown in previous studies, LRT may improve quality of life, through increased access to education, job opportunities, and education (Valley Metro, n.d.). Increased public-transit use is also associated with a greater number of individuals satisfying their daily exercise requirements. Accordingly, the ITHIM hails both the center platform and elevated grade LRT options as the alternatives with the greatest reduction in air quality and physical activity-related diseases, such as heart disease, dementia, cancer, stroke, and diabetes.

Despite its advantages, the development of a center platform may exacerbate predicted trends in traffic-related fatalities arising from shifts in pedestrian patterns, who may cross the roadway more frequently in order to access the LRT systems. This, coupled with the sizable cost and construction required to build a center platform, may quell the positive effects of the alternative on emissions and physical health. However, these potentially negative impacts must be balanced for long-term outcomes as demonstrated by Valley Metro, wherein public transit ridership soared 487%, and 81% of users walk ¼ mile or less to access transit options since the implementation of LRT in 2008 (n.d.).

Limited availability of green spaces, fewer travel lanes for public and general roadway-use, and risk of higher vehicle speeds associated with wider travel lanes should also be considered. Similar to recommendations formulated for previous designs, strategies to mitigate adverse health impacts aim to make active travel modes more desirable. Primarily, use of landscaping as a means to improve aesthetic appeal, help to reduce ambient stress caused by increased vehicle speeds and/or traffic congestion, and encourage walking or bicycling.

Elevated Grade-Separated LRT

Figure 17. Elevated Grade-Separated LRT



Much like the center platform design, the elevated grade-separated LRT has similar health impacts. Increases in ridership between the center platform LRT and the elevated grade LRT are expected to differ regarding the magnitude of health impacts. This is reflected in the Transportation-Alternative Health Analysis, where the elevated grade LRT excels in areas of air quality and resilience, and physical activity, when compared with the center platform LRT option. The magnitude of impacts also applies to negative effects on health. The elevated grade LRT score reflects the most negative health impacts among all the proposed alternatives regarding road safety. In spite of its shortcomings related to road safety, the elevated grade LRT alternative maintains a neutral-to-somewhat-positive overall score (0.48).

Like the center platform LRT, the elevated grade LRT is advantageous in improving air quality, reducing single-occupancy vehicle use, promoting enticing and efficient transit options, and encourages active travel behaviors. With increased ridership, the elevated LRT option is expected to exceed the center platform LRT design in reducing the burden of chronic diseases associated with poor air quality and minimal physical activity.

A distinct feature of this alternative is the elevated and separated design for the LRT system, which would minimize obstructions to the roadway and alleviate traffic congestion. As a consequence, the elevated LRT option allows for four (4) travel lanes, as opposed to the three (3) lanes proposed in other alternatives (*e.g.*, center platform LRT and BRT). Decreased frustration among vehicle operators, congestion, and time spent in traffic are among some of the benefits experienced by the elevated LRT design, however from the perspective of road safety, these factors are negative in their effects on road traffic speeds and crash risk.

While four travel lanes may be advantageous for drivers along the study corridor, pedestrians are not so fortunate. In contrast, the greater distance across the roadway increases pedestrian's exposure and risk of injury when crossing the street. This issue is compounded by the frequency at which LRT users may need to cross the roadway in order to access the platform. Similarly, a reduction in buffer setback space between the roadway and sidewalk could diminish the sense of safety among pedestrians and discourage walking as a travel mode.

General Recommendations

Prioritize transportation infrastructure aimed at connectivity, in order to bolster equitable access to healthy living. Among Census Block Groups, areas with higher education rates and decreased proportion of minorities are more likely to engage in physical activity (Gordon-Larsen et al., 2006). Older adults, individuals with disabilities, minorities, and low-income populations are evidenced in literature as subsets of the population disproportionately affected by the negative health impacts of limited transportation systems (Institute of Medicine, 2007; Shrestha et al., 2017). Equitable access to opportunities such as employment, businesses, healthy foods education, medical care, and social connection have significant potential to reduce health disparities (Badger, 2012; National Association of City Transportation Officials, n.d.). As part of the "Connected" metrics established in the TPA's Performance Measures, establish percentage goals of federal aid eligible mileage in relation to pedestrian facilities' proximity to elementary schools (within 2 miles), traditionally underserved communities (within 0.25 mile) and the proximity of pedestrian and bicycle facilities to transit hubs (respectively within 1 mile and 3 miles) (TPA, 2020b). Alternatives that increase equitable living through the availability of improved pedestrian and bicycle facilities, are aligned with existing performance goals by the TPA.

Prioritize projects using Performance Measures to achieve health equity. It is recommended that proposed transportation projects should be evaluated using the Performance Measures to best align the implementation of plans with achieving broader organizational goals. Similar actions have been taken place by State-level DOTs and MPOs as described on page 13 of this report.

Facilitate appropriate investments in efficient public transit infrastructure improvements that increase ridership and achieve health equity. By implementing policies that expand transit-ridership, users are more likely to engage in physical exercise, spend at local businesses, reduce the burden of chronic diseases, improve their mental health, and facilitate access to equitable employment opportunities, as well as goods and services. An essential component of these investments is ensuring they are contextual to the needs of those that live, work, and play in the study corridor. As such, over-spending on infrastructure better suited for densely populated cities may not be the best use of funding for the 86,736 residents that inhabit the study area. Implementing transit-exclusive service lanes, closing coverage gaps, and acquiring BRT vehicles are cost-effective options that can positively impact health and reduce disparity in the study area. Infrastructure like BRT are advantageous in that they produce fewer emissions than traditional buses, and reduce travel times through off-board fare collection and traffic-signal priority (FTA, 2015). In turn, similar investments may aid the TPA in achieving performance measure goals related to the decrease in the Daily Vehicle Miles Traveled per Person, and transit commute time (versus car commute time) (TPA, 2020b).

Consider transportation design elements that promote pedestrian activity. Several design elements set forth in the multimodal alternatives, can substantially impact a person's decision to walk along the study corridor. Sidewalks that are 12 feet wide, further away from vehicular traffic, and slower roadway speeds are among the features discussed between proposed alternatives that can effectively encourage pedestrian activity (Clarke & George, 2005; Heinrich et al., 2008; Galea et al., 2005). Prioritizing pedestrian-friendly designs may jointly reduce the burden of chronic diseases such as heart disease, diabetes, dementia, and cancer, and help the TPA achieve its commuter mode split target of 5% choosing to walk to work by 2030 (below target) (TPA, 2020b).

Prioritize crosswalk enhancements to increase health and safety. Across all alternatives, pedestrian safety may be improved through implementation of countermeasures that bolster crosswalk visibility. As a major commuting corridor, Okeechobee Blvd & SR7 experiences between 45,000 and 67,000 in Annual Average Daily Traffic (AADT) prior to the section consisting of the downtown West Palm Beach area (in this region the AADT is approximately 21,500) (TPA, 2020a). The current AADT along the study corridor exceeds the threshold identified by the Federal Highway Administration (FHWA) for additional crosswalk enhancements beyond the use of marked crosswalks (2018; Zegeer, 2005). Features such as high visibility markings at midblock pedestrian crossings and uncontrolled intersections (more than the standard parallel lines), increased "YIELD" or "STOP" signage prior to crosswalks, or curb extensions to reduce crossing distances are among some of the considerations to reduce pedestrian-related crashes in the study corridor (FHWA, 2018).

Consider transportation design elements that promote bicyclist activity. Differences in perceived safety and risk of injury among bicyclists are discussed in depth throughout this HIA report. Separated bicycle lanes substantially improve the perceived safety of bicyclists, which may in turn bolster existing modeshare splits for bicycling. However, a sense of safety must also be balanced with regard to inconveniences associated with building a separate bicycle lane, and the unchanging risk of injury, as compared to designated buffer lanes (Apasnore et al., 2019; Morrison et al., 2019). As a means to accelerate existing rates of the biking commuter mode share (0.61% of commuters in 2019) to the TPA's goal of 3% in 2030, the implementation of designs involving separated bicycle lanes is a recommended strategy to achieve such results (TPA, 2020b).

Plan future investigations of land use and displacement risk ratio as a measure of equity. The Displacement Risk Ratio (DRR), as developed by the Reinvestment Fund, is a measure of housing stability. The DRR identifies neighborhood shifts in housing affordability, relative to rises in income over a specified time period. As a result, the DRR allows decision makers to discern areas where vulnerable populations may have been involuntarily displaced due to a rise in housing prices that exceeds that of income (Dowdall, 2016). Land use may substantially influence the availability and cost of housing, which poses an opportunity for future research concerned with matters of equity.

Develop an architectural ITHIM tool to be used in corridor-level analysis that emphasizes equity, gathers environmental inputs from TPA Performance Measures, and informs a regional travel-demand ITHIM mechanism. Developing an ITHIM compatible at the corridor-level possesses potential to remediate existing limitations of the tool used in this HIA. Previous studies conducted in metropolitan areas such as Los Angeles, developed a customized version of the ITHIM in order to accurately reflect the potential health impacts of several proposed alternatives. Inputs collected from the TPA Performance Measures could help overcome existing barriers in data collection regarding travel behaviors available at the corridor-level.

Collaborate with FDOT to develop a monitoring plan for each of the main corridors/throughout the County. Such, will facilitate future multimodal corridor studies in Palm Beach County, and encourage the consideration of health into the transportation and planning field. Future studies may benefit by including cost-benefit analyses, and forecasting of long term health impacts due to transportation infrastructure investments.

Consider short-term changes that enhance facilities and build a culture to support a Safe System approach. A Safe System approach entails transportation infrastructure that is designed with human error in mind. Though crashes are inevitable, the Safe System approach attempts to reduce the risk of human error, and also minimize the severity of injury in the event of such incidents (Federal Highway Administration, 2021). Such strategies may help the TPA in achieving their "Vision Zero Plan", which is an identified target area included as part of their performance measures (TPA, 2020b). In addition to these considerations, the timeline for funding and implementation of any selected alternative must be weighed against existing health outcomes and disparities. States of health may significantly change and even deteriorate over time if the selected alternative is extremely extensive in design and execution.

Encourage an environment of conscious construction practices. Construction projects can be a significant contributor of environmental air pollutants, noise pollution, and may negatively impact the visual appeal of a community. By employing environmentally friendly techniques, sustainable construction projects may integrate solar technologies, source biodegradable materials, recycle existing materials during any demolition process (i.e., steel and/or concrete), utilize locally sourced materials, and ensure the availability of green spaces (Construction World, 2019). Investment in transportation infrastructure often leads to broader economic growth, which results from improved services that facilitate mobility, time, and cost savings. Development of novel transportation systems may substantially benefit from integrating sustainable, health conscious practices, in addition to economic incentives.

Incorporate landscaping and green space considerations into future transportation projects. Availability of green spaces is supported by an array of literature for its beneficial effects in reducing ambient stress, slower traffic speeds, enhanced bicycle and pedestrian activity, minimized exposure to air pollutants, mitigation of urban heat island effects, and increased perceived safety for those walking or bicycling in the area of interest (de Hartog et al., 2010; Dijkstra et al., 2008; Dill et al., 2010; McDonald et al., 2006; Rabl & Nazelle, 2012; Safe Routes to School National Partnership, 2012). By incorporating green elements into proposed transportation designs, health may substantially influenced to promote healthier lifestyles and reduce the negative health impacts associated with certain multimodal designs (e.g., increases in travel time due to traffic congestion; elevated traffic speeds resulting from wider lanes; reduction in buffer setbacks between the sidewalk and roadway).

