Development of a Comprehensive, Multimodal Travel Accessibility Index System at the Tax Parcel Level

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Accessibility measures the ease of reaching valued destinations

- Ease of reaching destinations here primarily means that destinations are available in a proximity to a particular location of interest on the map
- Proximity is evaluated by estimates of travel times by mode from origins to the destinations.
- Ease of use also depends on features of available paths. The paths between origins and destinations are the roads, sidewalks, trails, bikeways and other paths provided by the existing or proposed transportation or land use facilities.

Motivation For Determining a Accessibility Measure

- Trip generation modeling - accessibility factors that can be used with household based travel demand and behavior data developed in trip surveys
- Prediction of travel mode split
- Estimating and predicting usage of pedestrian and bicycle facilities. If trips performed by walking or biking are being considered, one naturally expects that available destinations in the locale will factor into an estimation of expected trips.
- Understanding the effects of various land use configurations

Victoria Transport Policy Institute, Todd Litman
"Evaluating Accessibilty for Transportation Planning"

Accessibility is defined as peoples' ability to reach desired goods, services, activities, and destinations. Litman argues that improving accessibility and reducing accessibility costs can help achieve many economic, social and environmental objectives and is the ultimate goal of most transportation activity. Therefore transportation planning and evaluation should be based on accessibility rather than traffic-based (vehicle movement) or mobility–based (people and goods movement) which tend to favor automobile transportation over other modes.

Victoria Transport Policy Institute, Todd Litman
"Evaluating Accessibilty for Transportation Planning"

Examples of Factors Affecting Accessibility

- **Transportation options**
- **User information**
- **Integration of modes**
- **Affordability**
- **Land use factors**
- **Network connectivity**
- **Roadway design**

With each factor addressed, Litman identifies improvement strategies and recommendations for best practices

“Low-Stress Bicycling and Network Connectivity” ,
Mineta Transportation Institute
Report 11-19, Maaza C. Mekuria, Peter G. Furth, Hilary Nixon, May 2012

When considering the suitability of an area for bicycling or walking, any measure or rating to account for that suitability needs to include a way of examining and classifying the types of access provided by the path between origins and destinations.

“Low-Stress Bicycling and Network Connectivity” , Mineta Transportation Institute
Report 11-19, Maaza C. Mekuria, Peter G. Furth, Hilary Nixon, May 2012

“Low-Stress Bicycling and Network Connectivity” establishes a stress criteria for road segments in order to classify the network and bases considerations on:

- **Physically separated bikeways**
- **Bike lanes**
- **Speed limits or prevailing speed**
- **Bike lane blockage**
- **Lane widths**
- **Signalized versus non-signalized intersections**
- **Presence and configuration of right turn lanes at intersections**

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“Low-Stress Bicycling and Network Connectivity” ,
Mineta Transportation Institute
Report 11-19, Maaza C. Mekuria, Peter G. Furth, Hilary Nixon, May 2012

“Low-Stress Bicycling and Network Connectivity” proposes classifying road segments by one of four levels of traffic stress.

- **Level of traffic stress (LTS) 1 - is meant to be a level that most children can tolerate**
- **LTS 2 - the level that will be tolerated by the mainstream adult population**
- **LTS 3 - the level tolerated by American cyclists who are “enthused and confident” but still prefer having their own dedicated space for riding**
- **LTS 4 - a level tolerated only by those characterized as “strong and fearless.”**

“Access to Destinations Study”
University of Minnesota Center for Transportation

The Access to Destinations Study encompassed a set of carefully designed research projects (11), The projects were organized according to three research components:

- understanding travel dimensions and reliability
- measuring accessibility
- and exploring implications of alternative transportation and land-use systems.

For accessibility, rather than on simple congestion measures the study changed the question from “How fast is traffic moving”? to “How easily are people reaching places they need or want to go?”. (El-Geneidy 2004) Findings of the ongoing study noted that while until this last decade congestion had been steadily worsening, the actual ease of reaching destinations in the Twin Cities areas has been getting better-all over the region.

