Implementation of Socioeconomic Geospatial Analysis for Strategic Prioritization

NCDOT Project 2023-38
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Implementation of Socioeconomic Geospatial Analysis for Strategic Prioritization

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16. Abstract

This project is a technology transfer effort focused on implementation assistance for methodologies, data, and concepts developed in RP 2021-17: Enhancing the Strategic Prioritization Process with Socioeconomic Geospatial Analysis. In response to interest from the Prioritization Workgroup in assessing and potentially improving how the accessibility benefits of bicycle and pedestrian ("bike/ped") project to points of interest are measured in the North Carolina State Transportation Improvement Program (STIP), a project focused on examining the topic was commissioned. Over five sessions in 2023 and 2024, a research team met with several Prioritization Workgroup members called the Accessibility Strike Team and discussed the opportunities and challenges of the Points of Interest (POI) measure for assessing accessibility benefits of bike/ped projects as part of the State Transportation Improvement Program. This effort included a review of accessibility concepts and common POI-based accessibility measures used by peer agencies around the country. These efforts resulted in the identification of opportunities to adapt the way accessibility is measured in the STIP, associated methods that could be applied, and areas that could benefit from future research.

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Executive Summary

In response to interest from the Prioritization Workgroup in assessing and potentially improving how the accessibility benefits of bicycle and pedestrian ("bike/ped") project to points of interest are measured in the North Carolina State Transportation Improvement Program (STIP), a project focused on examining the topic was commissioned. Over five sessions in 2023 and 2024, a research team from the Institute of Transportation Research and Education (ITRE) met with several Prioritization Workgroup members called the Accessibility Strike Team and discussed the opportunities and challenges of the Points of Interest (POI) measure for assessing accessibility benefits of bike/ped projects as part of the State Transportation Improvement Program. This effort included a review of accessibility concepts and common POI-based accessibility measures used by peer agencies around the country. Following this review, Strike Team discussions centered on three primary opportunities for measure improvement, specifically:

- **POI Definitions and Documentation**
  Strike Team members expressed a desire to have greater clarity about the definitions used for POI categories and the data sources. The research team recommended consistent metadata collection and the preparation of straightforward documentation materials.
- **Category Weighting**
  Strike Team members expressed interest in using weights to differentiate relative levels of importance of POI categories in terms of access to the bike/ped network. However, Strike Team members expressed that the Workgroup as a whole would need to make these determinations.
- **Distance Weighting**
  Strike Team members expressed a desire to have POI measures better reflect true connections rather than simple proximity. The research team presented distance weighting of POI (based on their proximity to projects) as an interim solution in lieu of intensive methods of assessing network connections.

Following the results of this effort, including the insights gained from the Strike Team, next steps may include:

- Circulating POI description examples for Workgroup feedback
- Undertaking a focused discussion with the Workgroup about weighting POIs by category based on work already done by the Strike Team
- Gaining input and questions from the Workgroup about distance weighting options and conducting a focused follow-up discussion based on this feedback and work already done by the Strike Team
- Conducting additional case studies to support these activities as needed

Contents

Overview

This effort stems from historic and current interest from the Prioritization Workgroup in assessing and potentially improving how the accessibility benefits of bicycle and pedestrian ("bike/ped") projects to points-of-interest (POI) are measured as part of the North Carolina State Transportation Improvement Program (STIP), including:

- The appropriateness and balance of current measures, including geographic advantages/disadvantages. The "Relative POI" approach explored through research attempted to address some of these concerns but ultimately was not the right fit.
- The types of destinations considered in the metric and how they compare: i.e., what matters as a "point of interest. New POI categories have been developed (major grocery retailers, pharmacies, and convenience stores), but with a growing list, questions of the relative importance of various destination types have been raised.

Strike Team Discussions

To help capture what the Workgroup wants to accomplish with the bike/ped measures of accessibility and to identify what opportunities could help further these goals, an "Accessibility Strike Team" comprised of a group of Prioritization Workgroup members was formed. Over five sessions in 2023 and 2024, a research team from the Institute of Transportation Research and Education (ITRE) at North Carolina State University facilitated discussions with Strike Team members focused on accessibility concepts. These sessions included a review of existing points-of-interest methods for measuring accessibility benefits of projects in the current prioritization process and a discussion of options for how to refine these methods in future prioritization cycles. The specific objectives of the Strike Team meetings were to:

- Review priorities and objectives with regards to measuring access for bike/ped projects
- Survey the state of practice for measuring access
- Ensure access measure methods are aligned with priorities and objectives
- Identify opportunities for method improvement

This summary report was compiled to document the discussion and opportunities that emerged from these meetings. The following report includes a summary of the current practices for bike/ped project accessibility benefits measurement, a national state-of-the-practice review, and an overview of the opportunities identified in the Strike Team meetings.

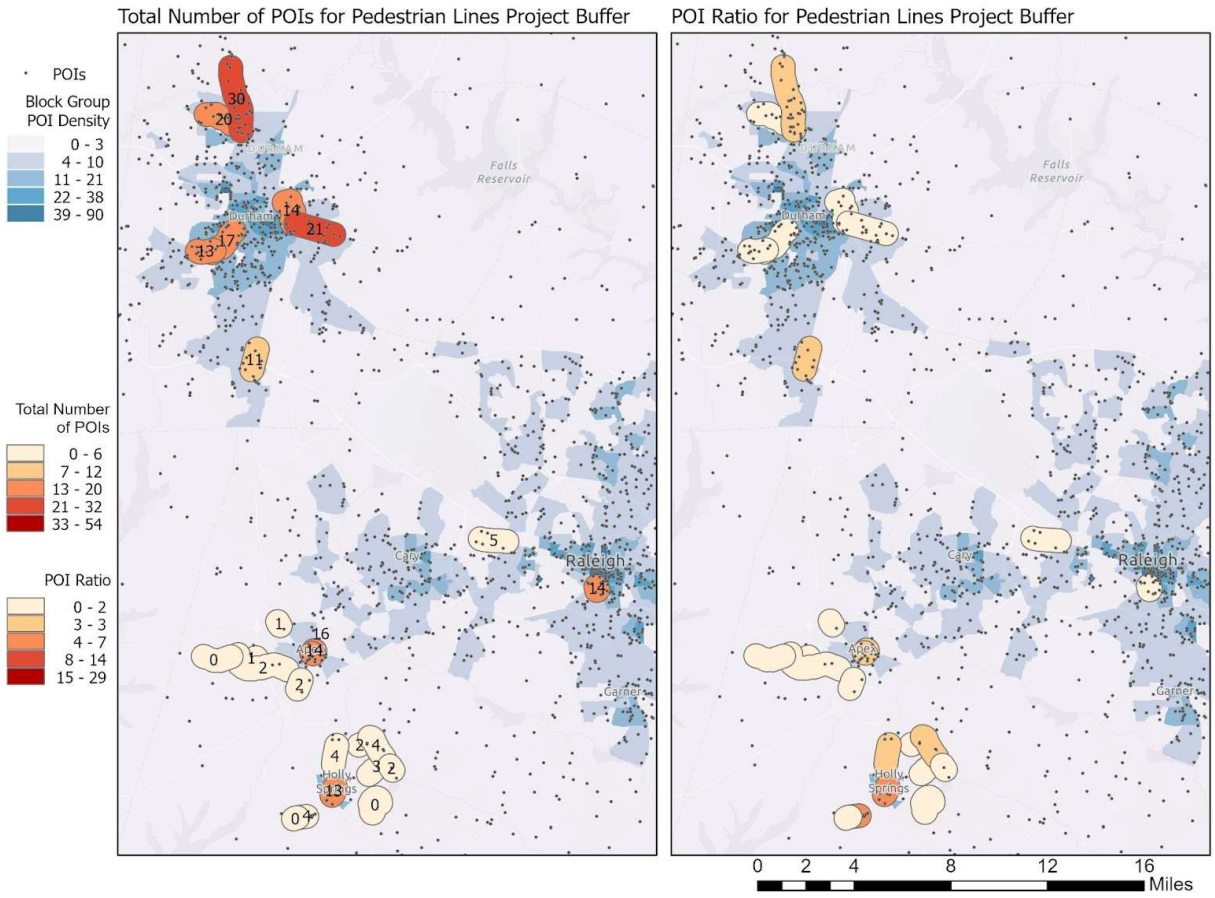
Prior Research Efforts

This project builds on previous research efforts to address POI analysis methods, issues, and related recommendations. This prior work, "RP2021-17, "Enhancing the Strategic Prioritization Process with Socioeconomic Geospatial Analysis," provides additional details on POI analysis considerations that have already been explored and context for the current project. The study report can be reviewed in full on the NCDOT website here.