Consider planting trees that have a larger surface area of leaves to generate more photosynthesis, rather than conifers that absorb more heat. Species with enhanced ability to conduct greater levels of photosynthesis also have greater capacity for reducing emissions, and may reduce the urban heat island effect along Okeechobee Blvd and SR7 (Dill et al., 2010).

Consider investing in an air monitor system to measure air quality. States are responsible for developing their own monitoring plans that ensure the ambient air monitoring networks meet minimum requirements set by the Clean Air Act. Often, states choose to situate monitors in areas with higher concentrations and/or higher population since the minimum monitoring requirements are based on population size. By situating an air monitoring system along the study corridor, decision makers can better aim interventions in highlighted areas of need.

Future Considerations

Light Rail Transit (LRT)

As mentioned in relation to the curbside dedicated lane BRT recommendations, this HIA may underscore the full potential of LRT alternatives in affecting the community's health. Reports such as the quality of life study published by Valley Metro, and results from Commute Seattle's 2019 Center City Commuter Mode Split Survey point toward investments in LRT systems as a significant source of commuter mode split, reduction in single occupancy vehicle trips, in face of increasing employment. In Seattle, transit-related investments such as LRT have led to a 9% reduction in single-occupancy vehicle commutes despite an increase of 90,000 jobs in the downtown Seattle area from 2010-2019 (Commute Seattle, 2019).

Housing Affordability & Transit-Oriented Development

Housing affordability is an additional area for future investigations to measure the impact of transportation alternatives on health. The provision of affordable housing is defined as housing options that do not cost more than 30% of an individual's income (HUD User, 2017). Staying below the 30% housing cost, is intended to provide households enough financial flexibility to pay for other non discretionary costs (HUD User, 2017). In addition to housing, transportation costs are often the second-most burdensome expense among households. The Center for Neighborhood Technology's (CNT) Housing and Transportation Affordability Index is a direct measure of affordability, as determined by the combined cost of housing and transportation expenses (2018). Under the Housing and Transportation Affordability Index, the county of Palm Beach exceeds the combined affordability benchmark of 45%, where 66% of Palm Beach County household income is spent on housing and transportation expenses (CNT, 2018; TPA, 2020a). Use of public-transit options, as opposed to personal vehicles, could save households approximately $10,000 a year (American Public Transportation Association (APTA), 2017; Valley Metro, n.d.).

Given the demonstrated need for affordable housing in the greater Palm Beach area, the Okeechobee Blvd and SR7 corridor could benefit from the expansion of high-capacity transit systems that incentivize public and private investment in the development of affordable housing options. In a large-scale study of four metropolitan hubs (Atlanta, Denver, Seattle, and Washington D.C.), Enterprise Community Partners built on previous research by AARP, the National Housing Trust, and Reconnecting America, wherein more than 250,000 privately owned, federally subsidized apartments were within walking distance to quality transit services across 20 metropolitan areas (2010). Two thirds of which were covered by federal housing contracts (AARP, 2010). The selection of Atlanta, Denver, Seattle, and Washington D.C. in this case study was due to existing commitments in expanding transit service such as the addition of light rail coverage, bus rapid transit, and facility improvements. Similar opportunities exist in the Okeechobee Blvd and SR7 study corridor. Implementation of transit services with high ridership capacity, such as LRT, should be evaluated for their ability to encourage the development of additional affordable housing options and expand transit-oriented development.

Limitations experienced in this HIA to fully capture the magnitude of LRT on health factors could be addressed in future studies through use of a Cost-Benefit Analysis and forecasting of long-term health impacts. Considering the substantial upfront costs of LRT systems, it is necessary for subsequent analyses to evaluate changes in health over an extended period of time, to not miss potential developments that may significantly affect health, as supported by findings by Valley Metro (n.d.) and Commute Seattle (2019).

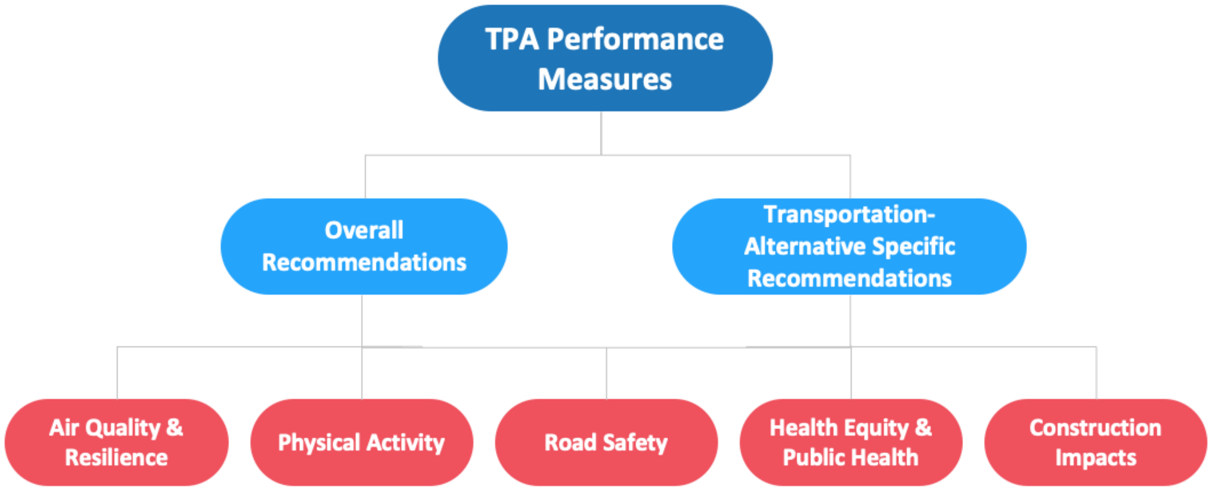
Monitoring & Evaluation

The goal of the monitoring and evaluation phase is to track the impact of HIA findings and recommendations on the selection and implementation of a specific multimodal transportation alternative. In completion of this stage, this HIA identified indicators and variables of interest for continued evaluation aligned with the Transportation Planning Agency (TPA) Performance Measures.

Monitoring & Evaluation Plan

The monitoring and evaluation plan set forth by this HIA are a continuation of overall recommendations. Informed by considerations related to air quality and resilience, physical activity, and road safety, the monitoring plan describes indicators for continued evaluation that pertain to overall recommendations and draw from mitigation strategies mentioned across the transportation-alternative scenarios.

Figure 18. Monitoring & Evaluation Overview



This HIA recommends the Palm Beach TPA adhere to a monitoring plan that answers the following points:

1. Which of the transportation-alternatives evaluated in this HIA have been selected to promote health and reduce disparities in the Okeechobee Blvd and SR7 corridor? Depending on the selected alternative, which of the specific recommendations in this HIA were enacted?
2. As a consequence of the transportation-alternative specific recommendations issued by this HIA, what evidence is there to support changes in the community's health along the Okeechobee Blvd & SR7 corridor?
3. As a consequence of the Overall Recommendations issued by this HIA, what evidence is there to support changes in the community's health along the Okeechobee Blvd & SR7 corridor?

Tables 22 through 26, highlight existing TPA Performance measures that should undergo continued evaluation in relation to the findings and recommendations established in this HIA. Currently available data for each of the indicators are listed as baseline statistics. Goal metrics are also listed to provide additional context of current conditions in the Okeechobee Blvd and SR7 corridor.

1. Air Quality & Resilience
2. Physical Activity
3. Road Safety
4. Health Equity & Public Health
5. Construction Impacts

Table 22. Monitoring & Evaluation Indicators for Air Quality & Resilience

Air Quality & Resilience		
Indicator	**Statistical Agency**	**TPA Performance Measure & Timeframe**
Travel Time Reliability on Non-Interstate Roads	INRIX, Inc.	**Baseline**: 98% of vehicles in 2020 **Goal**: ≥93% of vehicles by 2025 **Timing**: 2 years
Daily Fuel Use per person	Palm Beach TPA	**Baseline**: 1.14 gallons in 2020 **Goal:** ≤1.25 gallons by 2030 **Timing**: 10 years
Vehicle Miles Traveled (VMT) per Person	Palm Beach TPA	**Baseline**: 24.4 VMT per capita in 2020 **Goal**: ≤21 VMT per capita by 2030 **Timing**: 10 years
Percent of Federal Aid Roadways Susceptible to 1% Annual Flood Risk	Palm Beach TPA	**Baseline**: 26.7% of roadways in 2021 **Goal**: <25% of roadways by 2030 **Timing**: 10 years
Percent of Federal Aid Roadways Susceptible to 1.2’ of Sea Level Rise	Palm Beach TPA	**Baseline**: 3.9% of roadways in 2021 **Goal**: <3% of roadways by 2030 **Timing**: 10 years
PM2.5 and NO2 Concentration	Palm Beach TPA	To be considered for development by the TPA.
Vegetation Coverage	Palm Beach TPA	To be considered for development by the TPA.
Daily Fuel Use per person	Palm Beach TPA	**Baseline**: 1.14 gallons in 2020 **Goal:** ≤1.25 gallons by 2030 **Timing**: 10 years
Percent of Electric Vehicles in Bus Fleet	Palm Tran	**Baseline**: 0% of vehicles in 2020 **Goal**: 75% of vehicles by 2030 **Timing**: 10 years
Transit v. Car Average Commute Time	U.S. Census Bureau	**Baseline**: 2.11 ratio of transit commute time to single-driver commutes in 2019 **Goal**: 1.75 ratio of transit commute time to single-driver commutes by 2030

		Timing: 10 years

Table 23. Monitoring & Evaluation Indicators for Physical Activity

Physical Activity		
Indicator	**Statistical Agency**	**TPA Performance Measure & Timeframe**
Miles of Separated Bike Lanes	Palm Beach TPA	**Baseline**: 0.21 miles of separated bike lanes in 2021 **Goal**: 20 miles of separated bike lanes by 2030 **Timing**: 10 years
10' Shared Use Paths	Palm Beach TPA	**Baseline**: 87 miles in 2021 **Goal**: 100 miles by 2030 **Timing**: 10 years
8 to ft Paved Pathways on Federal-Aid Roads	Palm Beach TPA	**Baseline**: 293 miles in 2021 **Goal**: 305 miles by 2030 **Timing**: 10 years
Buffered Bike Lanes	Palm Beach TPA	**Baseline**: 12 miles of buffered bike lanes in 2021 **Goal**: 20 miles of buffered bike lanes by 2030 **Timing**: 10 years
Designated Bike Lanes	Palm Beach TPA	**Baseline**: 246 miles of buffered bike lanes in 2021 **Goal**: 300 miles of buffered bike lanes by 2030 **Timing**: 10 years
Sidewalks	Palm Beach TPA	**Baseline**: 1,183 miles in 2021 **Goal**: 1,300 miles by 2030 **Timing**: 10 years
Commuter Mode Split - Walking	U.S. Census Bureau	**Baseline**: 1.35% of commuters in 2019 **Goal**: 5% of commuters in 2030 **Timing**: 10 years
Commuter Mode Split - Biking	U.S. Census Bureau	**Baseline**: 0.61% of commuters in 2019 **Goal**: 3% of commuters in 2030 **Timing**: 10 years
Commuter Mode Split - Transit	U.S. Census Bureau	**Baseline**: 1.63% of commuters in 2019 **Goal**: 7% of commuters in 2030 **Timing**: 10 years