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“Access to Destinations Study”
University of Minnesota Center for Transportation

The University of Minnesota study addressed different ways to measure access and reports include detailed examples of the following methods:

- Cumulative Opportunity is an approach that calculates the number of opportunities that can be reached in a specific period of travel time

- Gravity- Gravity measures evaluate access in terms of the “cost” of getting there (travel time) , and like Newton’s law of gravity, nearby things exert stronger attraction than those far away

- Place Rank- This measure accounts for the number of opportunities that an individual foregoes in a zone to reach an opportunity in another zone

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WALKSCORE.COM

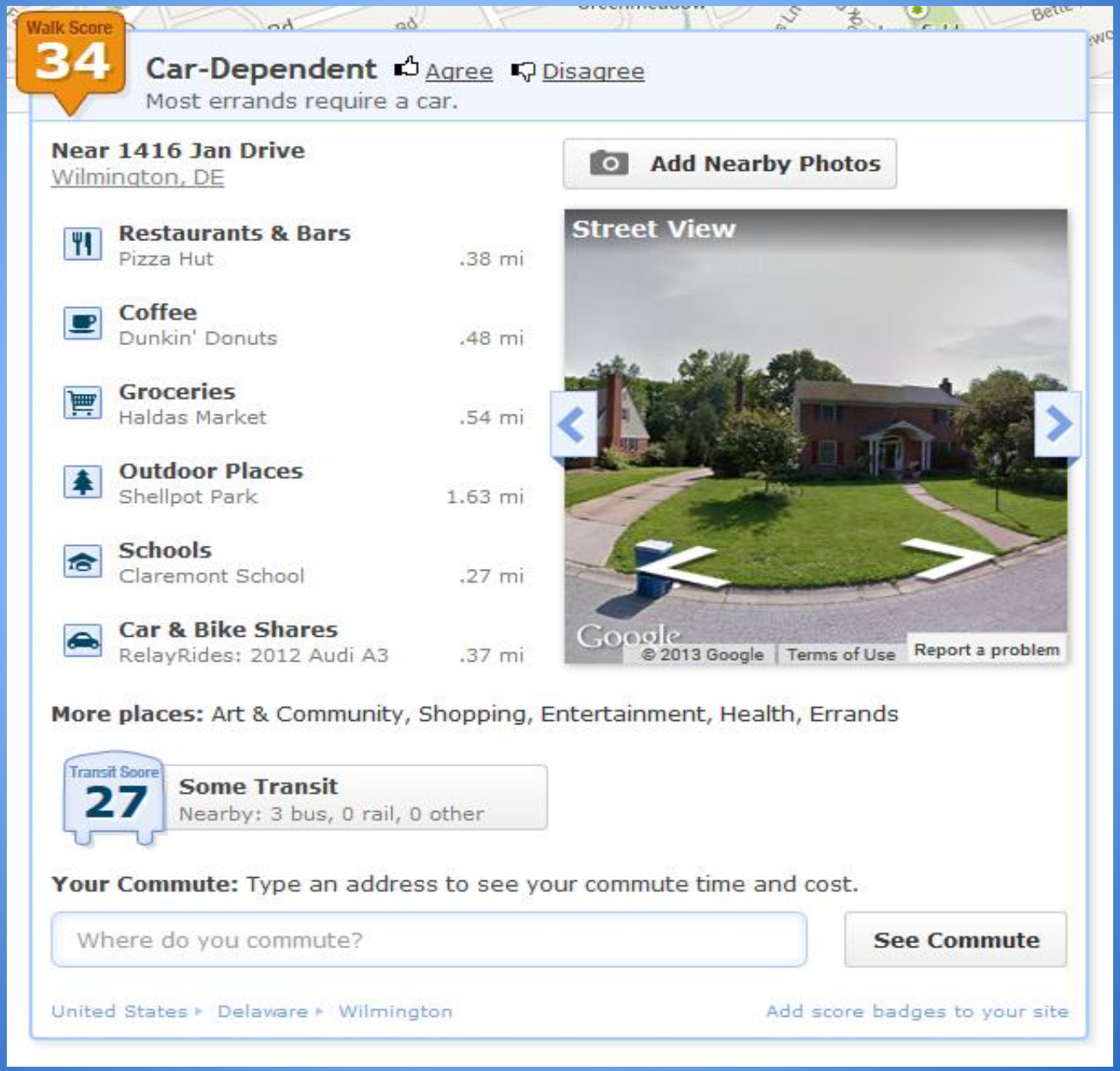
At this site, users can enter an address, and a “walkability” rating of the area is provided with references and maps of destinations in the area.

The score is based on a patent pending algorithm that classifies types of destinations and their proximity, and awards points based on the proximity of those destinations to produce a rating in the range of 1 to 100.

WALKSCORE.COM

Walk Score®	Description
90–100	**Walker's Paradise** Daily errands do not require a car.
70–89	**Very Walkable** Most errands can be accomplished on foot.
50–69	**Somewhat Walkable** Some errands can be accomplished on foot.
25–49	**Car-Dependent** Most errands require a car.
0–24	**Car-Dependent** Almost all errands require a car.

WALKSCORE.COM



Construction of accessibility measures in my projects began with origins and destinations.