This prior study identified biases in then-existing (P6) methodologies with a focus on bias towards urban projects in particular. The ITRE research team found that then-current methodology for measuring accessibility for bike/ped projects had the potential to "mask the value of more rural and/or smaller projects that could provide equity-related benefit." An alternative approach proposed by the research project attempted to address these biases by applying a "context-sensitive" methodology that accounted for a project's setting. This context-sensitive alternative was meant

to measure the effectiveness of projects in providing access to POI while considering the amount of POI available in the project's surroundings. An example of the difference in measure produced by this method is provided in Figure 1.

Figure 1. "Context Sensitive" POI Methodology Proposed by RP2021-17



Though the context-sensitive alternative appealed as a way to address the aforementioned biases, this method was found to over-correct for these biases and ultimately was not selected for implementation. While this effort and report include recognition of the biases addressed and methodology proposed in RP2021-17, this effort addresses accessibility measurement more broadly than RP2021-17. In addition to POI measurement methodologies, the scope of this effort includes a review of accessibility measurement priorities and objectives, common accessibility measurement definitions, practices of peer agencies, data sources, and destination categories.

Measuring Access in P7

In current prioritization process, project access to POI is part of a bundle of data points used to measure the Accessibility and Connectivity criterion for bike/ped projects. Figure 2 shows the data points that make up the Accessibility/Connectivity Criterion.

Figure 2. Calculation of Accessibility/Connectivity Criteria

Criteria	*Accessibility/Connectivity*
Measure	POI # total (no cap) + *Connection # total (no cap)* + *Route total*

The count of POI within the project buffer serves to measure the "Accessibility" component of the Accessibility and Connectivity Criterion. The stated purpose of this measure is to quantify the extent to which projects "provide access to nearby points of interest." This is conducted by counting POI within a distance of projects (1.5 miles for bike projects, 0.5 miles for pedestrian projects).

Figure 3 shows the count of POI by category in P6. It should be noted that while the majority of all POI are maintained as "points" with specific latitude and longitude coordinates, some POI are maintained as polygons that cover an area and others are maintained as linear features. For P7, three additional categories of POI have been identified. All of the P7 Additional POI are maintained as point features with specific latitude and longitude coordinates.

Figure 3. POI Categories and Feature Counts

	Category	**Count**
Points of Interest in P6	Government Building	652
	School/Adult Education Center*	3,448
	Medical Center	5,234
	Place of Worship	17,938
	Tourist Destination	4,048
	Transit Route	36
	University/College	96
	Park	5,172
	Employment Centers	*Applicant*
	Shelters	*Applicant*
		36,624
P7 Additional POI	Major Grocery Retailer	1,472
	Pharmacy	1,966
	Convenience Store	6,951
		10,389

For most categories, POI are "automatically" measured within SPOT On!ine. Two POI categories, Employment Centers and Shelters, are based on applicant-sourced data. Additional Tourist Destination data can also be manually submitted, though points also exist for that category for automatic calculation.

Acessibility Measures: National State of the Practice

A state of the practice review was conducted to help the research team and Strike Team understand how current and proposed methods with regards to measuring project accessibility benefits compare to common accessibility concepts and measurement techniques. The state of the practice review includes a survey of practices at several peer agencies at multiple levels of government across the United States. While numerous agencies were reviewed, this section details the results of a sample of agencies that represent the spectrum of how accessibility is measured.

This state of the practice review begins with a short overview of common definitions for accessibility. Priorities of peer agencies in their attempts to assess accessibility benefits in their prioritization processes were then summarized and the specific practices of these agencies were compared to show the range of methods used. This comparison focused on the types of destinations, equity considerations, analysis methods, and project impacts included in these methods.

Defining Accessibility

"Accessibility" can be broadly defined as the "ease with which people may reach destinations" (Sundquist et al., 2021). As a counter summary measure of transportation system performance to "mobility", "accessibility" is focused on how systems help users reach destinations rather than simply the ease at which they can move through the network. Accessibility definitions may differ subtly on the theme of reaching destinations. Other definitions include:

- "the ability to command the transportation facilities that are necessary to reach desired locations at suitable times" (Geertman & Van Eck, 1995)
- "the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)" (Geurs & Van Wee, 2004)
- "the ease of access to destinations of interest" (L.A. Merlin et al., 2017)
- "the level of access that communities have to transportation options and to needed services via transportation" (USDOT, 2023)

Accessibility is often conceptualized as having four interrelated components (Marwal & Silva, 2022):

1. Transportation: Locations and characteristics of transportation infrastructure
2. Land Use: Locations of and characteristics of destinations
3. Individual: Individual factors, including socioeconomic and health determinants, vehicle access, and safety perceptions, among others
4. Temporal: Opening hours of destinations, hours of transportation service provision, among others

For example, the accessibility benefit of a project like a bike path is dependent not only on the location of that path and the array of possible destinations it could serve, but also on factors related to the individuals (like age and disability) who are able to use it and less tangible factors like perceptions of safety and temporal factors like available daylight for travel. Framing "accessibility" as a combination of these factors helps to understand the strengths and limitations of individual measurement approaches for capturing benefits.

Comparison of Practices

The remainder of the state of practice review is focused on comparing the practices of other transportation agencies and is organized by the following themes:

- **Setting Priorities:** How agencies define how project accessibility benefits should be rewarded.
- **Types of Destinations**: The type, quantities, and weights for destinations considered
- **Equity Considerations**: The extent to which equity considerations are prioritized
- **Analysis Methods**: The techniques used to estimate accessibility and their degree of complexity
- **Project Impacts**: The extent to which change in accessibility attributable to the project is considered

Setting Priorities

Accessibility is framed differently across various transit agencies in the U.S. Specificity in prioritization varies, with some agencies utilizing broader criterion such as reduction in travel time while other agencies stipulate the prioritization of projects that improve access to specific points of interest and stratify by mode. Figure 4 shows a selection of accessibility-related priorities across several state, regional, and municipal agencies.

Figure 4. Comparison of accessibility prioritization by agency

Agency	Accessibility Priorities
Virginia DOT	Prioritize projects that improve access to jobs, education, and services, and affordable housing; by driving, transit, ferries, biking and/or walking.
Washington State DOT (Preliminary)	Prioritize projects that provide “worker and overall household access to jobs and other opportunities, as well as multiple and connected modal choices."
Utah DOT	"Reward projects located in closer proximity to educational facilities and recreational visitor destinations."
Vermont DOT	Prioritize projects that provide “better access to jobs" and "increase access to destinations that improve health.”
Atlanta Regional Commission	Together with Mobility as "Mobility & Access" Criterion: "Transportation infrastructure should be able to provide access to a variety of destinations and job opportunities for all types of trips and lifestyles."
Boston Region MPO	(from Long Range Plan): Improve multimodal access to jobs, affordable housing, essential services, education, logistics sites, open space, and other key destinations.
Broward MPO	Prioritize projects that reduce travel times or increase transit frequency to specific "activity centers."

Types of Destinations

Values and objectives inform the selection of destinations included in accessibility analyses. Overall, the state of the practice showed that:

- Nearly all agencies examined include analysis of access to jobs or workplaces.
- Some methods specifically identify “essential services”, while others consider destinations more broadly.
- Many agencies include network connectivity measures within accessibility analyses (including connections to transit).

Figure 5 summarizes the details of the analysis results.

Figure 5. Comparison of POIs utilized in prioritization by agency

Agency	Types of Destinations Included in POI
Virginia DOT	For analysis of Accessibility: Jobs, Multimodal Choices
	For analysis of Transportation Efficient Land Use: Jobs, banks, education, entertainment, food and drink, grocery, healthcare, public services, recreation, shopping.
Washington State DOT (Preliminary)	TBD: jobs, education, services, and affordable housing
Utah DOT	As part of Accessibility Measure: Educational facilities (K-12 and Higher), Tourism Areas (including state and national parks)
	Separately analyzed within Workplace Location Measure: Total employment within 3 miles.
Vermont DOT	Economic Access: Jobs
	Health Access: Health care/physical access facilities, (senior centers, parks, community gyms),
	Healthy food destinations (grocery store, food shelf, school lunch programs)
Atlanta Regional Commission	For Bike/Ped: Employs Heat Map tool that considers intersection density, employment and housing mix, transit propensity and access to a variety of destinations (not specified)
	For Roadways: Activity Centers, Freight Clusters
Boston Region MPO	Proximity to employment, residential, and civic activity hubs; proximity to transit service; proximity to sidewalks and protected/off road bike infrastructure.
	Separately analyzed within Clean Air/ Healthy Communities Criteria: Access to parks and open space
Broward MPO	Proximity to activity centers: MPO identified mobility hubs, Port Everglades, Fort Lauderdale Int'l Airport, Community redevelopment areas, and Broward Next activity centers.