Table 24. Monitoring & Evaluation Indicators for Road Safety

Road Safety		
Indicator	**Statistical Agency**	**TPA Performance Measure & Timeframe**
Crash Fatalities	Department of Transportation (FDOT)	**Baseline**: 178 fatalities in 2020 **Goal**: 0 fatalities in 2020 **Timing**: Annual
Serious Injuries	Department of Transportation (FDOT)	**Baseline**: 917 injuries in 2020 **Goal**: 0 injuries in 2020 **Timing**: Annual
Pedestrian & Bicycle Crash Fatalities	Department of Transportation (FDOT)	**Baseline**: 189 injuries in 2020 **Goal**: 0 injuries in 2020 **Timing**: Annual
Crosswalk Enhancements	Palm Beach TPA	To be considered for development by the TPA.*

Table 25. Monitoring & Evaluation Indicators for Health Equity and Public Health

Health Equity		
Indicator	**Statistical Agency**	**TPA Performance Measure & Timeframe**
Percent of Bike Facilities within 3 Miles of Transit Hub	Palm Beach TPA	**Baseline**: 20.6% of facilities in 2020 **Goal**: 100% of facilities in 2030 **Timing**: 10 years
Percent of Pedestrian Facilities within 3 Miles of Transit Hub	Palm Beach TPA	**Baseline**: 85% of facilities in 2020 **Goal**: 100% of facilities in 2030 **Timing**: 10 years
Percent of Pedestrian Facilities within 2 Miles of Elementary Schools	Palm Beach TPA	**Baseline**: 79.6% of facilities in 2020 **Goal**: 90% of facilities in 2030 **Timing**: 10 years
Corridor-Level ITHIM tool	Palm Beach TPA	To be considered for development by the TPA.
Percent of Pedestrian Facilities within 1/4 Mile of Underserved Communities	Palm Beach TPA U.S. Census Bureau	**Baseline**: 70.9% of facilities in 2020 **Goal**: 70% of facilities in 2030 **Timing**: 10 years
Displacement Risk Ratio (DRR)	Reinvestment Fund	To be considered for development by the TPA.

Table 26. Monitoring & Evaluation Indicators for Construction Impacts

Construction Impacts		
Indicator	**Statistical Agency**	**TPA Performance Measure & Timeframe**
Aesthetic Appeal	Palm Beach TPA	To be considered for development by the TPA.
Ambient Stress	Palm Beach TPA	To be considered for development by the TPA.
Noise Pollution	Palm Beach TPA	To be considered for development by the TPA.
PM2.5 and NO2 Concentration near Construction Sites	Palm Beach TPA	To be considered for development by the TPA.
Quality of Public Water Systems and Groundwater	Palm Beach TPA	To be considered for development by the TPA.
Material Waste	Palm Beach TPA	To be considered for development by the TPA.

Dictionary of Terms

- **Active Travel:** opting to travel in physically active forms, that can include walking, and bicycling (Paths for all, n.d.).
- **Affordable Housing:** The provision of affordable housing is defined as housing options that do not cost more than 30% of an individual's income (HUD User, 2017). Staying below the 30% housing cost, is intended to provide households enough financial flexibility to pay for other non discretionary costs (HUD User, 2017).
- **Business Access and Transit (BAT):** business access and transit (BAT) lanes allow for buses to navigate more efficiently through traffic and improve access to business as they are curbside lanes. BAT lanes are restricted for buses and turning vehicles (LTD, n.d.).
- **Bus Rapid Transit (BRT):** Bus rapid transit, or BRT is a bus-based transit system, characterized by dedicated bus lanes, off-board fare collection, traffic signal priority, elevated platforms, and expanded station facilities compared to more traditional bus stations. Investments in BRT have been endorsed by the Federal Transit Administration (FTA) as appropriate, and affordable transit alternatives suitable for application in big cities and mid-sized metropolitan areas, like the study corridor (2015). Mimicking elements of light rail transit (LRT), BRT alternatives are regarded as more reliable and efficient than regular bus systems. Dedicated bus lanes and traffic signal priority reduce the amount of time spent in traffic, making the alternative a more desirable transportation option over single-occupancy vehicles, while also lessening the amount of emissions released into the atmosphere (FTA, 2015).
- **Disability-Adjusted Life Years (DALYs):** DALYs measure of the burden of a disease over an individual's lifetime, equating the years of life lost due to premature mortality and years lost living in a suboptimal state of health (WHO, 2022).

- **Health Impact Assessment (HIA):** a process that analyzes and quantifies how a policy or investment influences people's health. The purpose of the HIA is to identify positive health impacts and reduce any negative health impacts of a potential policy or investment. In combining evidence-based strategies with commentary from stakeholders, policy makers, and community members, HIAs help to foster a broader understanding of the unique challenges communities face, particularly for vulnerable groups (Human Impact Partners, 2011).

- **Health Equity:** the opportunity for all to attain their full health potential regardless of socioeconomic status or individual circumstances. In order to work toward health equity, it is important to identify health disparities, use evidence-based mitigation strategies, and to incorporate health equity considerations into the decision-making process (Braveman et al., 2017; CDC, 2020; Weil, 2018).

- **Integrated Transportation and Health Impact Model (ITHIM):** ITHIM is a modeling tool that quantifies the impact of changes to active travel behavior patterns on health. Use of the ITHIM tool in a HIA is well established for its ability to quantify the impact of transportation infrastructure on health, specifically by looking at physical activity, road traffic injury risk, and exposure to fine particulate matter (PM2.5) air pollution. The Office of Research and Development within the United States Environmental Protection Agency endorsed the ITHIM Tool in 2016.

- **Greenhouse Gas Emissions:** Greenhouse gas emissions related to the transportation sector result from the burning of fossil fuels (often gasoline and diesel) by vehicles, trucks, ships, trains, and planes. Nationally, the transportation sector contributes to 29% of the United States' greenhouse gas emissions, passenger cars being one of the main sources of emissions (United States Environmental Protection Agency, 2021b). Increases in greenhouse gases are associated with a multitude of negative health outcomes including heat-related illnesses, lung cancer, asthma, displacement, and increased prevalence of communicable disease (National Institute for Environmental Health Sciences, 2019).

- **Fine Particulate Matter ($PM_{2.5}$):** $PM_{2.5}$ is also referred to as particle pollution, which forms as a result of chemical reactions between pollutants emitted from power plants, industries, and vehicles. PM2.5 is characterized by small inhalable particles, measuring ≤2.5 micrometers in size (United States Environmental Protection Agency, n.d.).

- **Light Rail Transit (LRT):** Light rail transit, or LRT, is a rail-based transit system capable of high capacity, long haul trips, as compared with traditional tram-systems. Powered by a catenary system, LRT systems are fully electric and possess substantial impact to reduce emissions resulting from vehicles and other forms of public transportation. Challenges to LRT require an appropriate balancing between the design of a comfortable and efficient service, without spending excessive capital on an alternative that exceeds the need of the study area and affected communities (RailSystem, n.d.).

- **Metabolic Equivalent Task (MET):** a measure of the intensity of an exercise or activity. In technical terms, the MET is a ratio of working metabolic rate to resting metabolic rate. At resting, an individuals' MET value would equal 1, whereas a MET value of 4 (such as during a light jog) indicates the body is exerting four times the amount of energy than it does at the resting metabolic rate (Bubnis, 2019). Changes in the body's metabolism depending on age and sex are reflected in age- and sex-specific MET weights. The MET is an important output of the ITHIM tool. Active travel time is multiplied by weights in order to generate MET hours, which allow the ITHIM to estimate changes in chronic diseases related to air quality and physical activity (University of California Los Angeles, 2009).

- **Nitrogen Dioxide (NO_2):** NO_2 is a byproduct of burning fuel associated with vehicle emissions (United States Environmental Protection Agency, 2021a).
- **Personal Miles Traveled (PMT):** are a measure of miles traveled from active travel modes, such as walking or bicycling (University of California, Davis, 2019).
- **Population Attributable Fraction (PAF):** Population Attributable Fractions, or PAFs, indicate the proportion of a disease in a population that is attributable to a certain exposure. The PAF assumes a causal relationship, where the disease burden could be avoided by adding or eliminating the exposure, presuming no other changes (World Health Organization (WHO), n.d.-b). PAFs predicted by the ITHIM tool account for age- and sex- specific differences in metabolic rates for active travel, as set forth by Woodcock et al. (2011).
- **Relative Risk:** ratio that calculates the probability of a certain event occurring in an exposed group versus the probability of the same event occurring in a non-exposed group (Tenny & Hoffman, 2021).
- **Resilience:** a community's ability to endure a disturbance or emergency while maintaining its functions and structures (Cariolet et al., 2018). In context of this HIA, the project team adapts the term resilience to air quality, specifically strategies to reduce concentrations and exposure to air pollution emissions along the Okeechobee Blvd & SR-7 study corridor.
- **Safety in numbers:** a protective phenomenon where rates of traffic injuries slow in response to higher activity levels among pedestrians and bicyclists. Though safety increases when more bicyclists and pedestrians are engaged in active travel behaviors, it appears a threshold exists whereby the safety in numbers concept concedes some of its protective effects (Jacobsen, 2003). Such, is used with reference to ITHIM applications in Los Angeles and Nashville (Nicholas et al., 2018; Whitfield et al., 2017).
- **Safe System approach:** is transportation infrastructure designed with human error in mind. Though crashes are inevitable, the Safe System approach attempts to reduce the risk of human error, and also minimize the severity of injury in the event of such incidents (Federal Highway Administration, 2021).
- **Vehicle Miles Traveled (VMT):** measures the total amount of driving over a given area (City of Los Altos, n.d.).

- **Vision Zero:** the "Vision Zero Plan" as established by the Palm Beach Transportation and Planning Agency, describes the mechanisms through which they hope to achieve zero traffic-related fatalities and serious injuries (TPA, n.d.-b).

REFERENCES

AARP (2010). Preserving Affordability and Access in Livable Communities: Subsidized Housing Opportunities Near Transit and the 50+ Population. https://assets.aarp.org/rgcenter/ppi/liv-com/2009-15.pdf

American Public Transportation Association (APTA). (2017). *Public Transportation Benefits*. https://www.apta.com/mediacenter/ptbenefits

Apasnore, P., Ismail, K., & Kassim, A. (2017). Bicycle-vehicle interactions at mid-sections of mixed traffic streets: examining passing distance and bicycle comfort perception. *Accid. Anal. Prev., 106,* 141-148.