Place Files for destinations, examples include

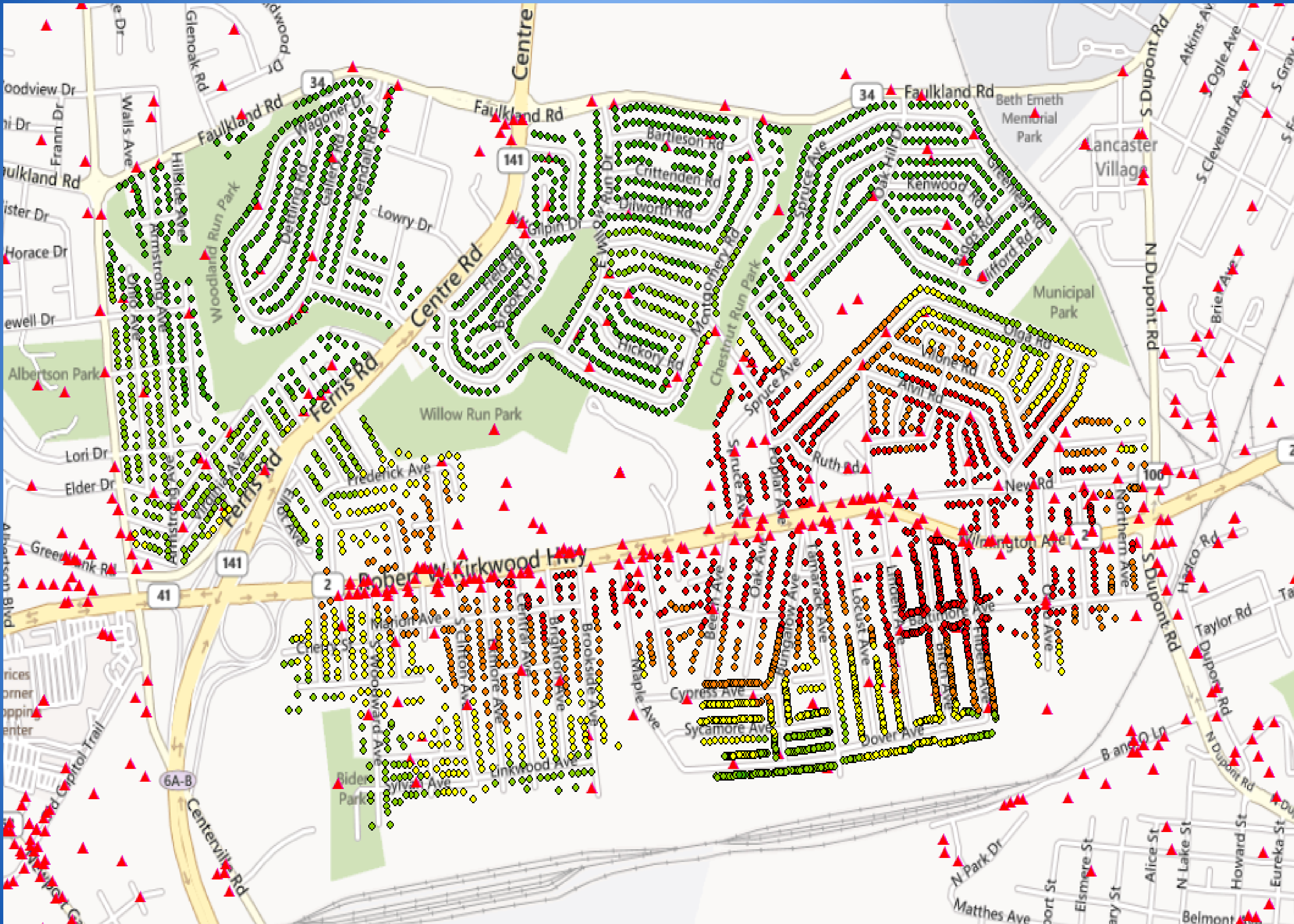
- GIS layers for places such as schools, day cares, parks, bus stops
- Major Employer point files and traffic zone based employment
- Google places
- Address files
- Tax parcel based maps and databases

Place File Categories, examples include

- Home – housing, apartments, mobile homes….
- Child Care
- Work
- Social – Recreation - parks, recreation, bars, museums..
- Transportation facilities – airports, bus stops, parking
- Store (basic needs) – pharmacy, grocery, convenience stores…
- Store (general) – books, electronics, florists, clothing, hardware..
- Community – library, police, fire, government …
- Bank or Post Office
- Place of worship
- Barber – Hair dresser
- Utilities
- Medical – hospitals, doctors offices, dentist, clinics….

