Local Access

Active Transportation Network Utility Score

User Guide

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METROPOLITAN AREA PLANNING COUNCIL
Smart Growth & Regional Collaboration

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Background

Communities across Massachusetts are looking for ways to make walking and biking a safer, healthier, and more convenient way to get around. There is a growing movement toward the creation of "Complete Streets" designed to accommodate travelers of all ages, incomes, and abilities, whether they are walking, biking, riding transit, or in a car. As of June 2016, nearly one-fifth of the municipalities in Massachusetts have adopted Complete Streets policies[1] and are participating in a Massachusetts Department of Transportation (MassDOT) program to implement those policies through capital investments. Given the urgent need and limited funds, it is critical for municipalities to focus and prioritize their investments where they will have the biggest impacts on safety, convenience, and congestion relief.

While it is clear that investments should be made where they can benefit the greatest number of users, there are few measures of active transportation *utility* for any given stretch of road. As in, *if this were* a good place to walk or bike, would many people find it a useful route between point A and point B?

Local Access is a tool developed to help answer this question. This measure provides a robust, quantitative estimate of current or potential roadway utility for walkers and bikers. The active transportation network utility score for each segment of roadway indicates how useful that street segment is for connecting residents with schools, shops, restaurants, parks, and transit stations.

The Local Access utility scores are based on a simplified travel demand model based on Massachusetts-specific travel surveys and hyperlocal data on population, connections, and destinations. For each census block, the model estimates various types of trips that residents might take on a given day and what local destinations they are likely to visit. The most direct route to each destination is calculated and each trip is assigned a walk or bike probability based on distance. The number of trips estimated for each roadway segment is summed up, and the results are normalized based on the range within the municipality to produce a score from 0 – 100. The dataset contains a separate score for four different types of destinations (school, shops and restaurants, transit stations, and parks) and two different modes (walking and biking), for a total of eight basic scores. These scores are combined and weighted to produce walking and biking scores as well as an overall composite score.

[1] https://masscompletestreets.com/Map/

What's in the Local Access Dataset?

Local Access scores gauge how many local walking and biking trips might use a given roadway segment to reach local destinations, if that segment and the surrounding network were truly "complete." Scores are expressed in a range of 0-100 and are available for all trip type and mode combinations (e.g., walk to school) as well as composite scores. Utility scores are meant to be used as a relative measure, and the normalized scores are based on the range of utility estimates for all street segments within a given municipality. Because of that, normalized scores can't be compared across cities and towns.

The scores are symbolized using line width of each segment, with wider lines indicating a higher utility. The figure below shows how the results appear on a map, using the Local Access: Shopping score in Winchester, MA as an example. The shading indicates population per acre, and the dots represent shops and restaurants. High utility roadway segments (shown with thicker lines) extend outward from the town center (3) to nearby neighborhoods (2). Lower-density neighborhoods (1) are anticipated to produce fewer shopping trips, so streets in that area are likely to serve a smaller number of trips. The map also shows that even some streets in the town center have low utility because they do not provide direct connections to surrounding areas.

Local Access scores for all trips and modes are available for nearly every roadway segment in Massachusetts. Data can be downloaded via data.mapc.org. A limited number of roadway attributes are included, and the data can be easily joined to the MassDOT roadway inventory for complete statistics. The Local Access dataset also includes "analysis zone" data that were used as model inputs: estimates of population, household, business, etc that serve as the basis for trip generation and attraction. Analysis zones are generally coincident with 2010 Census Block boundaries. Population and household statistics were drawn from the decennial census; other statistics were summarized from point data or overlying census tracts.