Atwood, J., Guo, F., Fitch, G., & Dingus, T. A. (2018). The driver-level crash risk associated with daily cellphone use and cellphone use while driving. *Accident; analysis and prevention*, *119*, 149–154. https://doi.org/10.1016/j.aap.2018.07.007

Badger, E. (2012). Cyclists and Pedestrians can end up spending more each month than drivers. City Lab. Retrieved December 22, 2021, from https://www.bloomberg.com/news/articles/2012-12-05/cyclists-and-pedestrians-can-end-up-spending-more-each-month-than-drivers

Bourcier, E., Charbonneau, D., Cahill, C., & Dannenberg, A. L. (2015). An evaluation of health impact assessments in the United States, 2011-2014. *Preventing chronic disease*, *12*, E23. https://doi.org/10.5888/pcd12.140376

Bowker, G. E., Baldauf, R., Isakov, V., Khylstov, A., & Petersen, W. (2007). The effects of roadside structures on the transport and dispersion of ultrafine particles from highways. *Atmospheric Environment, 41*, 8128-8139.

Braveman, P., Arkin, E., Orleans, T., Proctor, D., & Plough, A. (2017). *What is Health Equity?* Robert Wood Johnson Foundation. https://www.rwjf.org/en/library/research/2017/05/what-is-health-equity-.html

Broward Metropolitan Planning Organization & Parsons Brinckerhoff, Inc. (2015, April). *South Florida Climate Change Vulnerability Assessment and Adaptation Pilot Project*. https://www.palmbeachtpa.org/static/sitefiles/Plans_and_Resources/Climate_Change/South_FL_Climate_Change_Vulnerability.pdf

Bubnis, D. (2019). *What Exactly are METS, and What Should You Know About Them?* Healthline. https://www.healthline.com/health/what-are-mets

Cariolet, J.M., Colombert, M., Vuillet, M., & Diab, Y. (2018). Assessing the resilience of urban areas to traffic-related air pollution: Application in Greater Paris. *Science of The Total Environment, 615*, 588–596. https://www.sciencedirect.com/science/article/abs/pii/S0048969717326876

Centers for Disease Control and Prevention (CDC). (2018). PLACES. https://www.cdc.gov/places

Centers for Disease Control and Prevention (CDC). (2020). *CDC/ATSDR Social Vulnerability Index*. https://www.atsdr.cdc.gov/placeandhealth/svi/index.html.

Centers for Disease Control and Prevention (CDC). (2020). *Health Equity*. https://www.cdc.gov/chronicdisease/healthequity/index.htm

Center for Neighborhood Technology (CNT). (2018). *Housing and Transportation (H&T) Affordability Index*. https://htaindex.cnt.org/download/index.php

City of Los Altos. (n.d.). *Vehicle Miles Traveled (VMT).* https://www.losaltosca.gov/communitydevelopment/page/vehicle-miles-traveled-vmt

Clarke, P., & George, L.K. (2005). Understanding and addressing the challenges of disability: the role of the built environment in the disablement process. *American Journal of Public Health, 95*(11), 1933–1939.

Commute Seattle. (2019). *2019 Center city Commuter Mode Split Survey Results*. https://www.commuteseattle.com/resource/2019-center-city-commuter-mode-split-survey-results/

Construction World. (2019). *How to implement eco-friendly construction strategies.* constructionworld.org. Retrieved January 3, 2022, http://www.constructionworld.org/implement-eco-friendly-construction-strategies/

de Hartog, J.J., Boogaard, H., Nijland, H., & Hoek, G. (2010). Do the health benefits of cycling outweigh the risks? *Environ Health Perspect., 118*(8), 1109-1116.

Dijkstra, K., Pieterse, M.E., & Pruyn, A. (2008). Stress-reducing effects of indoor plants in the built healthcare environment: the mediating role of perceived attractiveness. *Preventive Medicine, 47*(3), 279–283.

Dill, J., Neal, M., Shandas, V., Luhr, G., Adkins, A., & Lund, D. (2010). *Demonstrating the Benefits of Green Streets for Active Aging: Final Report to EPA*. U.S. Environmental Protection Agency. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.230.9925&rep=rep1&type=pdf

Dowdall, E. (2016). *Measuring displacement risk in gentrifying neighborhoods.* The Reinvestment Fund. Retrieved January 3, 2022, from https://www.reinvestment.com/policy-solutions/blog/measuring-displacement-risk-gentrifying-neighborhoods/

Enterprise, The National Housing Trust, & Reconnecting America. (2010). *Preserving Affordable Housing Near Transit: Case Studies from Atlanta, Denver, Seattle, and Washington D.C*. Enterprise Community Partners. http://www.reconnectingamerica.org/assets/Uploads/preservingaffordablehousingneartransit2010.pdf

Federal Highway Administration (FHWA). (2018). *Crosswalk Visibility Enhancements: Safe Transportation for Every Pedestrian, Countermeasure Tech Sheet*. U.S. Department of Transportation. https://safety.fhwa.dot.gov/ped_bike/step/docs/TechSheet_VizEnhancemt_508compliant.pdf

Federal Transit Administration (FTA). (2010). *Public Transportation's Role in Responding to Climate Change*. U.S. Department of Transportation. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/PublicTransportationsRoleInRespondingToClimateChange2010.pdf

Federal Transit Administration (FTA). (2015). *Bus Rapid Transit*. U.S. Department of Transportation. Retrieved December 22, 2021, from https://www.transit.dot.gov/research-innovation/bus-rapid-transit

Federal Transit Administration (FTA). (2021). *Zero Deaths and Safe System.* U.S. Department of Transportation. Retrieved January 3, 2022, from https://safety.fhwa.dot.gov/zerodeaths/zero_deaths_vision.cfm

Ferrari, G., Oliveira Werneck, A., Rodrigues da Silva, D., Kovalskys, I., Gómez, G., Rigotti, A., Yadira Cortés Sanabria, L., García, M., Pareja, R. G., Herrera-Cuenca, M., Zimberg, I. Z., Guajardo, V., Pratt, M., Cofre Bolados, C., Saldía, E. J., Pires, C., Marques, A., Peralta, M., Rossato de Victo, E., Fisberg, M., … On Behalf Of The Elans Study Group (2020). Association between Perceived Neighborhood Built Environment and Walking and Cycling for Transport among Inhabitants from Latin America: The ELANS Study. *International journal of environmental research and public health*, *17*(18), 6858. https://doi.org/10.3390/ijerph17186858

Florida CHARTS. Florida Department of Health. Life Expectancy Report. Census tract 5-year estimates, 2019. Retrieved August, 2021 from https://www.flhealthcharts.gov/ChartsReports/rdPage.aspx?rdReport=ChartsProfiles.LifeExpectancyProfile

Galea, S., Ahern, J., Rudenstine, S., Wallace, Z., & Vlahov, D. (2005). Urban built environment and depression: a multilevel analysis. *Journal of Epidemiology Community Health. 59*(10), 822–827.

Gordon-Larsen, P., Nelson, M.C., Page, P., & Popkin, B.M. (2006). Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics. 117*(2), 417–424.

Götschi, T., Tainio, M., Maizlish, N., Schwanen, T., Goodman, A., & Woodcock, J. (2015). Contrasts in active transport behaviour across four countries: how do they translate into public health benefits?. *Preventive medicine*, *74*, 42–48. https://doi.org/10.1016/j.ypmed.2015.02.009

Health.gov. (n.d.-a). *Economic Stability - Healthy People 2030*. Retrieved June 17, 2021, from https://health.gov/healthypeople/objectives-and-data/browse-objectives/economic-stability

Health.gov. (n.d.-b). *Increase employment in working-age people — SDOH-02 - Healthy People 2030*. Retrieved June 17, 2021, from https://health.gov/healthypeople/objectives-and-data/browse-objectives/economic-stability/increase-employment-working-age-people-sdoh-02

Health.gov. (n.d.-c). *Transportation - Healthy People 2030*. Retrieved June 17, 2021, from https://health.gov/healthypeople/objectives-and-data/browse-objectives/transportation

Heinrich, K.M., Lee, R.E., Regan GR, et al. (2008). How does the built environment relate to body mass index and obesity prevalence among public housing residents? *American Journal of Health Promotion, 22*(3), 187–194.

Herron, M. (2019). *Deaths: Leading Causes for 2017*. Retrieved from https://www.cdc.gov/nchs/data/nvsr/nvsr68/nvsr68_06-508.pdf

HUD User. (2017). Defining Housing Affordability. PD&R Edge. https://www.huduser.gov/portal/pdredge/pdr-edge-featd-article-081417.html

Human Impact Partners. *A Health Impact Assessment Toolkit: A Handbook to Conducting HIA, 3rd Edition.* Oakland, CA: Human Impact Partners. February 2011.

Hunter, W., Feaganes, J., & Sinivasan, R. (2005). Conversions of Wide Curb Lanes: The Effect on Bicycle and Motor Vehicle Interactions**.** *Transportation Research Record Journal of the Transportation Research Board, 1939*(1), 37-44. https://doi.org/10.1177/0361198105193900105

Institute of Medicine (IOM). (2007). *The Future of Disability in America*. Washington, DC: The National Academies Press.

Iroz-Elardo, N., Hamberg, A., Main, E., Haggerty, B., Early-Alberts, J., & Cude, C. (2014). *Climate Smart Strategy Health Impact Assessment.* Oregon Health Authority. https://www.oregonmetro.gov/sites/default/files/2015/05/29/CSC-OHA-HealthImpactAssessment-ClimateSmartStrategy-092014.pdf

Jacobsen, P.L. (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *American Journal of Preventive Medicine, 9*(3), 205-209. http://dx.doi.org/10.1136/ip.9.3.205

Krewski, D., Jerrett, M., Burnett, R. T., Ma, R., Hughes, E., Shi, Y., Turner, M. C., Pope, C. A., 3rd, Thurston, G., Calle, E. E., Thun, M. J., Beckerman, B., DeLuca, P., Finkelstein, N., Ito, K., Moore, D. K., Newbold, K. B., Ramsay, T., Ross, Z., Shin, H., … Tempalski, B. (2009). Extended follow-up and spatial analysis of the American Cancer Society study linking particulate air pollution and mortality. *Research report (Health Effects Institute)*, (140), 5–136.

Kweon,B.-S., Rosenblatt-Naderi, J., Ellis, C.D., Shin, W.-H., & Danies, B.H. (2021). The Effects of Pedestrian Environments on Walking Behaviors and Perception of Pedestrian Safety. *Sustainability*, *13*,8728. https://doi.org/10.3390/ su13168728

Lee, M.S., & Jin, X. Prepared for the Planning and Environmental Management Office, Florida Department of Transportation - District 6. (2020). *Assessing the Health Impacts of Transportation Projects – a Synthesis.* https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/reports/fdot-bdv29-977-56-rpt.pdf?sfvrsn=4bb50c39_4

Li, F., Harmer, P.A., Cardinal, B.J., et *al*. (2008). Built environment, adiposity, and physical activity in adults aged 50–75. *American Journal of Preventive Medicine*, *35*(1), 38–46.

Lane Transit District (LTD). (n.d.). *Business Access & Transit Lanes (BAT Lanes)*. https://www.ltd.org/business-access-transit-lanes/

Massachusetts Department of Transportation, Office of Transportation Planning. (2020). *Public Health Assessment for Transportation Projects.* https://www.mass.gov/doc/public-health-assessment-for-transportation-projects/download

Maizlish, N., Woodcock J., Co, S., Ostro, B., Fanai, A., & Fairley, D. (2013). Health Cobenefits and Transportation-Related Reductions in Greenhouse Gas Emissions in the San Francisco Bay Area. *American Journal of Public Health, 103*(4), 703-709. https://doi.org/10.2105/AJPH.2012.300939

Mcdonald, E., Harper, A., Williams, J., & Hayter, J.A. (2006). *Street Trees and Intersection Safety.* Institute of Urban and Regional Development. https://escholarship.org/uc/item/9t6465vq

Mentimeter. (n.d.). *What is Mentimeter?* Retrieved January 10, 2022, from https://www.mentimeter.com/

Morrison, C.N, Thompson, J., Kondo, M.C, & Beck, B. (2019). On-road bicycle lane types, roadway characteristics, and risks for bicycle crashes. *Accident Analysis & Prevention, 123*, 123-131. https://doi.org/10.1016/j.aap.2018.11.017.