Equity Considerations

Equity considerations of accessibility measures pertain to the characteristics of individuals that affect their ability to benefit from transportation services when provisioned. Some approaches account for socioeconomic/demographic factors that can make projects more (or less) beneficial, or to address specific needs. These objectives may also be addressed by many agencies outside of specific "accessibility" measures. Figure 6 details these findings by agency.

Figure 6. Comparison of equity and accessibility considerations by agency

Agency	Equity Considerations
Virginia DOT	Change in access to jobs for Disadvantaged Populations (low-income, minority, or limited-English proficiency (LEP) population) is conducted alongside general analysis.
Washington State DOT (Preliminary)	Proposed to include, in an additional layer of analysis, benefits and burdens related to access to specific locations (including affordable housing and grocery stores) and for specific groups (people with disabilities and overburdened areas) among other methods.
Utah DOT	Low Income Household Accessibility is assessed as part of "Connected Communities" measure but sits outside of "accessibility" measures.
Vermont DOT	None specifically tied to accessibility analysis.
Atlanta Regional Commission	None specifically tied to accessibility analysis.
Boston Region MPO	Includes analysis of accessibility between affordable housing and jobs.
Broward MPO	None specifically tied to accessibility analysis.

Analysis Methods

In terms of methods used to for accessibility measures, the state of the practice showed that:

- Some analysis methods employed by peer agencies only account for simple proximity between network features and destinations.
- Others use estimated travel times on the current and proposed network.
- Techniques vary in the extent to which they define linkages between infrastructure and destinations. Some require connectivity rather than simple proximity.
- The extent to which new projects support multimodal trips is often assessed through network connections (to transit or multimodal facilities, for example).
- Some agencies use scores based on total destinations; others set caps.

Figure 7 summarizes examples of analysis methods agencies commonly apply.

Figure 7. Comparison of analysis methods by agency

Agency	Analysis Methods
Virginia DOT	Estimates travel times on transportation network (45 minute travel time for vehicle, 60 minutes for transit) and uses average change in access to employment opportunities as scoring measure.
Washington State DOT (Preliminary)	TBD: Proposes use of CubeAccess tool which models travel time on network
	Equity analytical layer looks for direct connections or decreased travel times to specific destinations
Utah DOT	Education and Tourism: Projects are scored based on Total Count of destinations within 1 mile
	Jobs: Projects are scored based on percentage of all workers both living and working in the project area.
Vermont DOT	Jobs: Assesses job count within multiple buffers (0.5, 1, and 2 miles)
	Other Destinations: Not specified
Atlanta Regional Commission	Heat Map approach with limited documentation
	Transit connections: Focus is on direct connections to transit.
Boston Region MPO	Uses a variety of proximity criteria (destinations within a distance of projects). Uses a simple point system whereby projects can earn a finite set of points (typically 1-3 points) for providing access to a variety of destinations.
Broward MPO	Uses travel time but does appears to use qualitative rather than quantitative methods.

STIP Accessibility Measure Assessment

Accessibility Measure: Proposed Goals

Following a discussion about the national state of the practice related to measuring accessibility, the Accessibility Strike Team discussed what a STIP accessibility measure for bike/ped projects should accomplish based on their experience and understanding the STIP. This subgroup of the Workgroup noted that the accessibility measure will ideally accomplish and consider the following:

- Focus on improvement not just proximity
- Equity
- Local/regional context
- Variance of POI level of importance
- Differentiate between and address proximity vs. direct access
- Factor in current state of access to transportation options
- Clearly define what is/not included in POI categories

Because the Strike Team acknowledged that accomplishing all of these aims in the current measure may not be feasible, they discussed the opportunities and challenges associated with making potential adjustments to the measure.

Accessibility Measure: Opportunities and Challenges

In an initial exercise with the Strike Team, the research team catalogued the group's thoughts on the opportunities and limitations of the current methodology following review of the state of practice of peer agencies. These comments, grouped into considerations of Available Data, Method Complexity, Submitter Burden, Repeatability, and Sustainability, helped shape the efforts of the research team to deliver options for method refinement. The results of this discussion are presented in Figure 8.

Figure 8. Opportunities and Challenges Identified by Strike Team Participants

Consideration	Opportunities	Challenges	Notes
Available Data	• Including lower-income jobs sounds valuable • Look at additional data sources that could be better • Better granular data	• Data needs to be available statewide • Is data available for defining locations of affordable housing? What would method be? • Data needs to be complete	• Don't just focus on census data but also on where people are working
Method Complexity	• Weighting by category • Multiple buffer • Make categories more intentional	• From scoring perspective, can be subjective, hard to QC	• Has to be explainable (and defined, documented)
Submitter Burden	• Define POIs • Consistent data source • Automation • Significant opportunity to improve this overall	• Time • GIS experience needed • Don't all use the same data • How are some of these defined • Can require referencing multiple data sources (DataAxle, Google)	• In the past we capped POIs -- there is an amazing range between how many you can have; capping isn't necessarily ideal either
Repeatability		• Not everyone is doing POIs the same way	
Sustainability		• Can, may have expanded POIs too much, esp if we are doing them all the same way • Updating POIs can be challenging	• This category added by Strike Team

The Strike Team's comments reflect a desire to limit submitter burden and increase the consistency of the methodology. Increased clarity about data sources and POI category definitions was requested. The Strike Team also expressed an interest in exploring new POI categories and methods that could be readily incorporated within the existing framework. These include exploring data available for locations of affordable housing and lower-income jobs, as well as method adjustments like using category weighting and distance weighting (for example, with multiple buffers).

The themes that emerged from these comments helped guide discussion of method refinement towards several major themes that are discussed further in other sections of this summary:

- **Defining and Refining POI Categories**
- **Category Weighting**
- **Distance Weighting**

Accessibility Measure: Defining and Refining POI Categories

POI Category Definition and Documentation

During discussions, Strike Team members indicated that in order to make the prioritization process as efficient and transparent as possible for users, the clear and precise definition of what is and is not included in POI categories is necessary.

The Strike Team's discussion highlighted the creation of documentation tailored for SPOT, while also recognizing the necessity for concise definitions suitable for presentations, such as the annual legislative report. A key point of deliberation was the level of specificity required, particularly in manual submissions, and the challenge of striking the right balance between providing enough information for clarity and avoiding overwhelming submitters with unnecessary details. The emphasis was on delivering clear guidance to submitters regarding the checking and addition of missing POIs. Additionally, there was exploration into defining the threshold between an excessive amount of information and the optimal amount needed for effective Quality Assurance/Quality Control (QA/QC) processes.

A particular concern is the need for a consistent definition for employment centers (addressed in greater detail in subsequent sections), shelters, and tourist destinations, as these point types are sourced by submitters rather than through automation. However, definitional refinement could benefit all categories by providing greater clarity on category contents.

To address these concerns, the research team introduced the idea of creating consistent metadata for all POI categories, which the Strike Team indicated would be helpful. The group discussed the benefits of developing metadata standards that would include capturing data source information, the date of availability, the update frequency, and the required processing steps, among other metadata items. An example of this metadata that was created for newly-added categories in P7 is provided in Figure 9.

Figure 9. Documentation of Metadata for Newly Identified POI

Data Set Name:

Major Full-Service Grocery Retailers

Description:

This is a filtered-version of the USDA SNAP Retailer Locator Data that identifies major full-service grocery retailers only. Full-service grocery retailers are those retailers retailing perishable staple foods as a core component of their retail services. These retailers are identified using a defined list of known retailer names.

Data Type	Point Locations
Format	Shapefile (Point)
POI Category Domain ID	9
Fields	**Field** / **Type** *OBJECTID* / *Object ID* *Shape* / *Geometry* *NAME* / *Text* *CATEGORY* / *Text* *ShapeType* / *Text*
Feature Service	Link
Notes	• 1,472 locations and 28 unique store brands identified • Designed for integration with SPOT Onl!ne POI Analysis

Original Data Source Information:

Data Source	U.S. Department of Agriculture (USDA) SNAP Retailer Locator Data
Links	Data Description: Link Data Download: Link
Description	The USDA maintains a database of retailers authorized to accept payments using the Supplemental Nutrition Assistance Program (SNAP) for food products. SNAP retailers are required to meet at least one of two criteria for the retailing of staple foods. SNAP retailers include full-service grocery stores and a variety of limited-service staple food retailers including dollar stores, convenience stores, and pharmacies. This data has been prepared to include only full-service grocery retailers using a pre-defined list of store names. Historical SNAP Retailer data is also available via the USDA for years 1990 and later.
Total Features	9,103
Latest Update	12/31/2022
Update Frequency	Continuous
Original Format	Tabular (CSV) or Shapefile (Point)
Original Fields	**Field** / **Type** *Store_Name* / *Text* *Address* / *Text* *Address Li* / *Text* *City* / *Text* *State* / *Text* *Zip5* / *Text* *Zip4* / *Text* *County* / *Text* *Longitude* / *Numeric* *Latitude* / *Numeric*

POI Category Refinement

EMPLOYMENT CENTERS

Special focus was given in Strike Team discussions to opportunities that could include how consistently POIs in the employment center category are applied. The POIs in this category are not automated and therefore must be generated and tabulated by submitters. Strike Team members voiced a range of concerns that have implications for both data quality and submitter burden, including:

- Submitters are not required to use the same data, and data sources vary in their completeness and quality.
- Obtaining complete business data can require referencing multiple data sources (DataAxle, Google, etc.).
- Small business may be left out of the analysis by requiring submitters to identify only those businesses with a minimum number of jobs.
- Some business location data does not reflect the location of where work is actually performed.
- GIS experience is needed or highly beneficial for submitters, adding to submitter burden.