Tax Parcel Approach

- Suitable scale for examining walking and biking
- Statewide tax parcel point file available
- Due to increasing demands to evaluate small scale developments, travel demand forecasting is being done at the tax parcel level in Delaware
- Availability of tax parcel based land use
- Places by address can be referenced
- Parcel based housing unit allocations



Faulkland Rd
Centre Rd
Ferris Rd
Willow Run Park
Woodland Run Park
Albertson Park
Municipal Park
Beth Emeth Memorial Park
Lancaster Village
Robert W Kirkwood Hwy
Wilmington Ave
Centerville Rd
S Dupont Rd
N Dupont Rd
Bartleson Rd
Crittenden Rd
Dilworth Rd
Hickory Rd
Kenwood Rd
Olga Rd
Ruth Rd
New Rd
Frederick Ave
Cypress Ave
Sycamore Ave
Dover Ave
Linkwood Ave
Sylvan Ave
Maple Ave
Locust Ave
Brookside Ave
Taylor Rd
B and O Ln
Matthes Ave
Belmont Ave
Lowry Dr
Lori Dr
Elder Dr
Horace Dr
Spruce Ave
Chestnut Run Park
Montgomery Rd
Bider Park

Paths- Participants in a Multimodal Network Dataset

- Roads, large and small, including driveways
- Paths offset from roadway, bike paths, walking paths
- Driveways
- Transit stops and routes
- Intersections modeled as turning movements with attributes (crosswalks, signals, crossing lanes, etc)

ESRI Network Dataset Attributes

- Cost – impedances/travel times
  apportioned along the edge
- Descriptors – presence of a sidewalk
  presence of a shoulder
  speed limit
- Restrictions – prohibited, avoided, preferred
- Hierarchy – order or rank of network elements

Most information can be associated with the network in terms of a cost.

Attributes of Path Segments

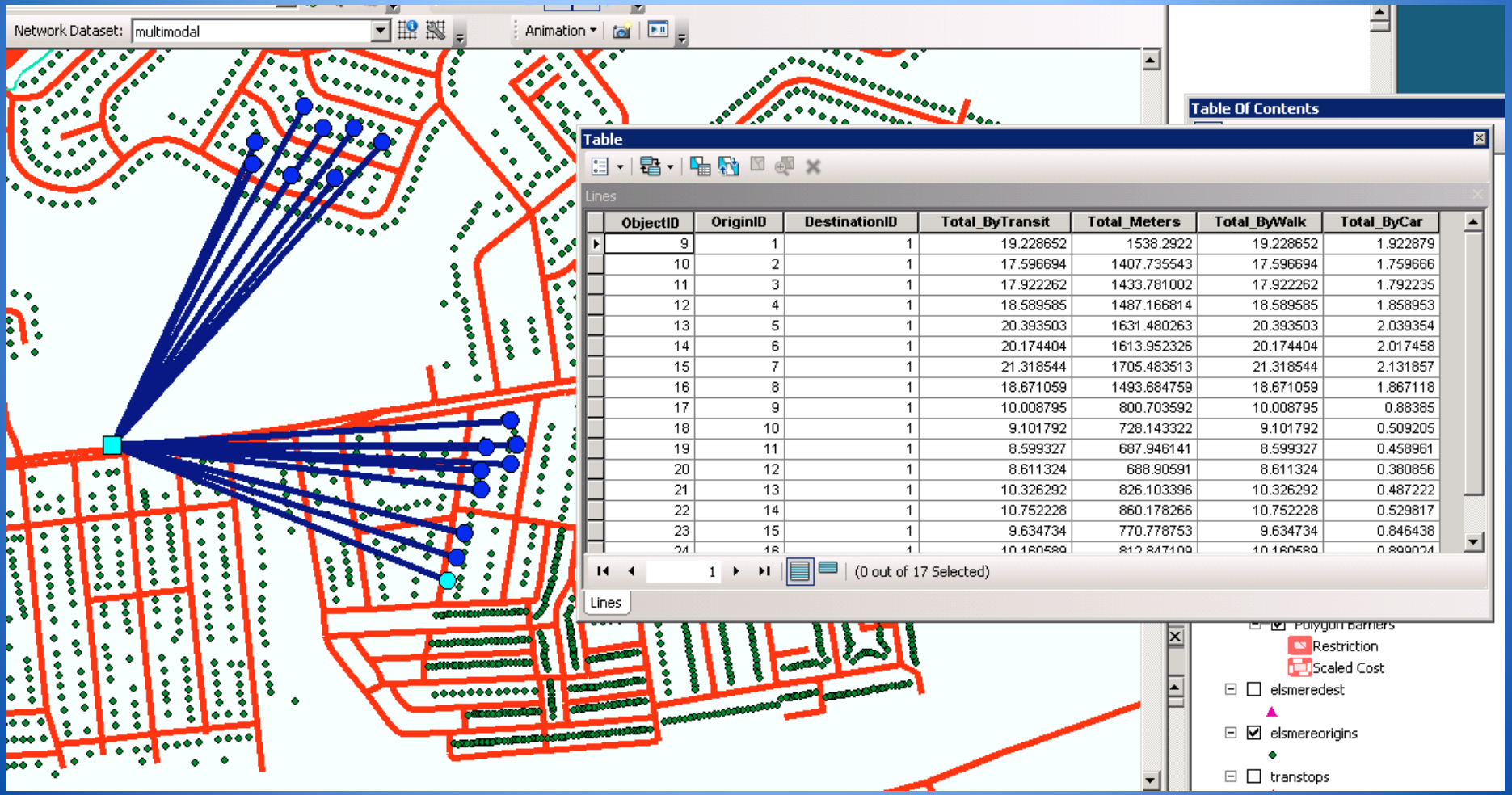
- Travel time by mode
- Functional class and speed
- Presence of a sidewalk
- Presence of a shoulder
- Presence of a bike lane
- Safety rating
- Lighting
- Level of service rating