Morse, H. (2019). *What you should know about Florida's new texting-while-driving law*. The Palm Beach Post. https://www.palmbeachpost.com/story/news/politics/county/2019/07/01/floridas-new-texting-driving-law-and-how-it-can-and-cant-be-enforced/4787990007/

National Association of City Transportation Officials (NACTO). (n.d.). *Urban Street Design Guide: Lane Width*. Retrieved December 22, 2021, from https://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/

National Institute for Environmental Health Sciences. (2019). *Health Impacts - Climate and Human Health*. Retrieved December 6, 2021, from https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/index.cfm

Netusil, N. R., Chattopadhyay, S., & Kovacs, K. F. (2010). Estimating the Demand for Tree Canopy: A Second-Stage Hedonic Price Analysis in Portland, Oregon. *Land Economics*, *86*(2), 281–293. http://www.jstor.org/stable/27821424

Nicholas, W., Vidyanti, I., Caesar, E., & Maizlish, N. (2018). *Implementing the City of Los Angeles' Mobility Plan 2035: Public Health Implications - Health Impact Assessment.* Los Angeles County Department of Public Health, Center for Health Impact Evaluation.

Palm Beach Transportation Planning Agency. (n.d.-a) *Commuter Mode Split*. Palm Beach Transportation Planning Agency. Retrieved December 6, 2021, from https://dashboards.mysidewalk.com/palm-beach-tpa-performance/commuter-mode-split#c-12688859

Palm Beach Transportation Planning Agency. (n.d.-b). *Safety / Vision Zero*. Retrieved June 17, 2021, from https://www.palmbeachtpa.org/safety

Palm Beach Transportation Planning Agency. (2020a). *Okeechobee Boulevard Transit-Supportive Land Use and Economic Development Analysis: Existing Conditions Report.*

Palm Beach Transportation Planning Agency. (2020b). *Performance Measures*. Palm Beach Transportation Planning Agency. Retrieved December 6, 2021, from https://www.palmbeachtpa.org/pm.

Paths for all. (n.d.). *About Active Travel*. https://www.pathsforall.org.uk/about-active-travel

Rabl, A., & de Nazelle, A. (2012). Benefits of Shift from Car to Active Transport. *Transportation Policy, 19*, 121-131.

RailSystem. (n.d.). *Light Rail Transit*. Retrieved December 22, 2021, from http://railsystem.net/light-rail-transit/

Sá, T. H., Tainio, M., Goodman, A., Edwards, P., Haines, A., Gouveia, N., Monteiro, C., & Woodcock, J. (2017). Health impact modelling of different travel patterns on physical activity, air pollution and road injuries for São Paulo, Brazil. *Environment international*, *108*, 22–31. https://doi.org/10.1016/j.envint.2017.07.009

Safe Routes to School National Partnership. (2012). Safe routes to school and traffic pollution: Get children moving and reduce exposure to unhealthy air. Safe Routes Partnership. http://www.saferoutespartnership.org/sites/default/files/pdf/Air_Source_Guide_web.pdf

Shrestha, B.P., Millonig, A., Hounsell, N.B. *et al.* (2017). Review of Public Transport Needs of Older People in European Context. *Population Ageing* ,*10*, 343–361. https://doi.org/10.1007/s12062-016-9168-9

Signal Four Analytics. (2020). *Florida Traffic Safety Dashboard: Road Traffic Crashes*. University of Florida. https://signal4analytics.com/

Tenny, S., & Hoffman, M.R. (2021). Relative Risk. *StatPearls*. https://www.ncbi.nlm.nih.gov/books/NBK430824/

Thornton, R.L., Glover, C.M., Cené, C.W., Glik, D.C., Henderson, J.A., & Williams, D.R. (2016). Evaluating Strategies For Reducing Health Disparities By Addressing The Social Determinants Of Health. *Health Affairs, 35*(8), 1416-1423. https://doi.org/10.1377/hlthaff.2015.1357

Todd, M. (2006). Enhanced Transit Strategies: Bus Lanes with Intermittent Priority and ITS Technology Architectures for TOD Enhancement. *UC Davis: Institute of Transportation Studies*. Retrieved from https://escholarship.org/uc/item/8h1969p9

United States Census Bureau. 2015-2019 American Community Survey 5-year estimates.

United States Environmental Protection Agency. (2016). *The Health Impact Assessment (HIA) Resource and Tool Compilation: A Comprehensive Toolkit for New and Experienced HIA*

Practitioners in the U.S. https://www.epa.gov/sites/default/files/2017-07/documents/hia_resource_and_tool_compilation.pdf

United States Environmental Protection Agency. (n.d.). *Particulate Matter (PM) Basics*. https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM

United States Environmental Protection Agency. (2021a). *Nitrogen Dioxide (NO_2) Pollution*. https://www.epa.gov/no2-pollution

United States Environmental Protection Agency. (2021b). *Sources of Greenhouse Gas Emissions*. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#transportation

University of California, Davis. (2019). California ITHIM. Retrieved November, 2021, from https://skylab.cdph.ca.gov/HealthyMobilityOptionTool-ITHIM/#UserSupport.

University of California Los Angeles, Center for Health Policy Research. (2009). *California Health Interview Survey*.

University of California Los Angeles, Center for Health Policy Research. (2012). *California Household Travel Survey*.

University of Wisconsin-Madison Global Health Institute. (2021). *Integrated Transport and Health Impacts Model: Overview*. University of Wisconsin-Madison Global Health Institute. https://ithim.ghi.wisc.edu/overview/

Valley Metro. (n.d.). *Building Communities + Enhancing Lives: a Quality of Life Report*. Valley Metro. https://drupal-space.nyc3.cdn.digitaloceanspaces.com/s3fs-public/uploads/event-resources/quality_of_life_report_12-3-18_-_final_reduced.pdf

Weil, A. (2018). Advancing Health Equity. *Health Affairs*, *37*(3), 343. https://www.healthaffairs.org/doi/pdf/10.1377/hlthaff.2018.0183

Whitfield, G.P., Meehan, L.A., Maizlish, N., & Wendel, A.M. (2017). The integrated transport and health impact modeling tool in Nashville, Tennessee, USA: Implementation steps and lessons learned. *Journal of Transport & Health, 5*, 172-181. https://doi.org/10.1016/j.jth.2016.06.009.

Woodcock, J., Edwards, P., Tonne, C., Armstrong, B. G., Ashiru, O., Banister, D., Beevers, S., Chalabi, Z., Chowdhury, Z., Cohen, A., Franco, O. H., Haines, A., Hickman, R., Lindsay, G., Mittal, I., Mohan, D., Tiwari, G., Woodward, A., & Roberts, I. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. *Lancet (London, England)*, *374*(9705), 1930–1943. https://doi.org/10.1016/S0140-6736(09)61714-1

Woodcock, J., Franco, O. H., Orsini, N., & Roberts, I. (2011). Non-vigorous physical activity and all-cause mortality: systematic review and meta-analysis of cohort studies. *International journal of epidemiology*, *40*(1), 121–138. https://doi.org/10.1093/ije/dyq104

Woodcock, J., Givoni, M., & Morgan, A. S. (2013). Health impact modelling of active travel visions for England and Wales using an Integrated Transport and Health Impact Modelling Tool (ITHIM). *PloS one*, *8*(1), e51462. https://doi.org/10.1371/journal.pone.0051462

Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., & Goodman, A. (2014). Health effects of the London bicycle sharing system: health impact modelling study. *BMJ (Clinical research ed.)*, *348*, g425. https://doi.org/10.1136/bmj.g425

World Health Organization (WHO). (n.d.-a). *Disability-adjusted life years (DALYs)*. WHO.int. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/158

World Health Organization (WHO). (n.d.-b). *Population attributable fraction.* WHO.int. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/1287

Wu, Y., Rowangould, D., London, J.K., & Karner, A. (2019). Modeling health equity in active transportation planning. *Transportation Research Part D: Transport and Environment, 67*, 528-540. https://doi.org/10.1016/j.trd.2019.01.011

Zegeer, C., R. Srinivasan, B. Lan, D. Carter, S. Smith, C. Sundstrom, N.J. Thirsk, J. Zegeer, C. Lyon, E. Ferguson, and R. Van Houten. (2017). *NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments*. Transportation Research Board, Washington, D.C.

APPENDIX A: DATA SOURCES USED IN THE ITHIM

Data	Source	Year(s)	Notes
Air Quality	UHS	2021	
American Community Survey	United States Census Bureau	2019	5-year estimates
Road Traffic Crashes	Signal Four Analytics	2018-2020 Average	Averaged across three years due to probable pandemic changes.
Deaths	Florida Charts	2018-2020 Average	For all of Palm Beach County (tract-level deaths not available); Averaged across three years due to probable pandemic changes.
*Relative risk changes per unit increase in air particulate matter	Woodcock et al., 2009		
*Relative risk changes per unit increase in MET hour-weeks	CARB recommendations based on Krewski et al., 2009		
*Baseline Personal & Vehicle Miles Traveled	California Household Travel Survey, 2012		Includes age and sex specific active travel. Average, minimum, and maximum estimates were retained as possible Florida baselines given Florida travel surveys were not available.
*Age- and sex-specific non-travel METS	California Health Interview Survey (Adult Survey), 2009		Average, minimum, and maximum estimates were retained as possible Florida baselines given Florida travel surveys were not available.
*Age-, sex-, and travel mode-specific MET weights for active travel	James Woodcock, 2011		

*Incorporated into the California ITHIM model.
MET: ratio of working metabolic rate relative to resting metabolic rate.
California Air Resources Board (CARB)
California Integrated Transport and Health Impact Model (University of California, 2019).