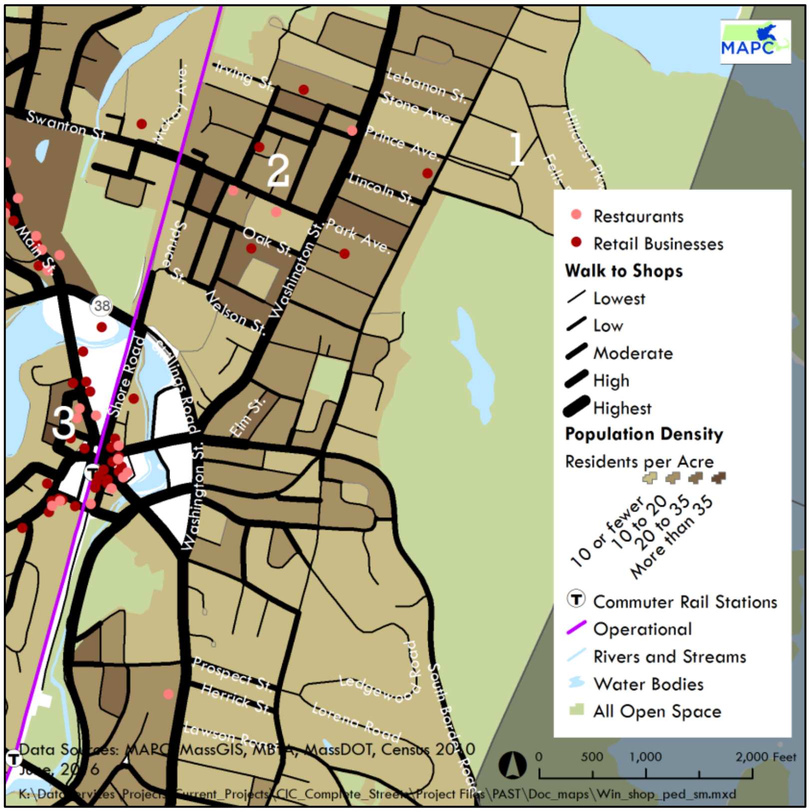

Figure 1: Local Access: Walk to Shopping Score for Winchester, MA

How to Use the Local Access Utility Scores

The utility scores can be combined with infrastructure data to help municipalities answer questions such as:

- Pedestrian & Bike Assessments: field investigation or documentation of local pedestrian conditions should focus on high-utility roadway segments likely to be used by the largest number of local residents.
- Planning and Prioritization: Local complete streets prioritization plans or pedestrian and bike plans can use the data to identify locations in need of improvement. High utility roadway segments that lack pedestrian and bike facilities or which have a history of pedestrian and bike crashes should be prioritized for further investigation and feasibility assessment.
- Project selection: In any given funding cycle, a city or town will have more potential project that can be funded with available resources. The Local Access scores can be used to screen the projects and possibly eliminate those likely to serve a relatively small number of users.
- Maintenance and enforcement: Local Access scores can be used to inform operational plans for snow clearance, vegetation management, or routine repair. The scores may also be used to prioritize code enforcement activities related to snow clearance or property

owner obligations, or police efforts to improve safety through signage, enhanced enforcement, or crossing guard deployment.

- Pedestrian counts and performance measurement: Local Access utility scores can be used to identify groupings of count locations that are representative of an entire municipality or study area. By counting active transportation activity in a variety of different locations across a study area (rather than only in high-use locations) it is possible to develop more robust areawide estimates of pedestrian miles traveled or other important outcomes.
- Wayfinding programs can use the data to place signs where many people will pass, or at key intersections where walkers might be redirected to a recommended pedestrian route.

How the Local Access Scores are Calculated

Local Access scores are calculated using travel demand software that uses input data on population and destinations to estimate the number of trips households are likely to make in a given day, the likely destinations of those trips, and the most direct routes connecting households to their destinations The four steps of the model are described briefly below. For more detailed information, see the Technical Report.

1. Trip Generation: *How many trips of each type begin and end in each block?*
A set of equations converts the analysis zone data into a number of trips produced by and attracted to each block for each trip type. Trip production and attraction rates account for household size, number of school-age children, size of establishment (store, school), and many other factors. Rates were based on the 2012 Massachusetts Travel Survey (MTS). The Analysis Zone inputs for each trip type are described in table 3 below.

2. Trip Distribution: *How many trips go from each block to each other block?*
Another set of equations describes, for each analysis zone, how many trips produced by that zone end up in every other analysis zone included in the study area. The “destination choice” model used to create these estimates was again based on the 2012 MTS and its information on how far residents are likely to travel for various purposes. Model input variables are on-road distance and WalkScore ®. Two zones that are closer together and have higher walkscores are more likely to have a higher exchange of trips.

3. Mode Choice: *How many of these trips might be made by walking or biking?*
Shorter trips are more likely to be made by walking and biking. The model accounts for this by reducing the trip probabilities as a function of distance, with longer trips less likely to occur, and thus contributing less to a given segment’s utility score. Separate walking and biking rates by trip distance were drawn from the 2012 MTS, with probabilities for walking and biking to school based on MAPC survey data on school commutes

4. Route Assignment: *What is the most direct route for each trip?*
Routes were assigned based on shortest network distance between the origin and destination census blocks. The network includes all surface roadways, regardless of whether or not they currently have a sidewalk or bike facility. Limited access highways are excluded from the network, as well as specific segments where a pedestrian connection is categorically infeasible or undesirable. The trips assigned to each segment were summed up for each trip type and mode to produce eight trip/mode specific utility score.