To address these concerns, the research team demonstrated the use of a jobs-based dataset available from the U.S. Census Bureau via the LEHD Origin-Destination Employment Statistics (LODES) program. This dataset has some notable advantages of being a well-supported federal data source that captures the actual location of work performed. LODES jobs data is also available for a variety of worker income tiers.

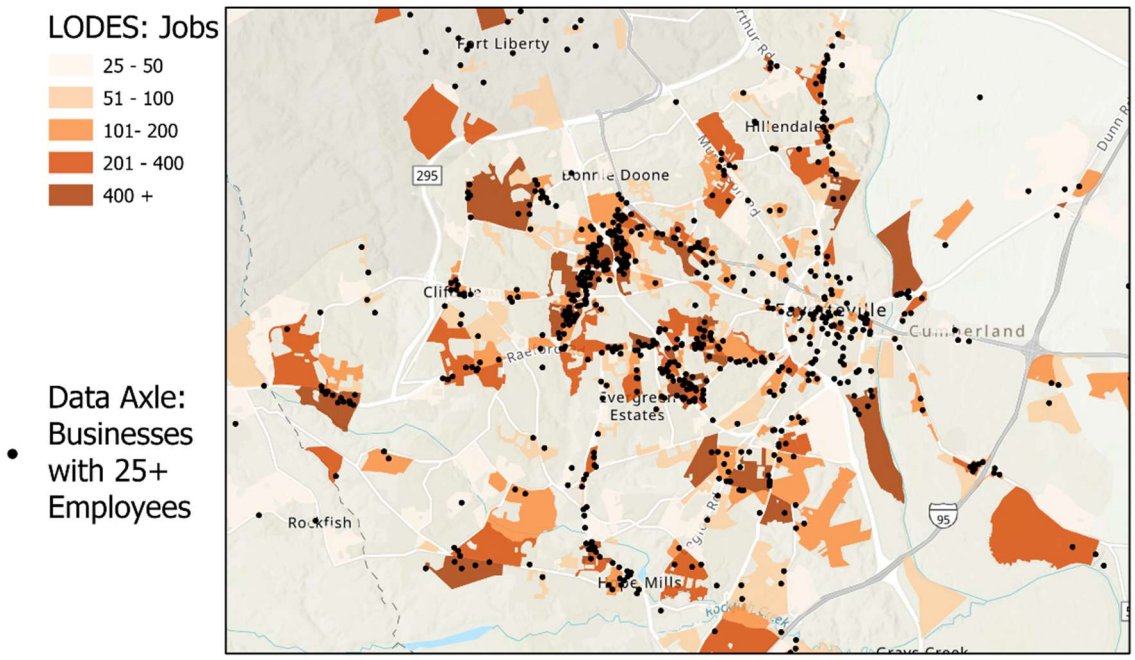
Limitations of this data source were also noted. The data is available only in polygon format (rather than point format). Additionally, this data is already in use in the Demand/Density Criteria of bike/ped project scoring, which could result in a data redundancy if used in POI analysis. A full comparison of the LODES data to the existing multiple-source employment center method is provided in Figure 10.

Figure 10. Strengths and Limitations of Existing Employment Center Data Methods vs. LODES Workplace Data

Source	Strengths	Limitations
Employment Center POI Data	• Specific point locations • Applicant flexibility • Ability to incorporate more recent data	• Applicant Burden • No consistent data source • No consistent definition • Data may not reflect location where work is performed • Smallest businesses may not be reflected in data
LODES Workplace Data	• Reflects locations where work is performed • Reflects magnitude (count of jobs) rather than just locations • Available for 3 earnings classes, multiple sectors, and multiple firm sizes • Statewide consistency • Well-aligned with practices of peer agencies	• Data is not "point" format (a process may be developed to be able to accommodate this data within existing POI method or standalone method) • Latest data is always for 2 years prior • **Duplicative of Demand/Density criteria**

A spatial comparison of LODES data (mapped at the Census block level) to business locations from Data Axle is provided in Figure 11.

Figure 11. LODES Workplace Data and Data Axle Business Locations



Given the limitations and possible redundancies that could be introduced by using LODES data in places of user-submitted employment center locations, the Strike Team preferred the status quo methods to the LODES data option.

The issue of redundancy with Demand/Density Criteria framed another Strike Team discussion about the overall merits of continuing to include employment centers as a POI category. Overall, the Strike Team's discussion reflected a high level of support for continuing to include the employment center category for several reasons:

- Employment centers are a distinct phenomenon from job counts and constitute actual "destinations" rather than summary statistics
- Linking bike/ped transportation to employment centers is a fundamental function of bike/ped networks
- As points, these locations may provide a useful function in capturing town and city centers where businesses may be smaller but more numerous; job counts alone will not necessarily capture this number of business enterprises

Given the desire for employment centers to remain a POI category and the interest expressed in acquiring data and developing a method that could make the category more consistent and automated, these objectives should remain a target for future research efforts.

SHELTERS

Like employment centers, shelters are category of POI that are calculated by submitters using submitter data sources. Strike Team participants expressed desire to obtain a reliable central source for this data as well. The group also sought clarity on the specific types of shelters that should be included in this data, as this information is not readily apparent from existing documentation.

Strike Team discussions revealed that the preferred use of this category (and likely its original intent) was to capture the location of homeless shelters rather than emergency shelters. Homeless shelters are likely to serve a population with low access to personal vehicles that would highly benefit from bike/ped infrastructure improvements. Emergency shelters serve as more intermittent places of refuge during extreme weather events. Linkages between these locations and destinations serving everyday needs were therefore viewed by the Strike Team as less critical.

The research team sought data source for homeless shelters with coverage for whole state of North Carolina. A data source that was reputable, available statewide, and updated at least every five years was sought but no source was identified that met these criteria.

Some homeless shelter listings maintained by local advocacy groups and non-governmental agencies were identified. However, these listings would need to be compiled and quality assured in order to assemble complete data for the state. The U.S. Department of Housing and Urban Development (HUD) hosts an online "Find Shelter" tool; however, the data was not linked to an internal HUD database in a way that could be extracted. The research team reached out to national and local HUD units but could not reach contacts who could provide access to the dataset. Because of the challenges with acquiring shelter data that could be sustainably extracted and automated for the STIP, the Strike Team recommended that automating shelter data should be held for future work.

AFFORDABLE HOUSING

Strike Team participants expressed interest in identifying locations of affordable housing for use in POI analysis. As shown in the state of practice review, many agencies consider the locations of affordable housing in their accessibility analyses. Like homeless shelters, these locations are not well catalogued at the state level — especially as point-based features. Regional differences in cost-of-living add further challenges to developing a reliable catalogue. The Strike Team therefore decided to preserve any data acquisition effort related to affordable housing for future work.

Accessibility Measure: Category Weighting

The Strike Team identified "weighting by category" as an opportunity to explore during the opportunities and limitations exercise related to POI accessibility. Category weighting is a technique currently in use by some peer agencies, including in Virginia DOT's "SmartScale" program, to assign higher values to certain types of POIs. By incorporating category weights, accessibility measures reflect values about the importance of connecting bike/ped infrastructure to certain types of destinations and services.

Importance of POI Categories

In an initial exercise, Strike Team participants reviewed POI types from P6 and P7, as well as POI types commonly utilized in other states, and gave input about the relative importance of bike/ped access to each. The levels of the importance the Strike Team designated for each POI type was either "Essential", "Important", or "Nice to Have." POI types such as education centers, medical centers, transit routes, employment centers, grocers and pharmacies were ranked by the majority of participants as essential.

The research team used the Strike Team's input captured in Figure 12 to demonstrate how category weighting could be implemented in future rounds of prioritization. Because most POI types were earmarked by the Strike Team as being either "Essential" or "Important", the feedback for the three-category exercise was condensed into two categories with the Strike Team's support. This two-category summary, shown in Figure 12, maintained the results categorized as "Essential" while adding the few POI types noted as "Nice to Have" to the group designated as "Important." This two-tiered approach aligns with the methods many of the agencies reviewed through the state of the practice utilize as well.