APPENDIX B: REFERENCE LIST FOR TABLES 6, 10, & 15 TRANSPORTATION DESIGN ELEMENTS & HEALTH-RELATED OUTCOMES

Tables 6, 10, & 15 Transportation Design Elements & Health-Related Outcomes for Air Quality and Resilience, Physical Activity, & Road Safety References
1. Kweon,B.-S., Rosenblatt-Naderi, J., Ellis, C.D., Shin, W.-H., & Danies, B.H. (2021). The Effects of Pedestrian Environments on Walking Behaviors and Perception of Pedestrian Safety. *Sustainability*, *13*,8728. https://doi.org/10.3390/ su13168728
2. Suminski, Richard & Heinrich, Katie & Poston, Walker & Hyder, Melissa & Jahnke, Sara. (2008). Characteristics of Urban Sidewalks/Streets and Objectively Measured Physical Activity. *Journal of urban health: bulletin of the New York Academy of Medicine, 85*, 178-90. 10.1007/s11524-007-9251-x.
3. Florida Department of Transportation (FDOT). (2009). *Conserve by Bicycle and Pedestrian Study Phase II*. FDOT, Tallahassee, FL.
4. National Association of City Transportation Officials (NACTO). (n.d.). *Urban Street Design Guide: Sidewalks*. Retrieved December 22, 2021, from https://nacto.org/publication/urban-street-design-guide/street-design-elements/sidewalks/#footnotes
5. Mcdonald, E., Harper, A., Williams, J., & Hayter, J.A. (2006). Street Trees and Intersection Safety. Institute of Urban and Regional Development. https://escholarship.org/uc/item/9t6465vq
6. Powell, K.E. Martin, L.M., & Chowdhury, P.P. (2003). Places to walk: convenience and regular physical activity. *Am J Public Health*. 93(9):1519-1521. https://doi.org/10.2105/AJPH.93.9.1519
7. Duncan, D. T., Sharifi, M., Melly, S. J., Marshall, R., Sequist, T. D., Rifas-Shiman, S. L., & Taveras, E. M. (2014). Characteristics of walkable built environments and BMI z-scores in children: evidence from a large electronic health record database. *Environmental health perspectives*, *122*(12), 1359–1365. https://doi.org/10.1289/ehp.1307704
8. Oreskovic, N. M., Winickoff, J. P., Kuhlthau, K. A., Romm, D., & Perrin, J. M. (2009). Obesity and the built environment among Massachusetts children. *Clinical pediatrics*, *48*(9), 904–912. https://doi.org/10.1177/0009922809336073
9. Torbic, D.J., Bauer, K.M., Fees, C.A., Harwood, D.W., Van Houten, R., LaPlante, J., & Roseberry, N., on behalf of the Transportation Research Board. (2014). Recommended Bicycle Lane Widths for Various Roadway Characteristics. National Cooperative Highway Research Program, Report 766. https://ssti.us/wp-

content/uploads/sites/1303/2014/08/nchrp_bike_lanes.pdf

10. Hunter, W., Feaganes, J., & Sinivasan, R. (2005). Conversions of Wide Curb Lanes: The Effect on Bicycle and Motor Vehicle Interactions**.** *Transportation Research Record Journal of the Transportation Research Board, 1939*(1), 37-44. https://doi.org/10.1177/0361198105193900105

11. Badger, E. (2012). Cyclists and Pedestrians can end up spending more each month than drivers. City Lab. Retrieved December 22, 2021, from https://www.bloomberg.com/news/articles/2012-12-05/cyclists-and-pedestrians-can-end-up-spending-more-each-month-than-drivers

12. Cortright, J. (2009). Walking the Walk: How Walkability Raises Housing Values in U.S. Cities. *CEOs for Cities.* Retrieved from https://nacto.org/docs/usdg/walking_the_walk_cortright.pdf

13. Rogers, S.H., Halstead, J.M., Gardner, K.M., & Carlson, C.H. (2010). Examining Walkability and Social Capital as Indicators of Quality of Life at the Municipal and Neighborhood Scales. *Applied Research Quality of Life 6*: 201–213.

14. Sallis, J.F., Bowles, H.R., Baumann, A., Bull, F.C., Craig, C.L., Sjöström, M., De Bourdeauhuji, I., Lefevre, J., Matsudo, V., Matsudo, S., Macfarlane, D.J., Fernando Gomez, L., Inoue, S., Murase, N., Volbekiene, V., McLean, G., Carr, H., Klasson Heggebo, L., Tomten, H., & Bergman, P. (2009). Neighborhood Environments and Physical Activity Among Adults in 11 Countries. *American Journal of Preventative Medicine, 36*(6). https://doi.org/10.1016/j.amepre.2009.01.031

15. Rabl, A., & de Nazelle, A. (2012). Benefits of Shift from Car to Active Transport. *Transportation Policy, 19*, 121-131.

16. de Hartog, J.J., Boogaard, H., Nijland, H., & Hoek, G. (2010). Do the health benefits of cycling outweigh the risks? *Environ Health Perspect., 118*(8), 1109-1116.

17. Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., & Goodman, A. (2014). Health effects of the London bicycle sharing system: health impact modelling study. *BMJ, 348*, g425.

18. Rojas-Rueda, D., de Nazelle, A., Tainio, M., & Nieuwenhuijsen, M.J. (2011). The health risks and benefits of cycling in urban environments compared with car use: health impact assessment study. *BMJ, 343*, d4521.

19. Holm, A.L., Glumer, C., & Diderichsen, F. (2012). Health Impact Assessment of increased cycling to place of work or education in Copenhagen. *BMJ Open, 2*(4).

20. Berke, E.M., Koepsell, T.D., Moudon, A.V., Hoskins, R.E., & Larson, E.B. (2007). Association of the built environment with physical activity and obesity in older persons. *American Journal of Public Health. 97*(3), 486–492.

21. Clarke, P., Ailshire, J.A., Bader, M., Morenoff, J.D., & House, J.S. (2008). Mobility disability and the urban built environment. *American Journal of Epidemiology, 168*(5), 506–513.

22. Galea, S., Ahern, J., Rudenstine, S., Wallace, Z., & Vlahov, D. (2005). Urban built environment and depression: a multilevel analysis. *Journal of Epidemiology Community Health. 59*(10), 822–827.

23. Clarke, P., & George, L.K. (2005). Understanding and addressing the challenges of disability: the role of the built environment in the disablement process. *American Journal of Public Health, 95*(11), 1933–1939.

24. Dijkstra, K., Pieterse, M.E., & Pruyn, A. (2008). Stress-reducing effects of indoor plants in the built healthcare

environment: the mediating role of perceived attractiveness. *Preventive Medicine, 47*(3), 279–283.

25. Heinrich, K.M., Lee, R.E., Regan GR, et al. (2008). How does the built environment relate to body mass index and obesity prevalence among public housing residents? *American Journal of Health Promotion, 22*(3), 187–194.

26. Li, F., Harmer, P.A., Cardinal, B.J., et al. (2008). Built environment, adiposity, and physical activity in adults aged 50–75. *American Journal of Preventive Medicine*, *35(*1), 38–46.

27. Leyden, K.M. (2003). Social capital and the built environment: the importance of walkable neighborhoods. *American Journal of Public Health, 93*(9), 1546–1551.

28. Rundle, A., Roux, A.V.D., Freeman, L.M., Miller, D., Neckerman, K.M., & Weiss, C.C. (2007). The urban built environment and obesity in New York City: a multilevel analysis. *American Journal of Health Promotion, 21*(4), 326–334.

29. Lopez-Zetina, J., Lee, H., & Friis, R. (2006). The link between obesity and the built environment: evidence from an ecological analysis of obesity and vehicle miles of travel in California. *Health Place, 12*(4), 656–664.

30. Titze, S., Stronegger, W.J., Janschitz, S., & Oja, P. (2008). Association of built-environment, social-environment and personal factors with bicycling as a mode of transportation among Austrian city dwellers. *Preventive Medicine, 47*(3), 252–259.

31. Boogaard, H., Borgman, F., Kamminga, J., & Hoek, G. (2009). Exposure to ultrafine and fine particles and noise during cycling and driving in 11 Dutch cities. *Atmospheric Environment, 43*(27), 4234–4241. https://doi.org/10.1016/j.atmosenv.2009.05.035.

32. Morrison, C.N, Thompson, J., Kondo, M.C, & Beck, B. (2019). On-road bicycle lane types, roadway characteristics, and risks for bicycle crashes. *Accident Analysis & Prevention, 123*, 123-131. https://doi.org/10.1016/j.aap.2018.11.017.

33. de Hartog, J.J., Boogaard, H., Nijland, H., & Hoek, G. (2010). Do the health benefits of cycling outweigh the risks? *Environ. Health Popul. Perspect. Issues, 118*(8), 1109-1116.

34. Götschi, T., Garrard, J., & Giles-Corti, B. (2016). Cycling as a part of daily life: a review of health perspectives. *Transp. Rev., 36*(1), 45-71.

35. Hamer, M., & Chida, Y. (2008). Active commuting and cardiovascular risk: a meta-analytic review. *Prev. Med., 46*(1), 9-13.

36. Apasnore, P., Ismail, K., & Kassim, A. (2017). Bicycle-vehicle interactions at mid-sections of mixed traffic streets: examining passing distance and bicycle comfort perception. *Accid. Anal. Prev., 106,* 141-148.

37. Fishman, E., Washington, S., & Haworth, N.L. (2012). Understanding the fear of bicycle riding in Australia. *J. Aust. Coll. Road Saf., 23*(3), 19-27.

38. Buehler, R., & Dill, J. (2016). Bikeway networks: a review of effects on cycling. *Transp. Rev., 36*(1), 9-27.

39. Gu, J., Mohit, B., & Muennig, P.A. (2017). The cost-effectiveness of bike lanes in New York City. *Inj. Prev., 23*(4), 239-243.

40. Ming Wen, L., & Rissel, C. (2008). Inverse associations between cycling to work, public transport, and overweight and obesity: findings from a population based study in Australia. *Prev. Med., 46*(1), 29-32.

41. National Association of City Transportation Officials (NACTO). (n.d.). *Urban Street Design Guide: Lane Width*. Retrieved December 22, 2021, from https://nacto.org/publication/urban-street-design-guide/street-design-elements/lane-width/

42. Petrisch, T. (n.d.). The Truth about Lane Widths. The Pedestrian and Bicycle Information Center. Retrieved December 22, 2021, from http://www.bicyclinginfo.org/library/details.cfm?id=4348.

43. Florida Department of Transportation. (2007). Appendix A-P and Appendix Q. Conserve By Bicycle Program Study Final Report. Tallahassee, FL: FDOT.

44. Dumbaugh, E., & Li, W. (2011). Designing for the Safety of Pedestrians, Cyclists, and Motorists in Urban Environments. *Journal of the American Planning Association 77*, 70.

45. Fitzpatrick, K., Carlson, P., Brewer, M., & Wooldridge, M. (2000). Design Factors That Affect Driver Speed on Suburban Arterials. *Transportation Research Record, 1751*, 18–25.

46. Macdonald, E., Sanders, R., & Supawanich, P. (2008). The Effects of Transportation Corridors' Roadside Design Features on User Behavior and Safety, and Their Contributions to Health, Environmental Quality, and Community Economic Vitality: a Literature Review. *UCTC Research Paper No. 878*. https://nacto.org/docs/usdg/effects_transportation_corridors_macdonald.pdf

47. Harwood, D.W., on behalf of the Transportation Research Board. (1990). Effective utilization of street width on urban arterials. *Transportation Research Board, 330*. https://trid.trb.org/view.aspx?id=312924

48. Potts, I.B., Harwood, D.W., & Richard, K.R. (2007). Relationship of Lane Width to Safety for Urban and Suburban Arterials. *Journal of the Transportation Research Board, 2023*(1), 63–82. https://doi.org/10.3141/2023-08

49. Fitzpatrick, K., Carlson, P., Brewer, M., & Wooldridge, M. (2000). Design Factors That Affect Driver Speed on Suburban Arterials. *Transportation Research Record, 1751*, 18–25.