These eight scores were then normalized and combined to create a composite score for each mode and for both modes together. The raw scores were rescaled to a range of 0 to 100, weighted as per Table3, and then combined into composite scores by mode. Each of these mode composite scores was also rescaled from 0 to 100, weighted (Walk: 10, Bike: 5), and averaged to produce a Raw Composite Utility Scores. Finally, this score was rescaled to 0 to 100 to create the Composite Utility Score.

Table 3

Field	Trip Production	Trip Attraction	Weight
Walk to School	Population 5-17 years	Public School Enrollment	10
Walk to Shopping	Households by household size	Restaurant Employees, Retail Employees	7
Walk to Parks	Households by household size	Open Space Acres	5
Walk to Transit	Households by household size	Transit Frequency	5
Bike to School	Population 5-17 years	Public School Enrollment	10
Bike to Shopping	Households by household size	Restaurant Employees, Retail Employees	7
Bike to Parks	Households by household size	Open Space Acres	5
Bike to Transit	Households by household size	Transit Frequency	5

How to Use the Local Access Dataset

Local Access data is made available as an geodatabase that can be downloaded via data.mapc.org. GIS software such as ArcMap or QGIS is required to use the data. The data can also be fully explored through an online webmap. Local users may wish to clip the dataset to their municipality or subregion to enable faster rendering and processing.

A data dictionary for the dataset is included in the geodatabase and is attached as a table at the end of this document. Fields with MassDOT and/or MassGIS listed as the source are from the MassDOT Roads Inventory Layer, which was used to create the network for the travel demand model. Some fields were added by MassGIS. See http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/eotroads.html for more information.

The "sidewalk" field was calculated by MAPC based on the sidewalk width data from the MassDOT Roads Inventory. Right and Left sidewalk widths were converted into presence/absence fields, where 1 = present, and 0 = absent. Then these two fields were added to give the number of sidewalks available on each roadway segment.

The Road Inventory ID can be used to join any additional attributes from the MassDOT road inventory to the Local Acces Utility Scores dataset. The road inventory contains details such as jurisdiction, information on shoulders and medians, and surface type.

Rescaling the Data for Localized Results

The data include a raw utility score for each trip purpose and mode, as well as a rescaled value (0-100) for each of those combinations as well. The rescaling was based on the distribution of values across Massachusetts, and so may not adequately reflect local variation. MAPC encourages users of the data to create their own localized scores based on the distribution of utility values in their community. This can be done by clipping the dataset to a municipality or study area. Be sure to include a buffer area into nearby municipalities so that "cross-border" connections are identified. The utility fields can then be updated based on the distribution of values for the roadway segments in the area. Users may also consider transforming the data in other ways; for example, by rescaling based on the log of the raw scores. It may also prove useful to group the data into quintiles for easier mapping and application. Ideally the percentiles would be weighted by the length of the road segment. This can't be done easily in ArcGIS, but other programs (such as R) have this function.

Updating the Sidewalk Gap Analysis

MAPC's online Local Access data viewer depicts a sidewalk gap analysis indented to highlight high utility roadway segments currently lacking active transportation facilities. Users can recreate and improve this analysis by adding more extensive and accurate information about complete streets facilities. The simplest improvements can be made by editing the "sidewalk" field in the data to reflect the actual presence or absence of sidewalks. The scores can also be joined to any other dataset with a MassDOT roadway inventory ID, such as pavement management system data, bike facility data, or level of stress analysis. A sidewalk gap analysis can be conducted for specific trip purposes, such as walking to school.

Interpreting 0 scores

Many road segments have utility scores of 0. This does not mean that those road segments are not useful at all, nor does it mean that no trips should be expected on those road segments, particularly in densely occupied areas. Even though the Local Access model uses very small analysis zones, some roadway segments still fall entirely within an analysis zone. When that is the case, those small road segments may have no trips loading on them. For segments with utility scores of 0, other factors will have to be used to rank them according to infrastructure investment priorities.

Caveats and Known Issues

The Local Access database is a work in progress. Because it is based on statewide datasets, it may not contain a perfectly accurate data on local conditions, or the model may fail to reflect local trip-making patterns or route preferences. This section describes the known issues with the dataset and their implications for local planning applications.

