

Using Analytical Models to Site Medical Distribution Centers

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City of Alexandria
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Presentation Outline

- City of Alexandria
 - GIS and stakeholders
 - Project and model
- Arlington County
 - Project and model
 - Application and joint effort

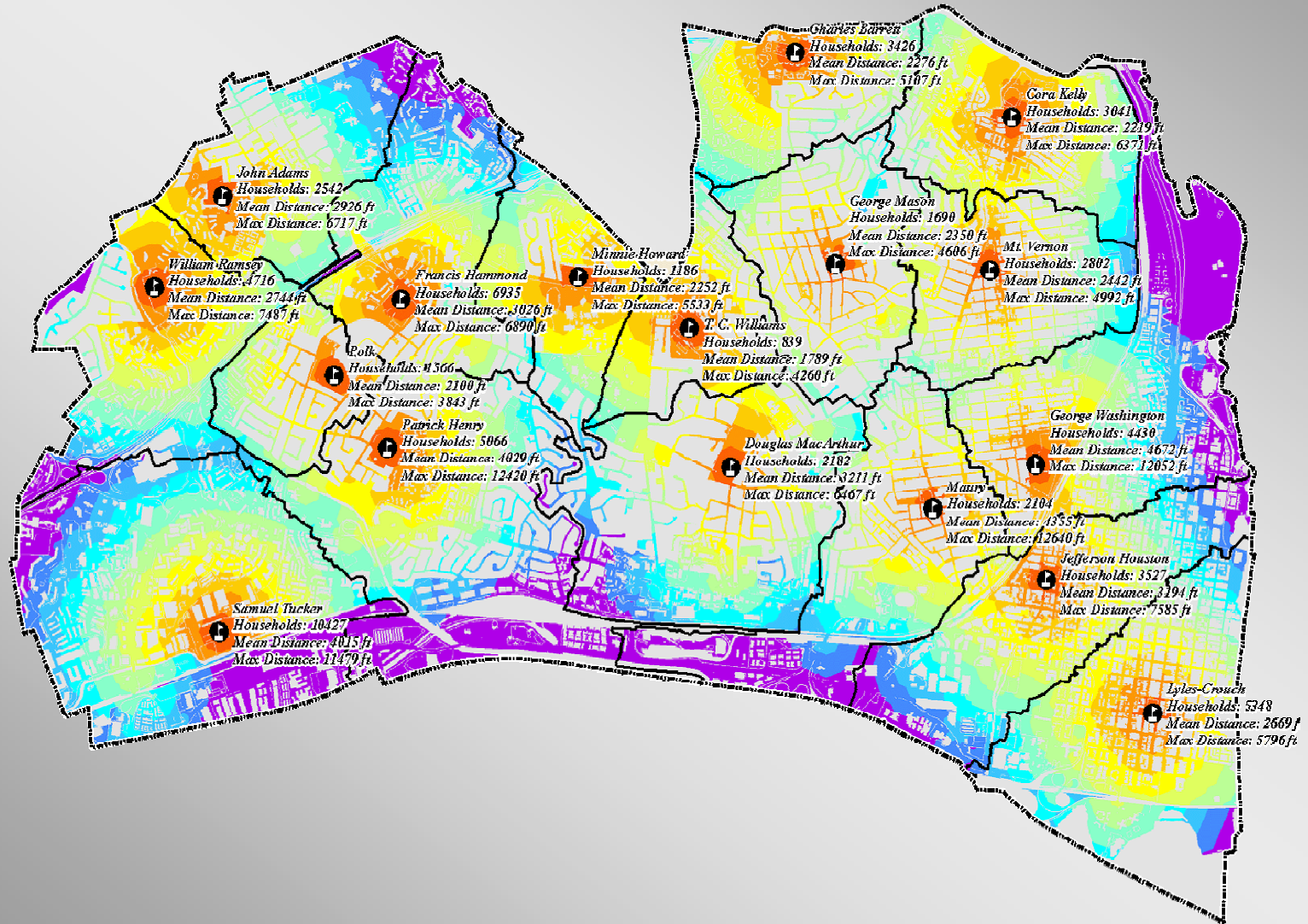
The Big Picture

When we fail to make Spatial Analysis part of the pre-event planning strategy, we can overlook critical selection criteria, such as the population each center might serve and its relative accessibility.

Under the City's default strategy, which uses schools as Emergency Medical Distribution Centers, portions of the City are effectively "cut off" from pedestrian access. To develop a better alternative, we generated a city-wide boolean raster model of pedestrian barriers ("Walking Accessibility Surface") and optimized allocations to centers based on walking accessibility, evenness of allocation, and landmark quality.