50. Federal Highway Administration. (2006). *Federal Highway Administration University Course on Bicycle and Pedestrian Transportation: LESSON 9: WALKWAYS, SIDEWALKS, AND PUBLIC SPACES*. U.S. Department of Transportation. https://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/chapt9.cfm

51. Safe Routes to School National Partnership. (2012). Safe routes to school and traffic pollution: Get children moving and reduce exposure to unhealthy air. Safe Routes Partnership. http://www.saferoutespartnership.org/sites/default/files/pdf/Air_Source_Guide_web.pdf

52. Bowker, G. E., Baldauf, R., Isakov, V., Khylstov, A., & Petersen, W. (2007). The effects of roadside structures on the transport and dispersion of ultrafine particles from highways. *Atmospheric Environment, 41*, 8128-8139.

53. Dill, J., Neal, M., Shandas, V., Luhr, G., Adkins, A., & Lund, D. (2010). U.S. Environmental Protection Agency. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.230.9925&rep=rep1&type=pdf

54. Netusil, N. R., Chattopadhyay, S., & Kovacs, K. F. (2010). Estimating the Demand for Tree Canopy: A Second-Stage Hedonic Price Analysis in Portland, Oregon. *Land Economics*, *86*(2), 281–293. http://www.jstor.org/stable/27821424

55. Takano, T., Nakamura, K., & Watanabe, M. (2002). Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces. *Journal of epidemiology and community*

health, *56*(12), 913–918. https://doi.org/10.1136/jech.56.12.913

56. Mundorf, N., Redding, C. A., & Bao, S. (2018). Sustainable Transportation and Health. *International journal of environmental research and public health*, *15*(3), 542. https://doi.org/10.3390/ijerph15030542

57. Shrestha, B.P., Millonig, A., Hounsell, N.B. *et al.* (2017). Review of Public Transport Needs of Older People in European Context. *Population Ageing* ,*10*, 343–361. https://doi.org/10.1007/s12062-016-9168-9

58. Institute of Medicine (IOM). (2007). *The Future of Disability in America*. Washington, DC: The National Academies Press.

59. Litman, T. (2020). *Evaluating Public Transportation Health Benefits.* Victoria Transport Policy Institute. https://www.vtpi.org/tran_health.pdf

60. Lamanna, M., Klinger, C., Liu, A., & Mirza, R. (2020). The Association between Public Transportation and Social Isolation in Older Adults: A Scoping Review of the Literature. *Canadian Journal on Aging / La Revue Canadienne Du Vieillissement, 39*(3), 393-405. doi:10.1017/S0714980819000345

61. Federal Transit Administration. (2010). *Public Transportation's Role in Responding to Climate Change*. U.S. Department of Transportation. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/PublicTransportationsRoleInRespondingToClimateChange2010.pdf

62. Environmental Pollution Centers. (n.d.). *Construction Sites Pollution*. Environmental Pollution Centers. https://www.environmentalpollutioncenters.org/construction/

63. Dong, Y.H., & Ng, S.T. (2015). A life cycle assessment model for evaluating the environmental impacts of building construction in Hong Kong. *Building and Environment, 89*, 183–191. https://doi.org/10.1016/j.buildenv.2015.02.020

64. Anciaes, P.R., Metcalfe, P.J., & Heywood, C. (2016). Social impacts of road traffic: perceptions and priorities of local residents. *Impact Assessment and Project Appraisal, 35*(2), 172–183. https://doi.org/10.1080/14615517.2016.1269464

65. Paunović, K., Jakovljević, B., & Belojević, G. (2009). Predictors of noise annoyance in noisy and quiet urban streets. *The Science of the total environment*, *407*(12), 3707–3711. https://doi.org/10.1016/j.scitotenv.2009.02.033

66. Oiamo, T. H., Luginaah, I. N., & Baxter, J. (2015). Cumulative effects of noise and odour annoyances on environmental and health related quality of life. *Social science & medicine (1982)*, *146*, 191–203. https://doi.org/10.1016/j.socscimed.2015.10.043

67. Orru, K., Orru, H., Maasikmets, M., Hendrikson, R., & Ainsaar, M. (2016). Well-being and environmental quality: Does pollution affect life satisfaction?. *Quality of life research : an international journal of quality of life aspects of treatment, care and rehabilitation*, *25*(3), 699–705. https://doi.org/10.1007/s11136-015-1104-6

68. Khreis, H., May, A.D., & Nieuwenhuijzen, M.J. (2017). Health impacts of urban transport policy measures: A guidance note for practice. *Journal of Transport & Health, 1*, 209–207. https://doi.org/10.1016/j.jth.2017.06.003

69. Kittelson & Associates, Inc. (2021). *Task 3.2 Okeechobee Blvd & SR7 Multimodal Corridor Study: Evaluation of*

Alternatives Methodology. Palm Beach Transportation and Planning Agency.

70. Kittelson & Associates, Inc. (2021). *Task 3.3 Okeechobee Blvd & SR7 Multimodal Corridor Study: Transit Service Plan*. Palm Beach Transportation and Planning Agency.

71. Signal Four Analytics. (2020). *Florida Traffic Safety Dashboard: Road Traffic Crashes*. University of Florida. https://signal4analytics.com/

72. United States Census Bureau. 2015-2019 American Community Survey 5-year estimates.

73. Kittleson & Associates, Inc. (2021). *Estimated Ridership* [SAWG Virtual Presentation]. Palm Beach Transportation and Planning Agency.

74. Urban Health Solutions. *Field Collection of Air Quality along Okeechobee Blvd & SR7 Corridor*.

75. Woodcock, J., Franco, O. H., Orsini, N., & Roberts, I. (2011). Non-vigorous physical activity and all-cause mortality: systematic review and meta-analysis of cohort studies. *International journal of epidemiology*, *40*(1), 121–138. https://doi.org/10.1093/ije/dyq104

76. Woodcock, J., Edwards, P., Tonne, C., Armstrong, B. G., Ashiru, O., Banister, D., Beevers, S., Chalabi, Z., Chowdhury, Z., Cohen, A., Franco, O. H., Haines, A., Hickman, R., Lindsay, G., Mittal, I., Mohan, D., Tiwari, G., Woodward, A., & Roberts, I. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. *Lancet (London, England)*, *374*(9705), 1930–1943. https://doi.org/10.1016/S0140-6736(09)61714-1

77. Krewski, D., Jerrett, M., Burnett, R. T., Ma, R., Hughes, E., Shi, Y., Turner, M. C., Pope, C. A., 3rd, Thurston, G., Calle, E. E., Thun, M. J., Beckerman, B., DeLuca, P., Finkelstein, N., Ito, K., Moore, D. K., Newbold, K. B., Ramsay, T., Ross, Z., Shin, H., … Tempalski, B. (2009). Extended follow-up and spatial analysis of the American Cancer Society study linking particulate air pollution and mortality. *Research report (Health Effects Institute)*, (140), 5–136.

78. Kittelson & Associates, Inc. (2021). *Task 3.3 Okeechobee Blvd & SR7 Multimodal Corridor Study: Running Time Fleet Requirements*. Palm Beach Transportation and Planning Agency.

79. Kittelson & Associates, Inc. (2021). *Task 3.3 Okeechobee Blvd & SR7 Multimodal Corridor Study: Transit Service Plan*. Palm Beach Transportation and Planning Agency.

80. Federal Highway Administration. (2004). *Summary Report: Evaluation of Lane Reduction "Road Diet" Measures and Their Effects on Crashes and Injuries*. U.S. Department of Transportation. https://www.fhwa.dot.gov/publications/research/safety/humanfac/04082/

81. Duduta, N., Adriazola, C., Hidalgo, D., Lindau, L.A., & Jaffe, R. (2012). *Understanding Road Safety Impact of High-Performance Bus Rapid Transit and Busway Design Features*. Journal of the Transportation Research Board, 2317(1), 8–14. https://doi.org/10.3141/2317-02

Appendix C: Transportation-Alternative Health Analysis Score Calculations

Air Quality & Resilience

Alternative	Potential Health Outcomes	Transportation-Alternative Health Score
No-Build	Existing pedestrian and bicycle activity levels	-2
	Perceived safety without a bicycle buffer	-2
	Green space is available along some corridor sections	0
	Buffer set-back from roadway to sidewalk, that provides increased sense of safety for pedestrians & protection from vehicle emissions	2
	Persistent emission trends	-2
	Estimated ridership	-2
	Rates of heart disease, stroke, and lung cancer	-2
		Composite Score: -1.14
Mixed Traffic with Limited Bus Stops	Minimal increase in public transit ridership from an added service route (Mall at Wellington Green and Intermodal Transit Center) & BRT option	-1
	Mixed traffic lanes may impact efficiency of the alternative in reducing emissions/ time spent in traffic	-2
	Increase in pedestrian activity from wider sidewalks (= across all alternatives except no-build)	2
	Minimal reduction in mortality from heart disease, stroke, and lung cancer	0
	Minimal increase in perceived safety for bicyclists due to wider bicycle lanes and designated buffer	-1
	Green space is available along some corridor sections	0
	Minimal reduction in perceived safety for pedestrians & protection from vehicle emissions due to smaller buffer set-back from roadway to sidewalk	1

		Composite Score: -1
BAT Curbside Lane	Minimal increase in ridership from implementation of Business Access and Transit Lane (reduce travel times)	-1
	Minimal potential reduction in emissions (> Mixed Traffic with Limited Bus stops)	0
	Increase in pedestrian activity from wider sidewalks (= across all alternatives except no-build)	2
	Minimal reduction in perceived safety for pedestrians & protection from vehicle emissions due to smaller buffer set-back from roadway to sidewalk (= Mixed Traffic with Limited Bus stops)	0
	Minimal reduction in mortality from heart disease, stroke, and lung cancer	0
	Minimal increase in perceived safety for bicyclists due to wider bicycle lanes and designated buffer	-1
	Green space is available along some corridor sections	0
		Composite Score: 0
Curbside Dedicated Lane BRT	Moderate increase in ridership from implementation of dedicated BRT lane & BRT option	1
	Increase in pedestrian activity from wider sidewalks (= across all alternatives except no-build)	2
	Separated buffer provides the maximum increase in perceived safety for bicyclists	2
	Small buffer area between roadway and sidewalk, leading to a decreased sense of safety and increased exposure to emissions for pedestrians	-1
	Reduction in emissions due to BRT usage, and increases in bicycle activity	2
	Moderate reduction in mortality from heart disease, stroke, and lung cancer	1
	Green space is available along some corridor sections	0
		Composite Score: 1
Center Platform Dedicated BRT	Moderate increase in ridership by having dedicated BRT lanes (< travel time than curbside dedicated BRT lane alternative due to elimination of non-transit vehicles)	2