1. Connectivity errors: Because the analysis was run on a statewide network, it was infeasible to inspect the entire network to ensure 100% accuracy in connectivity where roadway segments interconnect. Errors in the network could mean that some trips are unable to take routes requiring that connection, and may be assigned to other, longer pathways. This issue is more likely to occur in areas where cycle tracks and shared use paths intersect with surface roadways. Shared use paths such as rail trails are often included in the network, but MAPC staff have noticed that these segments are less likely to have accurate connectivity, and therefore may not have as many trips loading onto them as would otherwise. To correct this error, it is necessary to modify the travel network inputs for the travel model and regenerate the utility scores.

2. *Missing walking routes:* Walking trails and pedestrian-only shortcuts such as mid-block staircases are not included in the network. As with connectivity errors, it is necessary to modify the travel network inputs for the travel model (by manually adding the walking routes) and regenerate the utility scores.

3. *Travel around/within blocks nor represented:* All trips are produced and attracted from an abstract “centroid” within each block, which is connected to the roadway network through connectors running to various points on the boundary of the census block. As a result, all routes originate and terminate at the boundary of the census block containing their destination. Travel around and within and around the census block to reach the main entrance or final destination is not assigned to the network. This issue is most significant for schools, which attract very large numbers of trips. However, all of those trips “arrive” when they reach a connector at the perimeter of the block, and few are routed along the network to the actual school entrance(s.) As a result, the roadways surrounding the school appear to have very low utility scores. As with connectivity errors, it is necessary to modify the travel network inputs for the travel model (by

eliminating all connectors except for those corresponding to school entrances) and regenerate the utility scores.

4. *School trips assume proximity-based assignment:* The trip distribution model assumes that students will tend to be assigned to nearby schools if capacity is available (the total number of trips is limited based on reported enrollment.) In reality, many schools draw from a wide attendance zone, and students may be assigned to a school at some distance, even if other closer schools are available. To correct this issue, it would be necessary to input specific assignment zones for each school and regenerate the model results.

Acknowledgements

The first phase of this project was funded through a Community Innovation Challenge Grant from the Commonwealth of Massachusetts. The second phase was funded through a grant from the Centers for Disease Control, administered through the Massachusetts Department of Public Health, and a grant from the Barr Foundation.

Data Dictionaries

Local Access Utility Scores

Table 1

Field Name	Field Alias	Source	Description & Values
rd_inv_id	Road Inventory Unique Identifier	MassDOT/ MassGIS	Unique road segment ID from the MassDOT Road Inventory file
class	Roadway Classification	MassGIS	Type of roadway based on functional classification and access 1 – Limited Access Highway 2- Multi-lane Highway, not limited access 3 – Other numbered route 4 – Major Road – arterials and collectors 5 – Minor Street or Road (w/ Road Inventory information, not class 1-4) 6 – Minor Street or Road (w/ minimal Road Inventory information and no street name)
rt_number	Route number	MassGIS	Primary route number
atlrtnum1	Alternate Route Number	MassGIS	Alternate route numbers
streetname	Street Name	MassGIS	Street name
truckroute	Truck Route	MassDOT	Truck Route 0 – Not a parkway – not a designated truck route 1 – Designated truck route under Federal authority 2 – Designated truck route under State authority 3 – Department of Conservation and Recreation Parkway – no trucks allowed
sidewalk	Number of Sidewalks	MassDOT/ MAPC	Number of sidewalks 0 – No Sidewalks 1 – Sidewalk on one side 2 – Sidewalks on both sides
speedlimit	Speed Limit	MassDOT	Posted speed limit in mph
adt	Annual Average Daily Traffic	MassDOT	Calculated Average Daily Traffic for the year
adt_year	Annual Average Daily Traffic Year	MassDOT	Year of ADT collection
wlk_rw	Raw Walk Utility Score	MAPC	Raw composite utility score for walking trips to school, shops, parks, and transit
wlk_sch_rw	Raw Walk to School Utility Score	MAPC	Raw utility score for walking trips to public schools
wlk_shp_rw	Raw Walk to Shops and Restaurants	MAPC	Raw utility score for walking trips to shops and restaurants