The Network Analyst OD Cost Matrix function can establish a path between every origin and destination and for every path between each particular origin and destination can accumulate across network attributes. For instance if travel time by each mode is associated with each segment in a path then the travel time for segments in the path is aggregated. Any cost or descriptive attribute can be accumulated in this way.

Therefore for any given point in space statistics can be generated such as:

- number of destinations within a 10 minute walk
- Number of grocery stores within a 20 minute drive
- The distance to the closest grocery store by walking
- The total number of jobs within a 45 minute trip by bus

Example OD-Cost Matrix Example



Attributes and impedances can be formulated that answer more complex questions such as:

- **Number of destinations within a 10 minute walk using sidewalks**
- **Number of destinations that are within a LOS-2 bike trip**
- **Number of housing units around a school that can be reached by a LOS 1 walking trip where LOS-1 corresponds to a path that only includes sidewalks and safe intersections**

Examples of Level of Service Definitions:

Walking LOS C – Walk anywhere along roadway or other path, 3 miles per hour, no walking on expressways or interstates

Walking LOS B - Walk only if there's a sidewalk on either side, or trail, or local street or shoulder (> 2 feet) and no walking on expressway or interstates.

Walking LOS A - Walk only if there's a sidewalk or dedicated path

Bike LOS C – 12 mph, bike most anywhere on roadway or paths, no biking on one way streets, no biking on interstate or expressways

Bike LOS B - There must be a shoulder (>2feet) or sidewalk if not a local street, or designated bike way or dedicated trail

Bike LOS A - Designated Bikeway or trail, or sidewalk or a subdivision local road.

A similar LOS could be developed for transit trips.