	Increase in pedestrian activity from wider sidewalks (= across all alternatives except no-build)	2
	Separated buffer provides the maximum increase in perceived safety for bicyclists	2
	Minimal reduction buffer area between roadway and sidewalk compared to no-build scenario, impacting the sense of safety and exposure to emissions for pedestrians	0
	Moderate reduction in emissions from increases in ridership & bicycle activity	1
	Moderate reduction in mortality from heart disease, stroke, and lung cancer	1
	Less green space is available because of converting the median	-2
		Composite Score: 0.86
Center Platform Dedicated LRT	LRT is powered by electricity and has a high ridership capacity, leading to a significant reduction in emissions	2
	Increase in pedestrian activity from wider sidewalks (= across all alternatives except no-build)	2
	Separated buffer provides the maximum increase in perceived safety for bicyclists	2
	Moderate reduction in buffer area between roadway and sidewalk compared to no-build scenario, impacting the sense of safety and increased exposure to emissions for pedestrians	-1
	Maximum reduction in emissions from increases in ridership & bicycle activity	2
	Significant reduction in mortality from heart disease, stroke, and lung cancer	2
	Less green space is available because of converting the median	-2
		Composite Score: 1
Elevated Grade Separated LRT	LRT is powered by electricity and has a high ridership capacity, leading to a significant reduction in emissions (> ridership than Center platform LRT)	2
	Increase in pedestrian activity from wider sidewalks (= across all alternatives except no-build)	2
	Separated buffer provides the maximum increase in perceived safety for bicyclists	2

	Small buffer area between roadway and sidewalk, leading to a decreased sense of safety and increased exposure to emissions for pedestrians	-1
	Maximum reduction in emissions from increases in ridership & bicycle activity	2
	Significant reduction in mortality from heart disease, stroke, and lung cancer	2
	Green space is available underneath the elevated platform	2
		Composite Score: 1.57

Physical Activity

Alternative	Potential Health Outcomes	Transportation-Alternative Health Score
No-Build	Existing number of individuals meeting daily exercise requirements	-2
	Sidewalk width	-2
	High ambient stress among bicyclists and pedestrians due to narrow lanes	-2
	Aesthetic appeal given lack of construction impacts	0
	Aesthetic appeal is not compromised over an extended period of time	0
	Large buffer set-back from roadway to sidewalk, that provides increased sense of safety for pedestrians	2
	Rates of heart disease, cancers, dementia, diabetes, and stroke	-2
		Composite Score: -0.86
Mixed Traffic with Limited Bus Stops	Minimal increase in the number of individuals meeting daily exercise requirements related to public transit use	-1
	Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build)	2
	Aesthetic appeal given lack of construction impacts	0
	Aesthetic appeal is not compromised over an extended period of time required to implement the transportation alternative	0
	Minimal reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke	0

	Ambient stress for bicyclists that have wider lanes, but no physical barrier	-1
	Some reduction in perceived safety for pedestrians due to smaller buffer set-back from roadway to sidewalk	-1
		Composite Score: -0.14
BAT Curbside Lane	Minimal increase in the number of individuals meeting daily exercise requirements related to public transit use	-1
	Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build)	2
	Aesthetic appeal is maintained given limited construction required to implement a BAT curbside lane	0
	Aesthetic appeal is not compromised over an extended period of time required to implement the transportation alternative	0
	Minimal reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke	0
	Ambient stress for bicyclists that have wider lanes, but no physical barrier	-1
	Moderate reduction in perceived safety for pedestrians due to small buffer set-back from roadway to sidewalk	-1
		Composite Score: -0.14
Curbside Dedicated Lane BRT	Moderate increase in the number of individuals meeting daily exercise requirements associated with increased public transit use & ridership (BRT)	0
	Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build)	2
	Aesthetic appeal is maintained given limited construction required to implement a BRT curbside lane	0
	Aesthetic appeal is not compromised over an extended period of time required to implement the transportation alternative	0
	Moderate reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke	1
	Minimal amount ambient stress for bicyclists that have wider lanes, and a physical barrier	2
	Small buffer setback in combination with a dedicated bus lane provides minimal reduction in perceived safety	0
		Composite Score: 0.71
Center Platform Dedicated BRT	Moderate increase in the number of individuals meeting daily exercise requirements associated with increased public transit use	1

	& ridership (BRT) (>Curbside Dedicated BRT)	
	Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build)	2
	Aesthetic appeal is compromised due to significant construction efforts required to build a center platform dedicated lane	-2
	Negative aesthetic impacts experienced over a longer period given the extensiveness of the project	-2
	Moderate reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke	1
	Minimal amount ambient stress for bicyclists that have wider lanes, and a physical barrier	2
	Minimal increase in perceived safety among pedestrians due to small buffer setback from roadway to sidewalk as compared to no build, yet pedestrian dedicated onboarding area in the center platform promotes slower traffic speeds	1
		Composite Score: 0.43
Center Platform Dedicated LRT	Maximum increase in the number of individuals meeting daily exercise requirements associated with increased public transit use & ridership (LRT has a high ridership)	2
	Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build)	2
	Aesthetic appeal is compromised due to significant construction efforts required to build a center platform dedicated lane	-2
	Negative aesthetic impacts experienced over a longer period given the extensiveness of the project	-2
	Significant reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke	2
	Minimal amount ambient stress for bicyclists that have wider lanes, and a physical barrier	2
	Minimal increase in perceived safety among pedestrians due to small buffer setback from roadway to sidewalk as compared to no build, yet pedestrian dedicated onboarding area in the center platform promotes slower traffic speeds	1
		Composite Score: 0.71
Elevated Grade Separated LRT	Maximum increase in the number of individuals meeting daily exercise requirements associated with increased public transit use & ridership (Elevated LRT has the highest ridership)	2
	Wide sidewalks are considered more desirable and encourage pedestrian activity (= across all alternatives, except no-build)	2

	Aesthetic appeal is compromised due to significant construction efforts required to build an elevated platform dedicated lane	-2
	Negative aesthetic impacts experienced over a longer period given the extensiveness of the project	-2
	Significant reduction in mortality from heart disease, cancers, dementia, diabetes, and stroke	2
	Minimal amount ambient stress for bicyclists that have wider lanes, and a physical barrier	2
	Increase in perceived safety among pedestrians due to buffer setback from roadway to sidewalk as compared to no build, yet pedestrian dedicated onboarding area on the elevated platform and below the LRT space, promotes slower traffic speeds	2
		Composite Score: 0.86

Road Safety

Alternative	Potential Health Outcomes	Transportation-Alternative Health Score
No-Build	Narrow bicycle lane leads to maximum exposure to roadway traffic	-2
	Risk of injury without a designated or separated buffer	-2
	Large buffer set-back from roadway to sidewalk, that reduces pedestrian exposure to vehicular traffic	2
	Travel lane width of 12’ is linked with high travel speeds and risk of severe injury and/or fatality	-2
	Minimal risk of road traffic fatalities compared to other travel scenarios projected by ITHIM	2
	Maximum distance across travel lanes, increasing time and risk for pedestrians crossing the roadway	-2
	Number of travel lanes for non-transit vehicles to meet road capacity (decrease congestion and increase traffic speeds)	-2
	Minimal risk of road crashes among transit users with availability of curbside service (not necessary to cross the roadway for transit-access)	2
		Composite Score: -0.5
Mixed Traffic with Limited Bus Stops	Wide bicycle lane reduces bicyclist exposures to roadway traffic	2
	Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present	2
	Pedestrian exposure to vehicular traffic due to the buffer size from roadway to sidewalk	-1
	Reduced travel lane widths promote slower traffic speed	1
	Minimal risk of road traffic fatalities projected by ITHIM (= BAT Curbside Lane	2
	Minimal reduction in roadway width compared to no-build, similar time and exposure for pedestrians to cross the roadway	0

	Number of travel lanes for non-transit vehicles to meet road capacity (decrease congestion and increase traffic speeds)	-2
	Minimal risk of road crashes among transit users with availability of curbside service (not necessary to cross the roadway for transit-access)	2
		Composite Score: 0.75
BAT Curbside Lane	Wide bicycle lane reduces bicyclist exposures to roadway traffic	2
	Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present	2
	Pedestrian exposure to vehicular traffic due to the buffer size from roadway to sidewalk	-1
	Maximum reduction in vehicle speeds due to travel lane width	2
	Minimal risk of road traffic fatalities projected by ITHIM	2
	Moderate reduction in roadway width compared to no-build, less time and exposure for pedestrians to cross the roadway	1
	Reduced number of travel lanes for non-transit vehicles to meet road capacity (increase congestion and reduce traffic speeds) and dedicated bus lane provides an additional safety buffer for pedestrians and bicyclists	2
	Minimal risk of road crashes among transit users with availability of curbside service (not necessary to cross the roadway for transit-access)	2
		Composite Score: 1.50
Curbside Dedicated Lane BRT	Wide bicycle lane reduces bicyclist exposures to roadway traffic	2
	Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present	2
	Maximum pedestrian exposure to vehicular traffic due to the buffer size from roadway to sidewalk	-2
	Travel lane widths of 12' are associated with increased travel speeds and increased risk of injury	-2
	Moderate risk of road traffic fatalities projected by ITHIM	-1
	Maximum reduction in roadway width compared to no-build, less time and exposure for pedestrians to cross the roadway	2
	Reduced number of travel lanes for non-transit vehicles to meet road capacity (increase congestion and reduce traffic speeds) and dedicated bus lane provides an additional safety buffer for pedestrians and bicyclists	2
	Minimal risk of road crashes among transit users with availability of curbside service (not necessary to cross the roadway for transit-access)	2
		Composite Score: 0.63
Center Platform Dedicated BRT	Wide bicycle lane reduces bicyclist exposures to roadway traffic	2
	Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present	2
	Pedestrian exposure to vehicular traffic is somewhat increased due to the buffer size from roadway to sidewalk	1
	Travel lane widths of 12' are associated with increased travel speeds and increased risk of injury	-2
	Moderate risk of road traffic fatalities projected by ITHIM	-1
	Maximum reduction in roadway width compared to no-build, less time and exposure for pedestrians to cross the roadway	2

	Reduced number of travel lanes for non-transit vehicles to meet road capacity (increase congestion and reduce traffic speeds)	1
	Maximum risk of road crashes for BRT users crossing the roadway from the center platform to the sidewalk	-2
		Composite Score: 0.38
Center Platform Dedicated LRT	Wide bicycle lane reduces bicyclist exposures to roadway traffic	2
	Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present	2
	Pedestrian exposure to vehicular traffic is increased due to the buffer size from roadway to sidewalk (= Mixed Traffic alternative & BAT Curbside Lane)	-1
	Travel lane widths of 12' are associated with increased travel speeds and increased risk of injury	-2
	Significant risk of road traffic fatalities projected by ITHIM (= Elevated LRT)	-2
	Maximum reduction in roadway width compared to no-build, less time and exposure for pedestrians to cross the roadway	2
	Reduced number of travel lanes for non-transit vehicles to meet road capacity (increase congestion and reduce traffic speeds)	1
	Maximum risk of road crashes among LRT users crossing the roadway from the center platform to the sidewalk	-2
		Composite Score: 0
Elevated Grade Separated LRT	Wide bicycle lane reduces bicyclist exposures to roadway traffic	2
	Risk of injury is reduced for bicyclists regardless of the type of buffer, so long as a buffer is present	2
	Maximum pedestrian exposure to vehicular traffic due to the buffer size from roadway to sidewalk	-2
	Travel lane widths of 12' are associated with increased travel speeds and increased risk of injury	-2
	Significant risk of road traffic fatalities projected by ITHIM (= Center Platform LRT)	-2
	Greatest distance across travel lanes, increasing time and risk for pedestrians crossing the roadway	-2
	Number of travel lanes for non-transit vehicles to meet road capacity (decrease congestion and increase traffic speeds)	-2
	Maximum risk of road crashes among LRT users crossing the roadway from the elevated platform to the sidewalk	-2
		Composite Score: -1