Figure 12. Demonstration of Two-Tier Categorization from Strike Team Participant Feedback

	Strike Team Identified as Essential	**Strike Team Identified as Important**
PIO Category	School/Adult Education Center	Government Building
	Medical Center	Tourist Destination
	Transit Route	University/College
	Park	Convenience Store
	Employment Centers	Affordable Housing
	Major Grocery Store	Multimodal Choices
	Pharmacy	
	Employment Centers	
	Shelters	

Figure 13 presents the full results of the exercise, including the total number of participants that described bike/ped access to each category as "Essential", "Important", and "Nice to Have."

Figure 13. Count of Participants providing Input on Importance of POI Categories

POI Type	Source of POI	Access is Essential	Access is Important	Access is Nice to Have
Government Building	*P6 or before*	1	2	1
School/Adult Education Center	*P6 or before*	6	0	0
Medical Center	*P6 or before*	5	0	0
Tourist Destination	*P6 or before*	0	5	1
Transit Route	*P6 or before*	6	0	0
University/College	*P6 or before*	1	4	0
Park	*P6 or before*	2	1	1
Employment Centers	*P6 or before*	3	3	0
Shelters	*P6 or before*	2	2	1
Major Grocery Retailer	*New in P7*	4	2	0
Pharmacy	*New in P7*	4	2	0
Convenience Store	*New in P7*	1	3	0
Affordable Housing	*Commonly Used by other States*	2	3	0
Multimodal Choices	*Commonly Used by other States*	2	3	0
Added: Outdoor Recreation	*Added by Strike Team*	N/A	N/A	N/A

Places of Worship

Places of worship, which were not part of the original exercise were deemed as "Important" POI after discussion with the Strike Team. There are around 18,000 place of worship POIs listed in the current STIP data source. The Strike Team noted that places of worship can be utilized as more than one POI, which could create duplication in analysis. For example, a place of worship may also be utilized as a school or a shelter. Additionally, it was mentioned that some places of worship that are not currently in use may be counted, and ideally there would be a way to identify active vs. non-active POIs in this category more regularly. The group also discussed the importance of places of worship in relation to other POIs and discussed how they should be weighted because of the high number of POIs in this category. Ultimately, the Strike Team deems places of worship as "Important." They noted the resources these POIs can offer to communities, especially those that be underserved and/or geographically isolated, but were concerned that designating this POI type as "Essential" could skew the data given the number of points in this category compared to others.

Accessibility Measure: Distance Weighting

Proximity vs. Connectedness

Throughout the Strike Team meetings, participants emphasized the value focusing not just on the proximity of bike/ped projects to a POI, but on the actual connections and the quality of those connections as well. For example, while a bike/ped project may be geographically proximate to a park or transit route, it may not be properly connected or have direct access to these destinations. Network gaps or barriers like highways and rivers may prevent bike/ped projects from actually providing connection to proximate POIs.

Some peer agencies, such as Virginia DOT, use network modeling and build/no-build scenario testing to determine how proposed projects result in travel time savings for bike and ped projects. As an overview, this methodology:

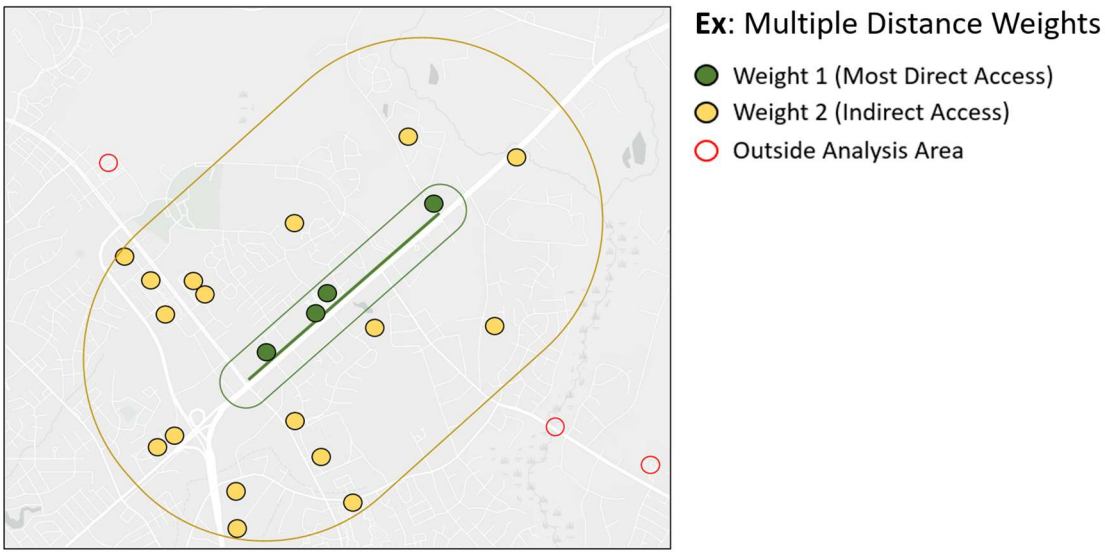
- Is designed to be more precise than basic proximity analyses because it considers the destinations that are reachable by network features.
- Accounts for the impacts of projects by assessing the differences between accessibility measures in build and no-build scenarios.
- Reasonably approximates destinations reachable from new infrastructure.
- Is computationally intensive and relies heavily on high quality bicycle and pedestrian network data that is not currently complete for all locations in North Carolina.

Because of the benefits of this approach, the research team proposed two methods common in the practices of peer agencies and in academic accessibility analyses that could add nuance to the basic proximity analysis method currently employed in the prioritization process. These methods reflect the idea that the more proximate a destination is to new bike/ped infrastructure, the greater the magnitude of project impact for reaching that destination. These methods are Multiple Distance Weights and Continuous Distance Weights.

Multiple Distance Weights

In this approach, used by the Vermont Department of Transportation and NCDOT Ferry Division for scoring, POIs are totaled within multiple distance buffers of proposed projects and decreasing weights are applied to each. An example is shown in Figure 14.

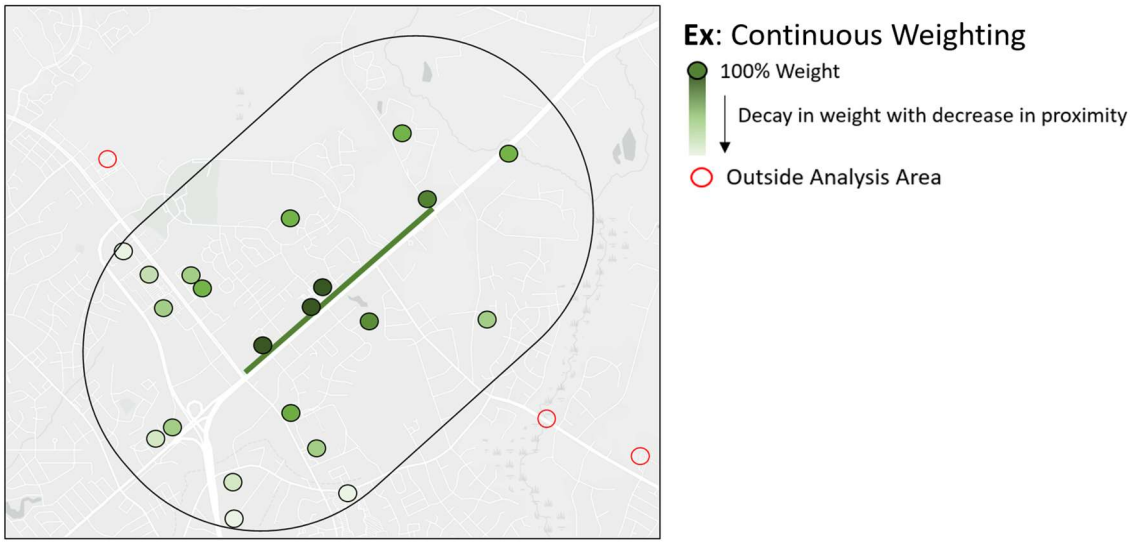
Figure 14. Multiple Distance Weighting



Continuous Distance Weights

In this approach, POI within the analysis area are continuously weighted based on the inverse of their proximity to the project. That is, those POI most proximate to the project receive closest to 100% weight, and weights descend to zero as POI become less proximate. An example is shown in Figure 15.

Figure 15. Continuous Distance Weighting



Strike Team participants expressed an interest in seeing a distance weighting technique employed with sample data. The following section demonstrates the combination of category weighting and distance weighting techniques and its impact in theoretical measurement scenarios.