- Originated from CDC City Readiness Initiative
 - Aids state and local officials in developing plans that support mass dispensing drugs to 100% of the identified population within 48 hours of a decision to do so.
 - Provides funding to states, whose CRI jurisdictions cover 500 counties. This means that 56% of the US population lives within a CRI jurisdiction.
 - Awarded Metropolitan Statistical Areas (MSA) close to \$60 million in aid for 2006-2007
 - For more detailed information:
<http://www.bt.cdc.gov/planning/guidance05/pdf/appendix3.pdf>
- Transportation Modes for Citizens
 - Walking only
 - Between 1 and 1½ Mile Walking Distance

- Both jurisdictions received this project as a basic “buffer analysis”
 - Stakeholders in each City’s Health Department identified the need for a GIS role in the decision-making, but didn’t know the best way to answer the question at hand: how do we best choose and evaluate which sites we choose for emergency medical distribution centers?
- Alexandria developed the model, and Arlington became interested in participating through a presentation among regional health departments



The Question

- Assuming that the population is **on foot** during an Emergency event, what is the optimal **location** and **number** of Medical Distribution Centers?
 - Whether the emergency event is an Anthrax Plume or the Aftermath of a Hurricane, Medical supplies and services (e.g., Vaccines, Medications, Supplies, and Basic Triage) need to be distributed **efficiently and equitably** during and after it. This is why we need to make Spatial Analysis part of the pre-event planning strategy.

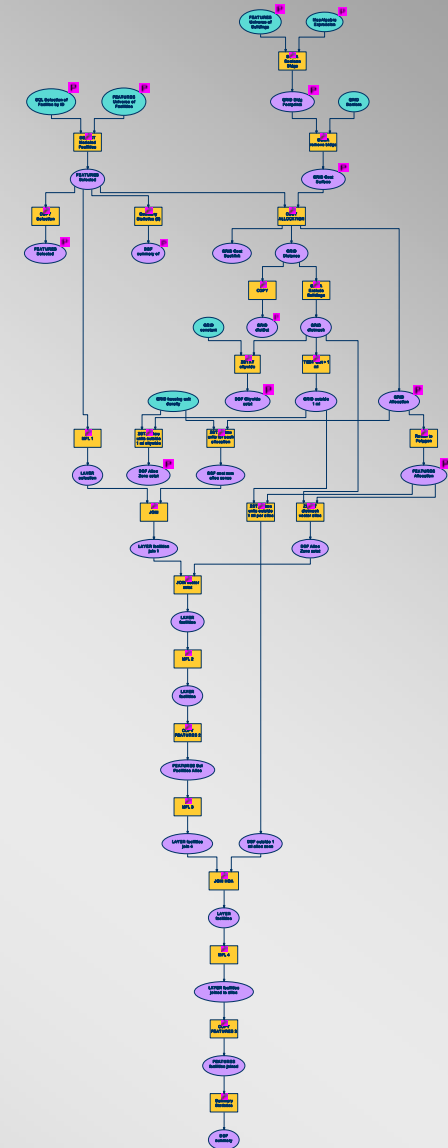
Walking v. "as the crow flies"

- E.g., people tend to avoid crossing into private residential property
 - We still need references for these assumptions



Tools & Inputs

- Tools
 - ArcGIS ModelBuilder
 - ArcGIS Spatial Analyst
- Inputs
 - Boolean raster surface based on 100-scale planimetric data (our “Walking Accessibility Surface”)
 - Paved areas and roads, sidewalks and crosswalks, building footprints, rail lines, parcels, even fences
 - Rasterize and classify barriers based objective rules
 - Housing Unit data
 - A proxy for family count
 - Assumption: one person from each family to use the center
 - Rasterize into housing unit density



The optimization

- How does the optimization work?
 - It starts with a 40-facility universe of potential sites for use as Emergency Medical Distribution Centers. To select the optimal number and configuration of these sites, we developed a model to iterate through siting alternatives and successively drop the lowest performer.
- What makes one configuration of Emergency Medical Distribution Centers better than another?
 - We assess the differences and optimize based on four metrics