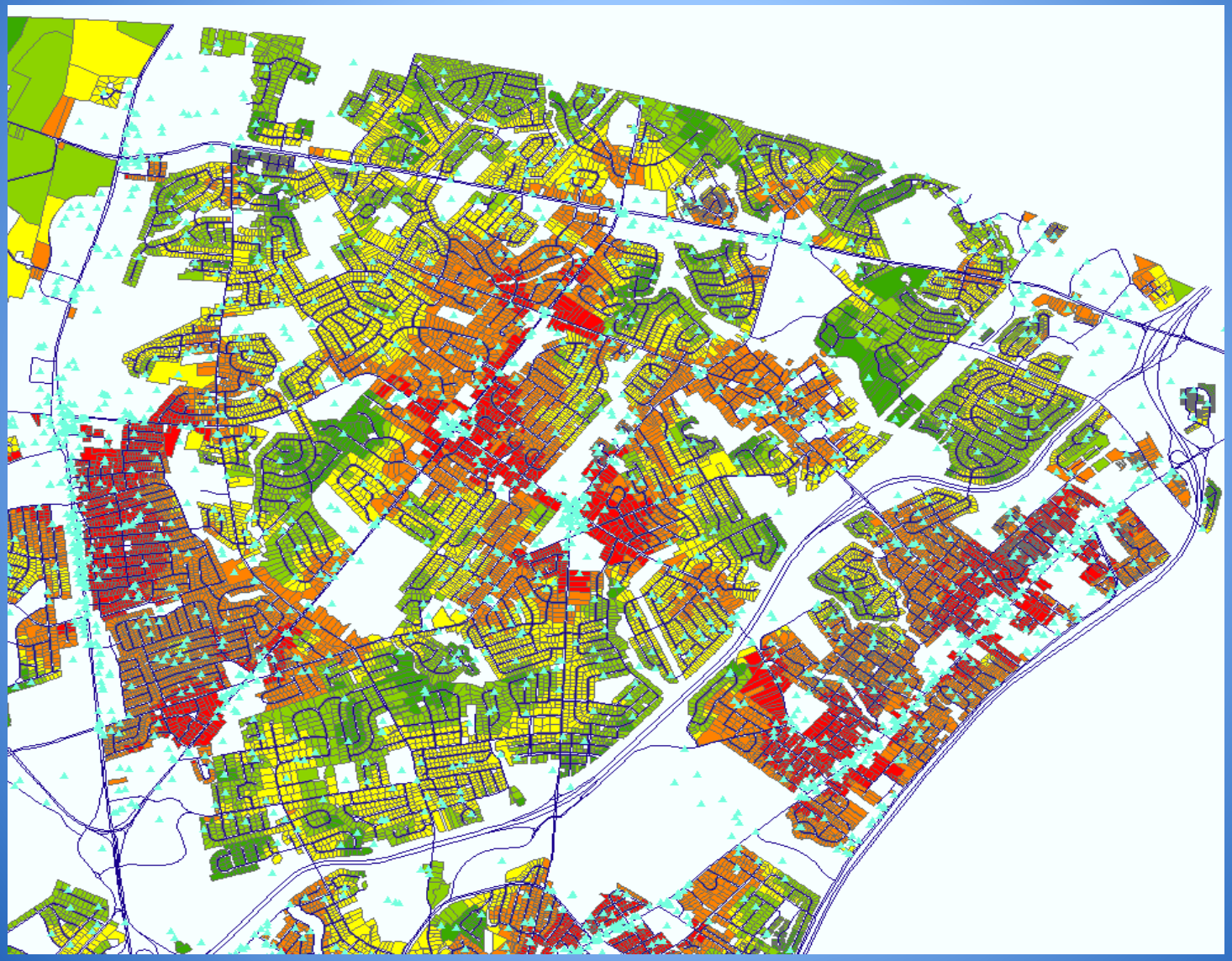
For each housing unit, number of destinations within a 10 minute walk (LOS C)

Effect of adding a path

Effect of adding a path

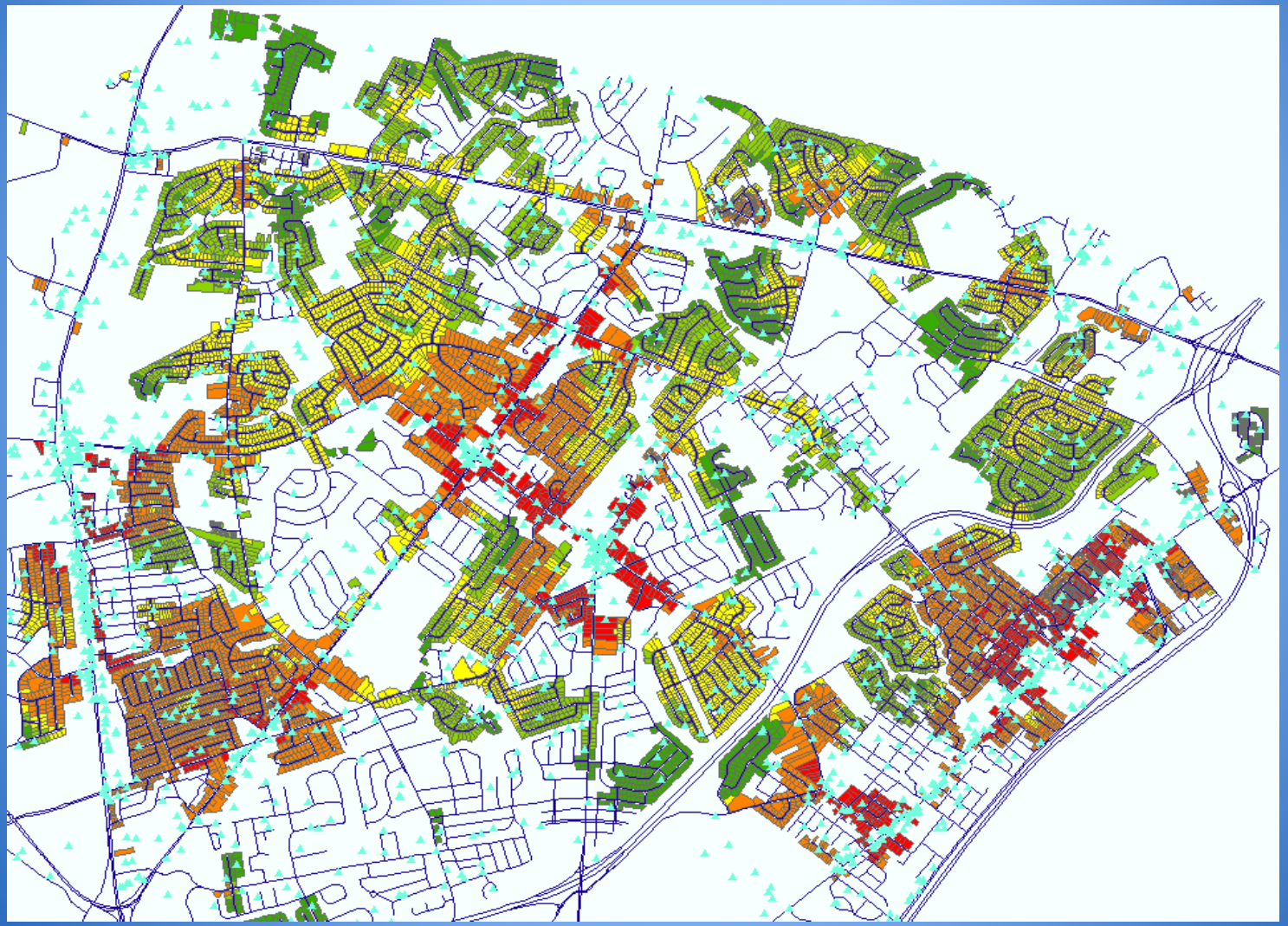
Number of destinations within a 10 minute walk