Case Studies

The research team used P5 project data and a portion of P7 POI data (points only) to illustrate how employing category and distance weighting techniques would alter results for a variety of project types in a variety of settings. The following Case Studies provide a brief description of the project, map the project, the buffers employed for the project, and the category-weighted POI in the vicinity. All projects report statistics for a variety of methods to calculate the final POI-based measure. These methods are summarized in Figure 16.

Figure 16. Descriptions of POI Measurement Methods used in Case Studies

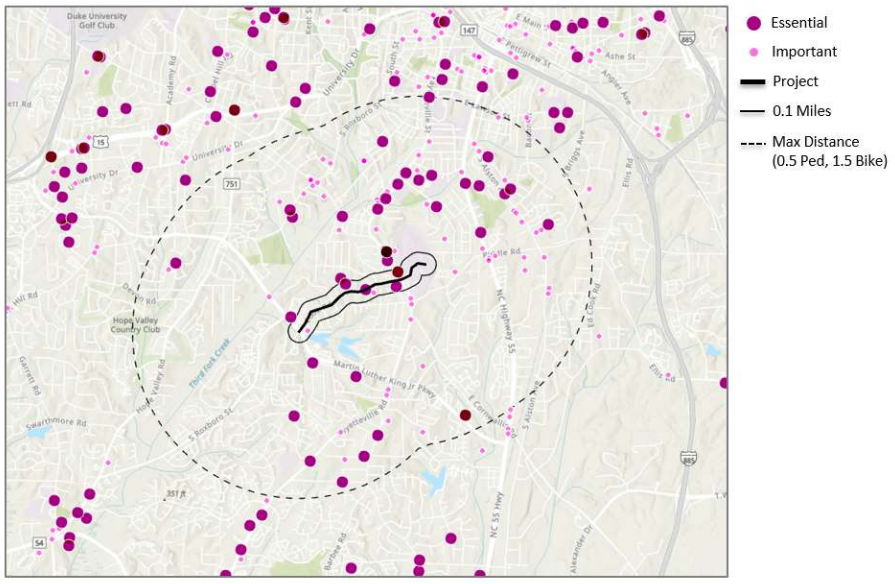
Method	Description
Count	The count of all POI within the maximum distance. This is the current methodology.
Count + Weighted Categories	The count of all POI within the maximum distance after weighting is applied to POI. "Essential" POI are weighted 1; "Important" POI are weighted 0.5
Multiple DW (1/0.5) + Weighted Categories	POI are weighted by category; POI within the inner buffer (0.1) miles receive a distance weight of 1; POI between the inner and maximum distance receive a distance weight of 0.5
Multiple DW (1/0.25) + Weighted Categories	POI are weighted by category; POI within the inner buffer (0.1) miles receive a distance weight of 1; POI between the inner buffer and maximum distance receive a distance weight of 0.25
Continuous DW + Weighted Categories	POI are weighted by category; POI receive a distance weight based on their distance from the project. POI intersecting the project receive a distance weight of 1. Distance weights descent to zero at the maximum distance.

Bike Projects

Case 1

P5 SPOTID: B150405
Mode: Bike
County: Durham
Land Use: Large City (Durham)
Description: Construct buffered bike lanes and sidewalks on both sides of the road. Provide a safe facility for bicyclists and pedestrians and improved access to regional off-road bike/ped facilities.

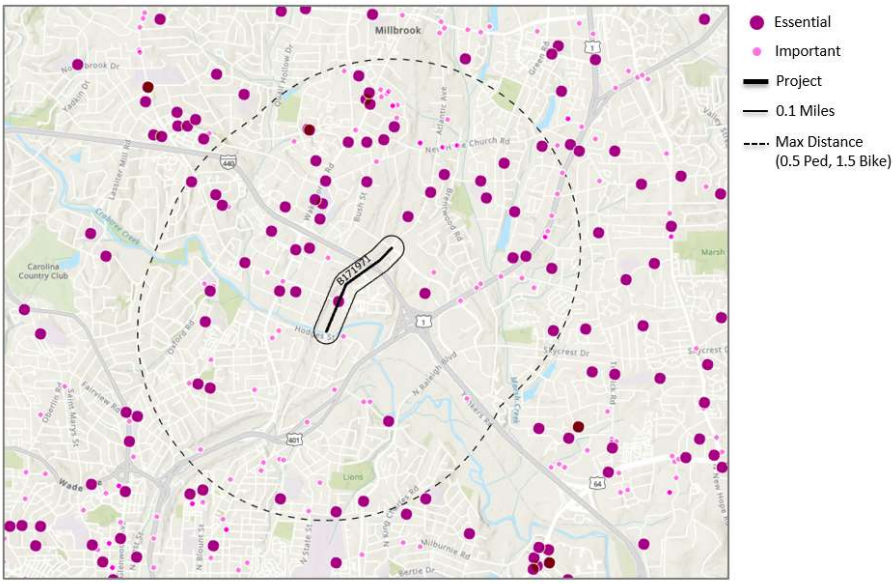
Method	Result
Count	100
Count + Weighted Categories	70
Multiple DW (1/0.5) + Weighted Cat.	38
Multiple DW (1/.25) + Weighted Cat.	22
Continuous DW + Weighted Cat.	34



Case 2

P5 SPOTID: B171971
Mode: Bike
County: Wake
Land Use: Large City (Raleigh)
Description: Construct a shared-use path on the west side of Atlantic Ave. Improve safety and connectivity of bike/ped network.

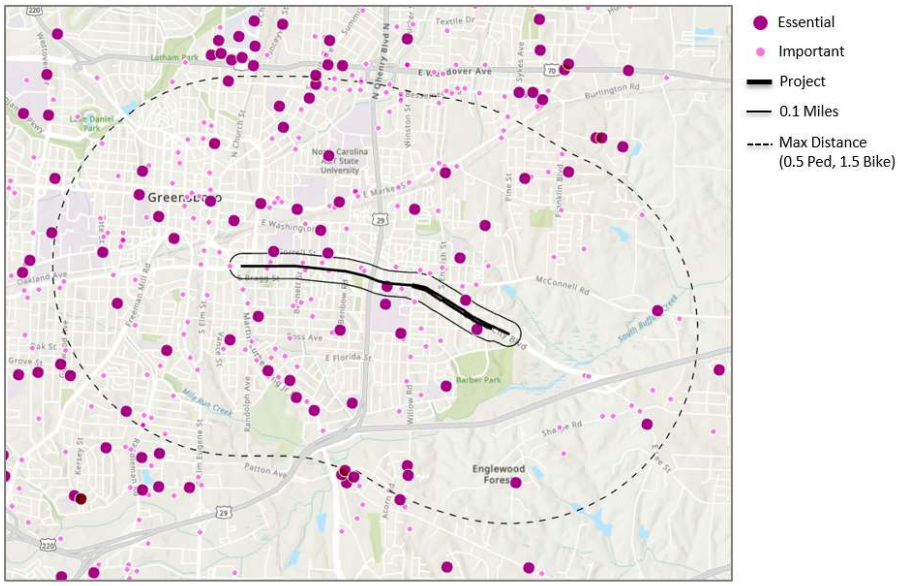
Method	Result
Count	111
Count + Weighted Categories	80
Multiple DW (1/0.5) + Weighted Cat.	41
Multiple DW (1/.25) + Weighted Cat.	21
Continuous DW + Weighted Cat.	30



Case 3

P5 SPOTID: B172277
Mode: Bike
County: Guilford
Land Use: Large City (Greensboro)
Description: Bike lanes, curb, gutter, and sidewalk improvements. Provides bicycle safety, connectivity and access; connects to Downtown Greenway

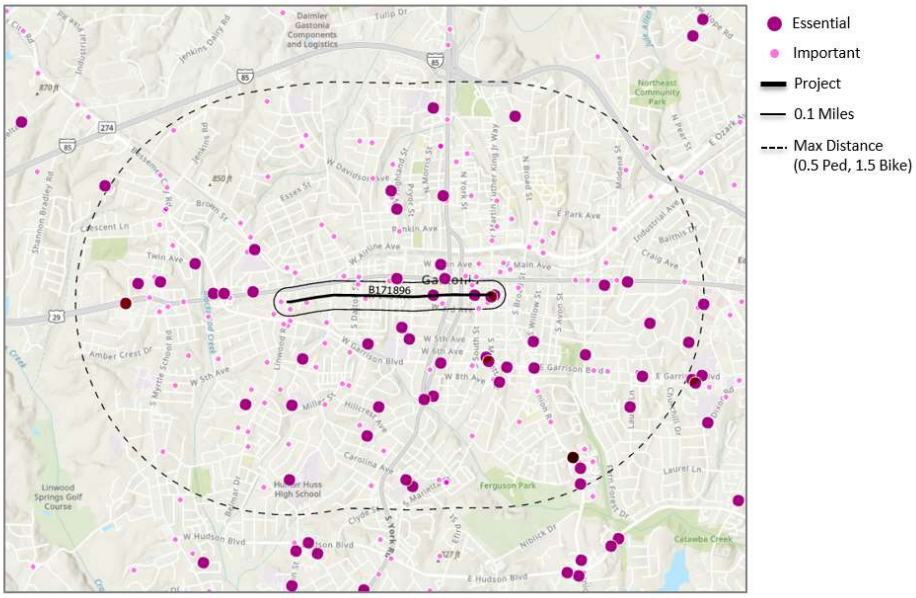
Method	Result
Count	208
Count + Weighted Categories	128
Multiple DW (1/0.5) + Weighted Cat.	68
Multiple DW (1/.25) + Weighted Cat.	38
Continuous DW + Weighted Cat.	59