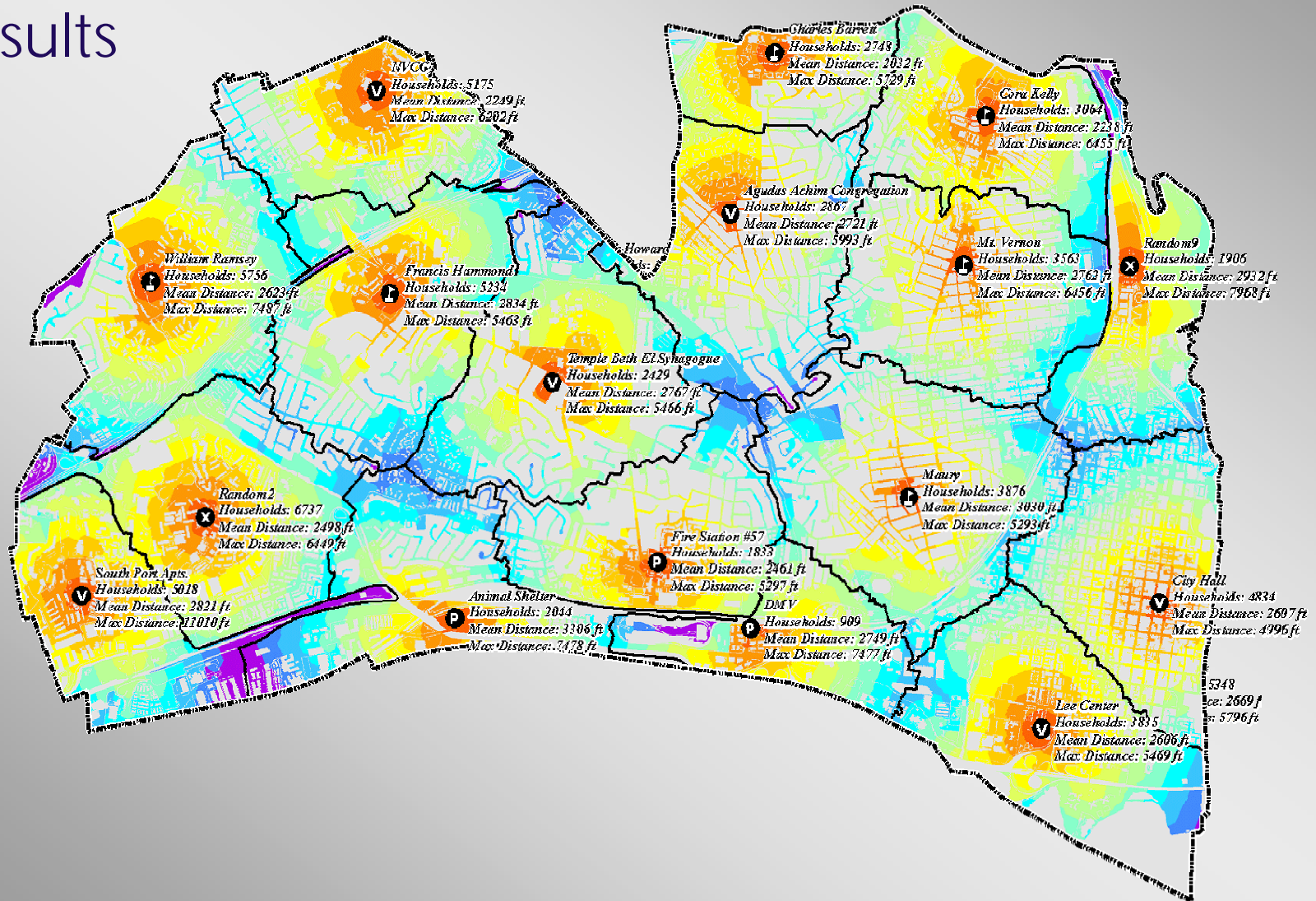
Metrics

- **(m4) Percentage of households outside** maximum walking distance (1 mile) to the nearest site (ensures centers are located where the people are)
- **(m3) Mean Walking Distance** from any given location in the city to the nearest facility
- **(m2) Evenness of the Population** Allocated to each site (assuming individuals will tend to walk to the closest facility)
- **(m1) Aggregate Landmark Quality** of the selected sites (e.g., a neighborhood school is more readily located than a church)