	Utility Score		
wlk_prk_rw	Raw Walk to Parks Utility Score	MAPC	Raw utility score for walking trips to open spaces
wlk_trn_rw	Raw Walk to Transit Utility Score	MAPC	Raw utility score for walking trips to transit stations
wlk	Walk Utility Score	MAPC	Utility score for walking trips to school, shops, parks, and transit, rescaled to a range of 0 to 100
wlk_sch	Walk to School Utility Score	MAPC	Utility score for walking trips to school, rescaled to a range of 0 to 100
wlk_shp	Walk to Shops and Restaurants Utility Score	MAPC	Utility score for walking to shops and restaurants, rescaled to a range of 0 to 100
wlk_prk	Walk to Parks Utility Score	MAPC	Utility score for walking trips to open spaces, rescaled to a range of 0 to 100
wlk_trn	Walk to Transit Utility Score	MAPC	Utility score for walking trips to transit stations, rescaled to a range of 0 to 100
bik_rw	Raw Bike Utility Score	MAPC	Raw composite utility score for bike trips to school, shops, parks, and transit
bik_sch_rw	Raw Bike to School Utility Score	MAPC	Raw utility score for bike trips to public schools
bik_shp_rw	Raw Bike to Shops and Restaurants Utility Score	MAPC	Raw utility score for bike trips to shops and restaurants
bik_prk_rw	Raw Bike to Parks Utility Score	MAPC	Raw utility score for bike trips to open spaces
bik_trn_rw	Raw Bike to Transit Utility Score	MAPC	Raw utility score for bike trips to transit stations
bik	Bike Utility Score	MAPC	Composite utility score for bike trips to schools, shopping, parks, and transit, rescaled to a range of 0 to 100
bik_sch	Bike to School Utility Score	MAPC	Utility score for bike trips to public schools, rescaled to a range of 0 to 100
bik_shp	Bike to Shops and Restaurants Utility Score	MAPC	Utility score for bike trips to shops and restaurants, rescaled to a range of 0 to 100
bik_prk	Bike to Parks Utility Score	MAPC	Utility score for bike trips to open spaces, rescaled to a range of 0 to 100
bik_trn	Bike to Transit Utility Score	MAPC	Utility score for bike trips to transit stations, rescaled to a range of 0 to 100
cmputil_rw	Raw Composite Utility Score	MAPC	Raw composite utility score, includes both walk and bike trips of all purposes
cmputil	Composite Utility Score	MAPC	Composite Utility score, includes both walk and bike trips of all purposes, rescaled to a range of 0 to 100

Local Access Analysis Zone Fields

Table 2

Field Name	Field Alias	Source	Description & Values
blk10_id	2010 Census Block ID	Census 2010	15 digit Unique Identifier
walkscore	Walk Score	Walk Score	Average WalkScore ® for the census block, derived from a 250m grid of WalkScore ® data (2012)
area_acres	Area in Acres	MAPC	Area in Acres
os_acres	Open Space Acres	MassGIS/ MAPC	Acres of open space in the census block. Calculated based on the MassGIS Open Space layer.
hh	Total Households	Census 2010	Total number of households
hh1	1-Person Households	Census 2010	Number of 1 person households
hh2	2 -Person Households	Census 2010	Number of 2 person households
hh3	3 -Person Households	Census 2010	Number of 3 person households
hh4	4-Person Households	Census 2010	Number of 4 person households
hh5	5-Person Households	Census 2010	Number of 5 person households
hh6	6-Person Households	Census 2010	Number of 6 person households
hh7pl	7 or more Person Households	Census 2010	Number of 7 or more person households
enroll	Enrollment	MassGIS, MDESE 2015	School Enrollment. Includes only information for public schools.
pop	Total Population	Census 2010	Total population
pop_5_17	Population 5-17 years	Census 2010	Number of children age 5 to 17
trans_frq	Transit Frequency	GTFS, EPA SLD	Aggregate frequency of transit service per hour from 4 to 7pm on weekdays for all transit stops within the block
rta_yn	Includes a Regional Transit Authority Bus Stop	GTFS	Indicates whether the census block contains an RTA bus stop 0 – No 1 – Yes
mbta_rt_yn	Includes an MBTA Rapid Transit Stop	MBTA	Indicates whether the census block contains an MBTA subway or bus rapid transit stop. Does not

			include planned transit, such as the Silver Line Gateway or the Green Line Extension projects. 0 – No 1 – Yes
mbta_cr_yn	Includes a Commuter Rail Stop	MBTA	Indicates whether the census block contains an MBTA commuter rail stop 0 – No 1 – Yes
mbta_bs_yn	Includes an MBTA Bus Stop	MBTA	Indicates whether the census block contains an MBTA bus stop 0 – No 1 – Yes
ferry	Includes a Ferry Terminal	MBTA	Indicates whether the census block contains an MBTA ferry terminal 0 – No 1 – Yes
emp_44_45	Retail Employees	InfoGroup 2016	Number of employees at businesses with NAICS codes in sectors 44 or 45, "Retail Trade"
emp_72	Restaurant Employees	InfoGroup 2016	Number of employees at businesses with NAICS codes in sector 72, "Accommodation and Food Services"