Case 4

P5 SPOTID: B171896
Mode: Bike
County: Gaston
Land Use: Medium City (Gastonia)
Description: Construct on-road bicycle facility via shared lane markings. Construct sidewalk. Increase safety and connectivity

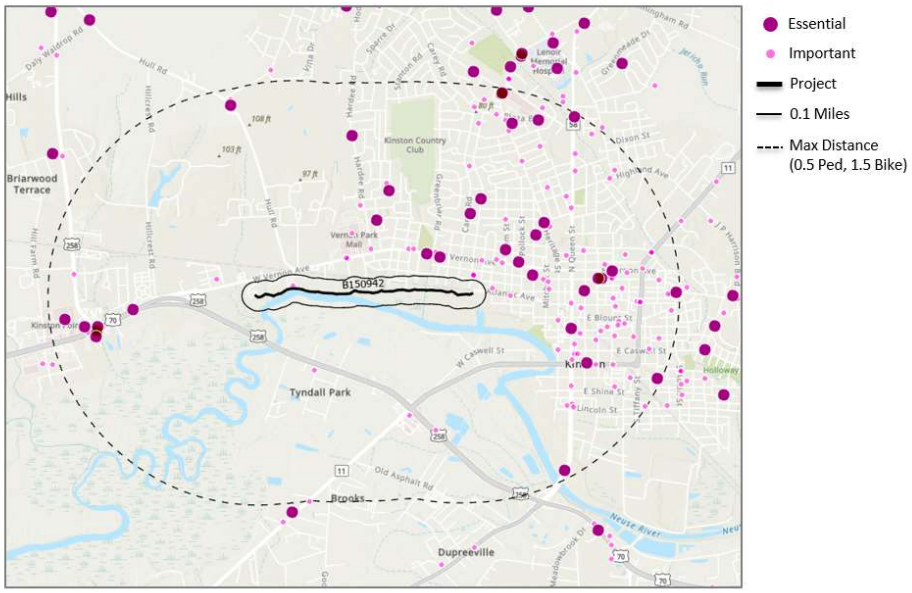
Method	Result
Count	177
Count + Weighted Categories	115
Multiple DW (1/0.5) + Weighted Cat.	62
Multiple DW (1/.25) + Weighted Cat.	35
Continuous DW + Weighted Cat.	59



Case 5

P5 SPOTID: B150942
Mode: Bike
County: Lenoir
Land Use: Small City (Kinston)
Description: Kinston Riverwalk - Construct off road multi-use path along the Neuse Riverbank through Downtown Kinston. Connects to existing path and extends MTS Trail

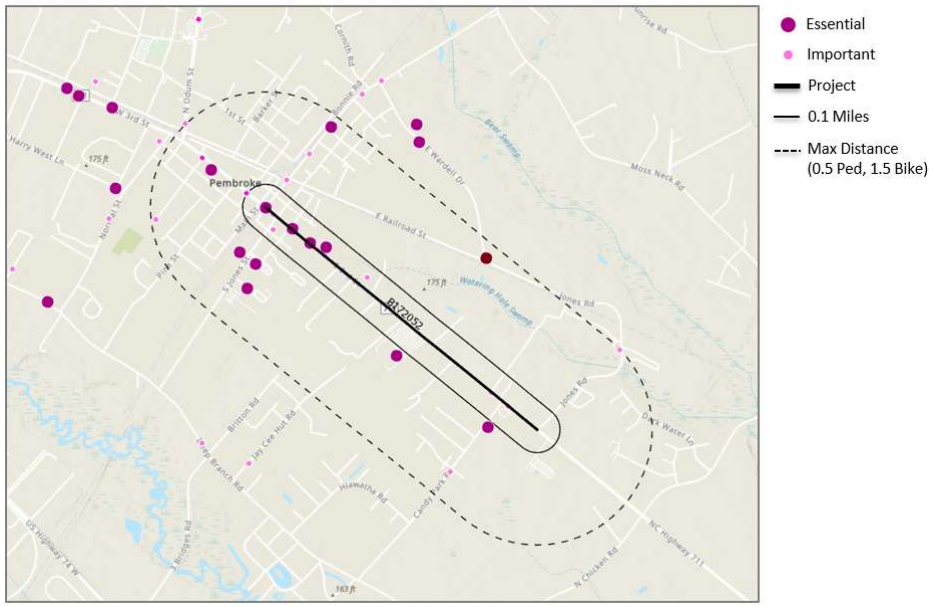
Method	Result
Count	137
Count + Weighted Categories	85
Multiple DW (1/0.5) + Weighted Cat.	43
Multiple DW (1/.25) + Weighted Cat.	22
Continuous DW + Weighted Cat.	31



Case 6

P5 SPOTID: B172052
Mode: Ped
County: Robeson
Land Use: Small Town (Pembroke)
Description: Construct sidewalks on both sides of NC 711 from Jones St to Walmart Shopping Center to improve safety for pedestrians

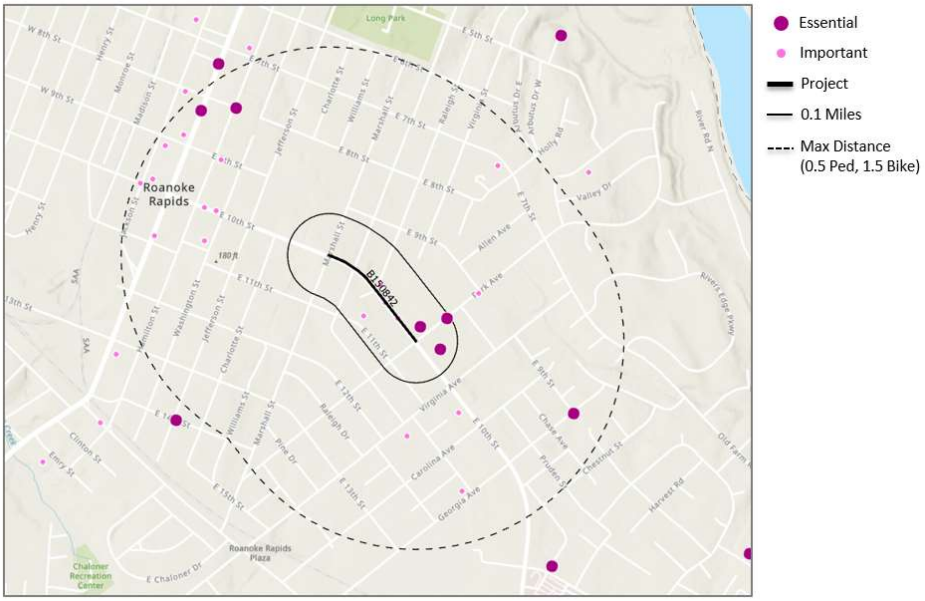
Method	Result
Count	28
Count + Weighted Categories	20.5
Multiple DW (1/0.5) + Weighted Cat.	14
Multiple DW (1/.25) + Weighted Cat.	10
Continuous DW + Weighted Cat.	12



Case 7

P5 SPOTID: B150842
Mode: Ped
County: Halifax
Land Use: Small City (Roanoke Rapids)
Description: New sidewalk on both sides; improve safety and mobility for pedestrians.