Key Assumptions

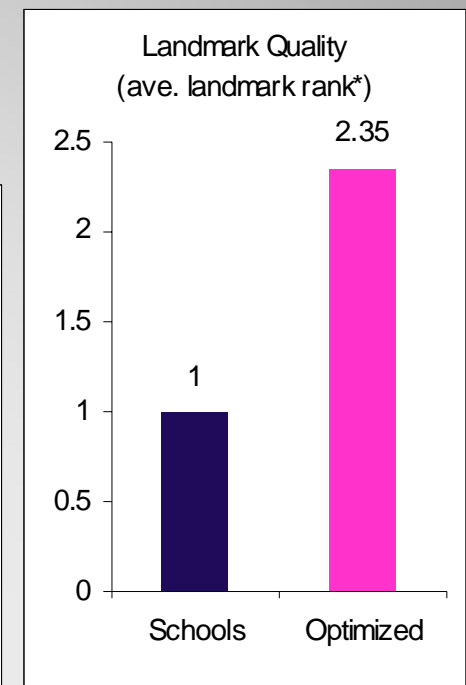
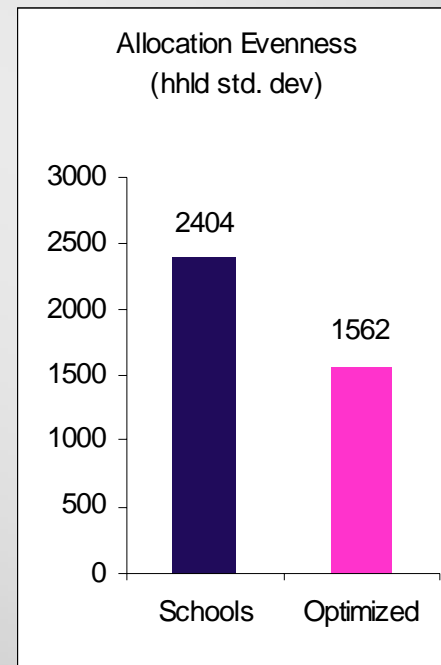
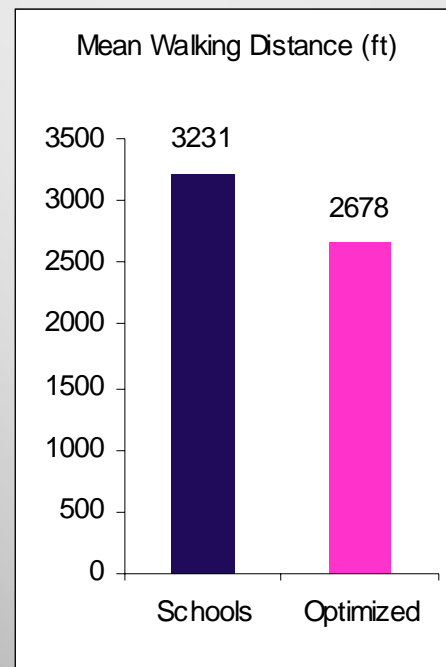
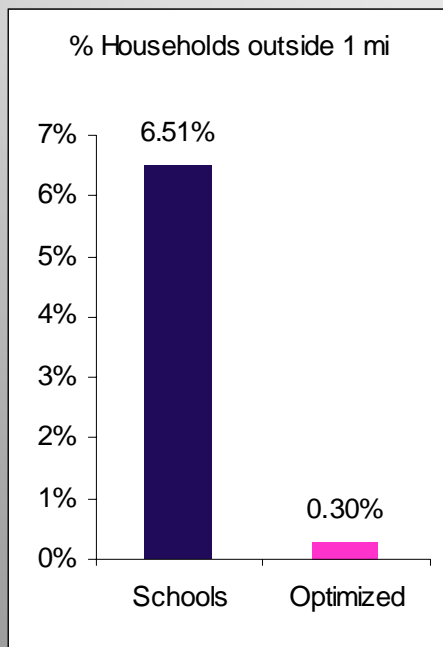
- Barriers to movement on foot include physical impediments such as fences, buildings, and water, and social boundaries such as private residential property lines
- Individuals will tend to walk freely over all other unfenced property, private or public
- Underpasses and overpasses provide the only bypasses for pedestrian access through major highways