(LOS C) Dark Green 1-7, Light Green 8-16, Yellow 17-35, Orange 36-104, Red 105 and greater

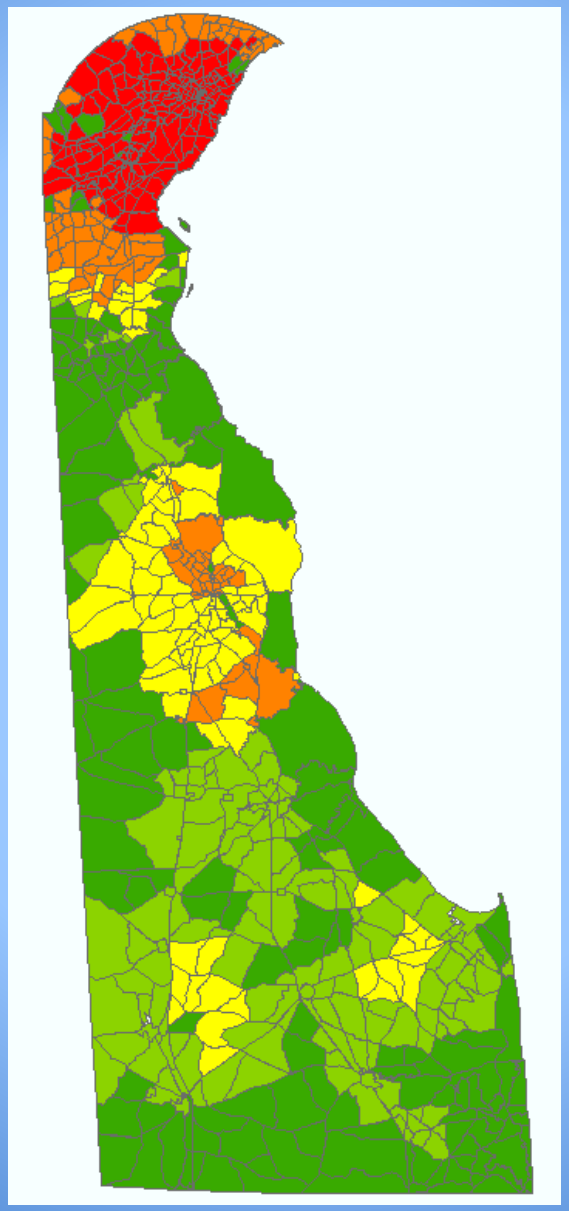


Number of destinations within a 10 minute walk with sidewalks

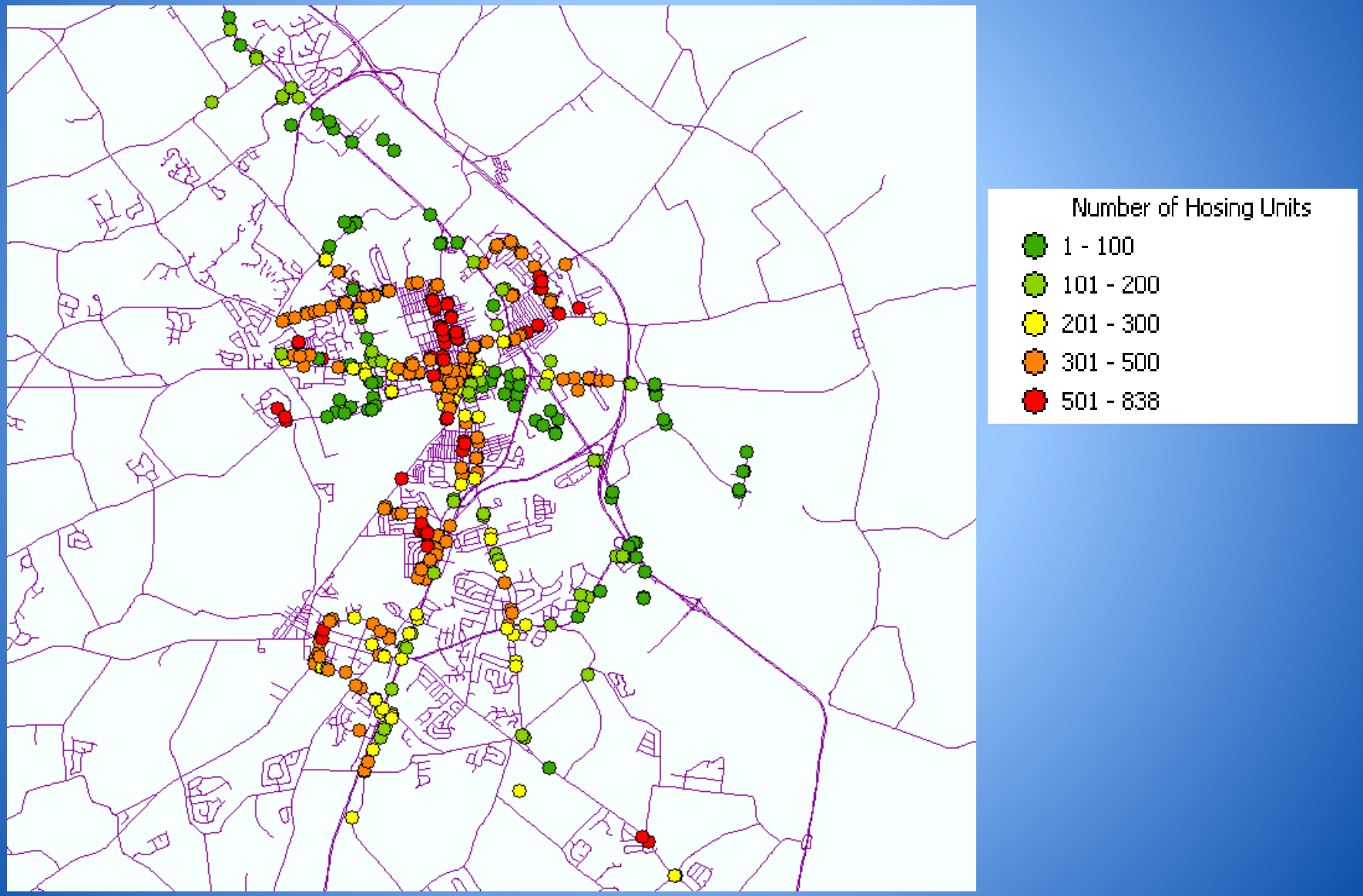
(LOS A) Dark Green 1-7, Light Green 8-16, Yellow 17-35, Orange 36-104, Red 105 and greater



Number of jobs within a 20 minute car ride



Number of housing units within a 10 minute walk for each bus stop



Applications

- Trip generation and mode split modeling
- Safe routes to school
- Predicting and modeling usage of new facilities
- Greenway and bikeway development
- Examining transit markets
- Developing statistics that describe benefits of mixed use housing
- Optimum location of facilities
- Others?

Summary

- Network Analyst and the network dataset model allows for a very detailed study of accessibility and generation of accessibility measures. Capabilities included in ESRI products are very extensive

- Significant advances are possible in comparison to previous studies that focus on methods such “as the bird flies” buffering type studies

- Detailed path and origin and destination data is more available in recent years. In some areas detailed data may not be available for wide areas but for many small area studies the data could be generated.

Summary

- How places are categorized has a great deal to do with the usefulness of any measure of accessibility and additional study is needed in this area. Accessibility to medical facilities, community services, or basic needs businesses like grocery stores would be of more interest than general commercial for instance.

- Accessibility in regards to level of service provides a much more meaningful measure in some cases.

Summary

- **Addition of new pedestrian and bicycle facilities could achieve better focus and support when measures of their effects are available.**

- **This study employed mostly Cumulative Opportunity measures but certainly gravity and place rank approaches can be more appropriate in some circumstances**

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  Study paper available at www.cadsr.udel.edu
  www.cadsr.udel.edu/projects/DOCUMENTS/statewideaccessibility.pdf