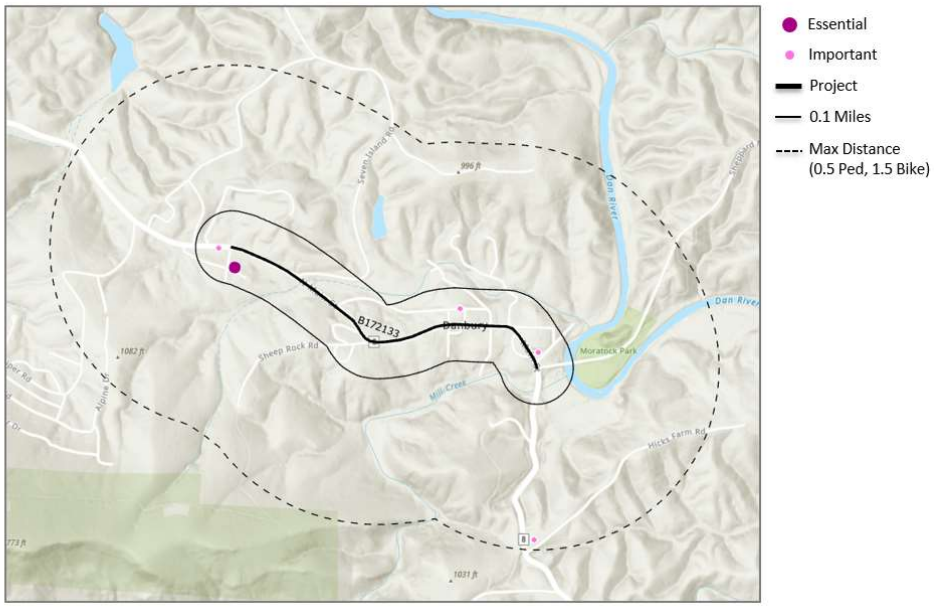
Method	Result
Count	24
Count + Weighted Categories	15
Multiple DW (1/0.5) + Weighted Cat.	10
Multiple DW (1/.25) + Weighted Cat.	7.5
Continuous DW + Weighted Cat.	7



Case 8

P5 SPOTID: B172133
Mode: Ped
County: Stokes
Land Use: Small Town (Danbury)
Description: Sidewalk construction to expand recent streetscape improvements and provide an opportunity to route the Mountains to Sea Trail through downtown Danbury

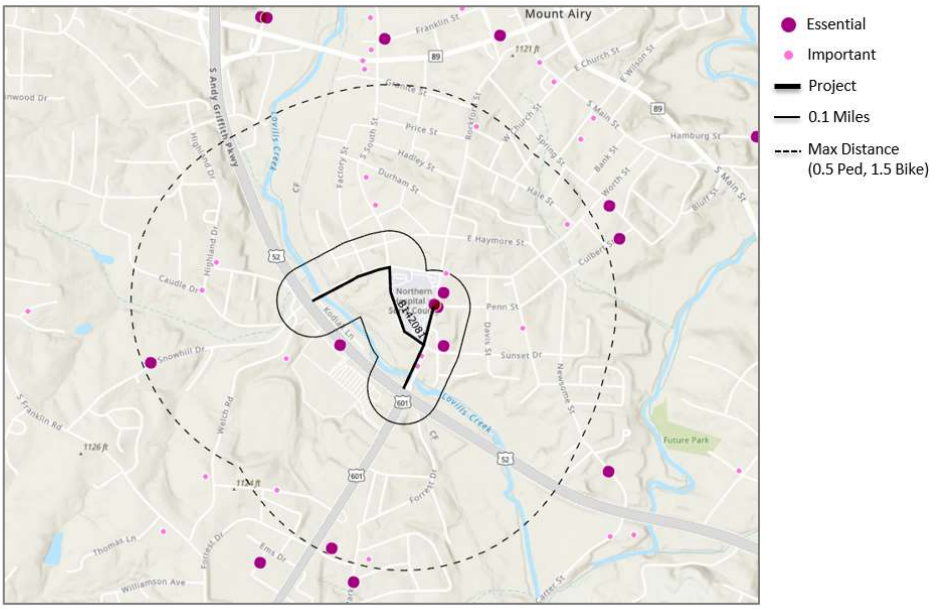
Method	Result
Count	5
Count + Weighted Categories	3
Multiple DW (1/0.5) + Weighted Cat.	3
Multiple DW (1/.25) + Weighted Cat.	3
Continuous DW + Weighted Cat.	2



Case 9

P5 SPOTID: B142081
Mode: Ped
County: Surry
Land Use: Small City (Mount Airy)
Description: Sidewalk construction to enhance sidewalk connectivity near hospital.

Method	Result
Count	20
Count + Weighted Categories	14
Multiple DW (1/0.5) + Weighted Cat.	10
Multiple DW (1/.25) + Weighted Cat.	8
Continuous DW + Weighted Cat.	8



Discussion of Cases

These cases are meant to demonstrate the effects of adding category and distance weighting to the existing methodology. They do not include all categories of POI, but they include a sufficient sample to demonstrate the effects of these methods. The methods employed in the case studies result in decreases in the final numeric result in each of the methods depicted relative to the simple Count method. This is expected because the methods reduce the influence of certain categories of POI, as well as more distant POI, on the final outcome.

The extent of decrease differs for each project and depends on its particular setting relative to the POI in its area of impact. For example, Case 5 experiences a nearly 80% decrease from the Count method to the Continuous DW method, while Cases 6, 8, and 9 experience closer to a 60% decrease. This can be explained by the fact that very

few of the POI in Case 5 are highly proximate to the project, while the POI in Cases 6, 8, and 9 are very proximate to the project. In this way, the method benefits projects with many POI that are very proximate, rather than just many POI within the maximum analysis area.

In most cases, the result of the continuous distance weighting method fell between the two multiple distance weighting methods. For this reason, strike Team participants noted that the continuous distance weighting method seemed to result in a good balance among the methods tested.

Although these methods are meant to emphasize connections rather than just proximity, some inherent methodological bias is still present. Because the maximum distance is greater for bike projects than for pedestrian projects, bike projects will have greater potential in the POI measure pedestrian projects, all else held equal. Also, these results are highly informed by the local/regional context and the density of POI in the areas around projects. These inherent biases did not deter the interest of the Strike Team and they indicated that they saw value in continuing to explore the approaches documented in the case studies.

Results and Next Steps

The Accessibility Strike Team, comprised of Workgroup members and organized to re-examine the way accessibility is measured for bike/ped projects, noted that the STIP accessibility measure will ideally accomplish and consider the following:

- Focus on improvement not just proximity
- Equity
- Local/regional context
- Variance of POI level of importance
- Differentiate between and address proximity vs. direct access
- Factor in current state of access to transportation options
- Clearly define what is/not included in POI categories

As part of the Strike Team discussions facilitated by the ITRE research team, the group identified approaches for addressing these aims that can support the prioritization process or be incorporated into a STIP accessibility measure. These approaches that the Strike Team deemed as potentially feasible options are:

POI Definitions & Documentation
Enhancing POI descriptions and making these descriptions a standard practice to 10 help clearly define what is/not included in POI categories so that data submitted is more accurate and the prioritization process is more transparent, 2) better capture local/regional context because of these improvements.

Category Weighting
Incorporating weighting for POI level of importance to communities to 1) consider the variance of POI level of importance amongst the different POI categories 2) include some consideration for equity, 3) reduce the dependence on simple proximity analysis, 4) better capture local/regional context.

Distance Weighting
Incorporating weighting for POIs that varies based on distance a to 1) reduce the dependence on simple proximity analysis, 2) somewhat differentiate between and address proximity vs. direct access, 3) better capture local/regional context.

Needs for Further Research

The primary opportunities identified in this report are readily implementable solutions that address some of the Strike Team's feedback. Not all of the opportunities and challenges identified throughout the Strike Team sessions could be paired with near-term solutions. These items are recommended for further research.

Current Accessibility Levels & Project Impacts
While the Strike Team suggested that the current state of access to transportation options should be considered in a STIP accessibility measure, this item was deemed too complex to address at this time. There is an opportunity to explore the feasibility of integrating consideration for this factor in the future, which will likely need to involve some type of network analyses and would ideally include a comparison of the current state of the transportation system to a future state with and without a given project of interest.

Improved Data Sources for Current and Future POIs

As documented in the report, ideal data sources with statewide coverage for certain POI categories could not be identified during the course of this effort. This includes point locations for affordable housing, low-income jobs, and homeless shelters. Additionally, no consensus was formed around an appropriate source for employment centers that could be included in the automatic set of POIs, though this objective remained important for Strike Team Participants.

Continued Refinement: While discussions with the Strike Team did not yield strong opinions supporting the reduction of any POI categories from the set analyzed, issues of POI redundancy were discussed, including overlap between the employment center POI category and job counts assessed in the Demand/Density criteria. Likewise, the Strike team discussed the overall utility of certain categories of POI, like government buildings. Future research may be directed towards refinement of the total number of POI categories to reduce redundancy and enhance the value that each included category contributes to the analysis.

Next Steps

Following the results of this effort, including the insights gained from the Strike Team, next steps may include:

- Circulating POI description examples for Workgroup feedback
- Undertaking a focused discussion with the Workgroup about weighting PIOs by category based on work already done by the Strike Team
- Gaining input and questions from the Workgroup about distance POI weighting options and conducting a focused follow-up discussion based on this feedback and work already done by the Strike Team
- Conducting additional case studies to support these activities as needed.

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