- Results



Results

- Metrics – Before and After optimization
 - Baseline = “schools only” scenario



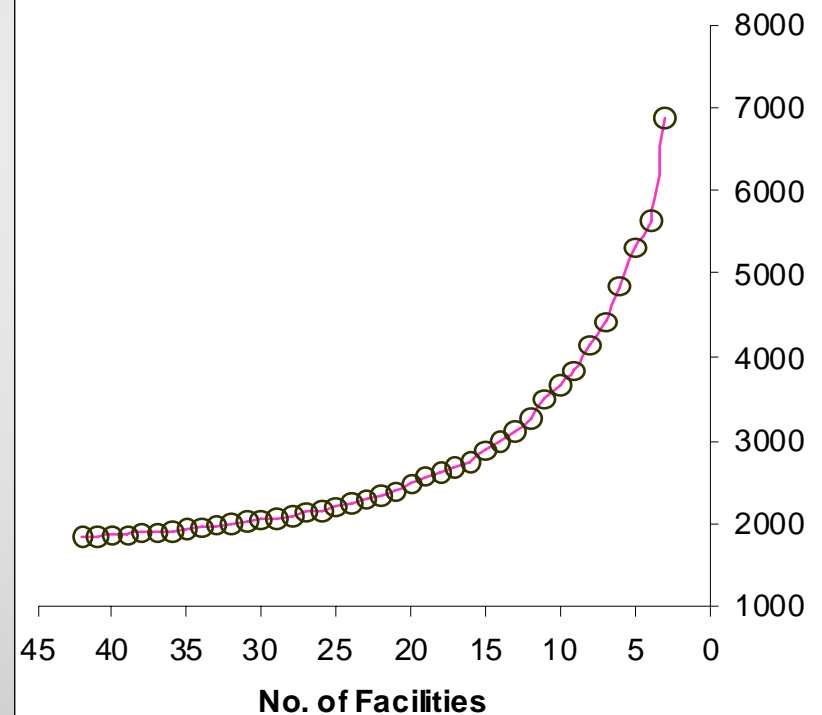
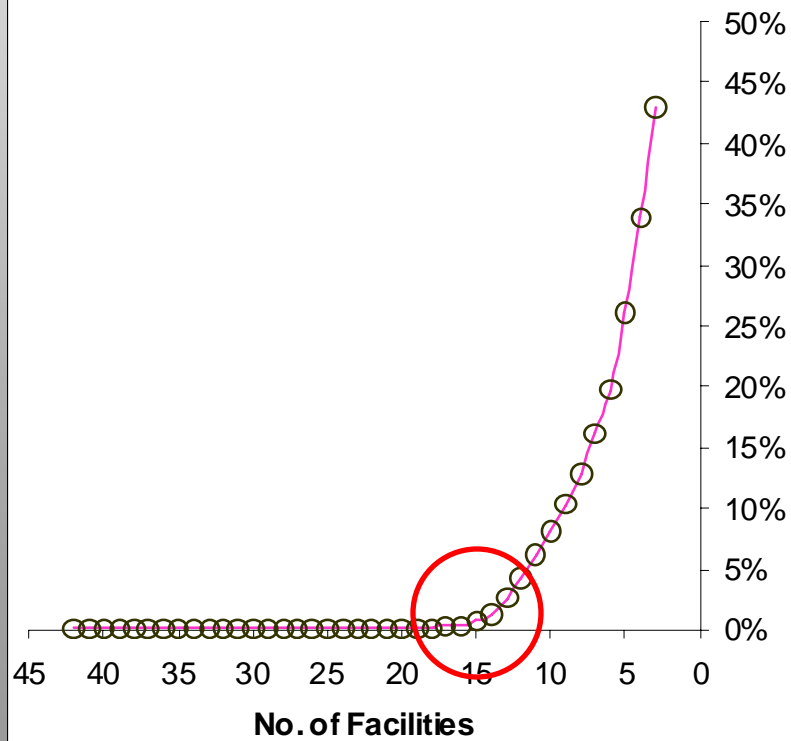
Results by Iteration

(m4)

(m3)

% Households outside 1 mi Walking Distance from Selected Facility

Mean Walking Distance (ft)



Arlington's Medication Model-Overview

- Based on the Alexandria Model
- Model Scenario from the County's Health Planner and the CDC City Readiness Initiative
- Initially Two Models: 1 mile and 1½ mile walking distance
- Model relied heavily on Human Input

- Emergency Centers
 - Medication Centers (MC)
 - Deliver medicine in first 48 hours
 - Medication Center's should be less than a 1½ mile walk for Head of House Hold one way
- Medication Center Staffing
 - ~20 staff/MC
 - Estimated 1 Head of House Hold Processed, from start to finish, in 5 Minutes
- Phase Approach for Opening MC's
 - Two Phases (Phase 1: 1½ Miles Model; Phase 2: 1 Mile Model)
 - Phase 1 only covered in this presentation
- Arlington Demographics
 - 2000 Census: 86,352 House Holds (HH)
 - 2008 Estimates: 96,069 House Holds (HH)

Medication Center Selection Criteria

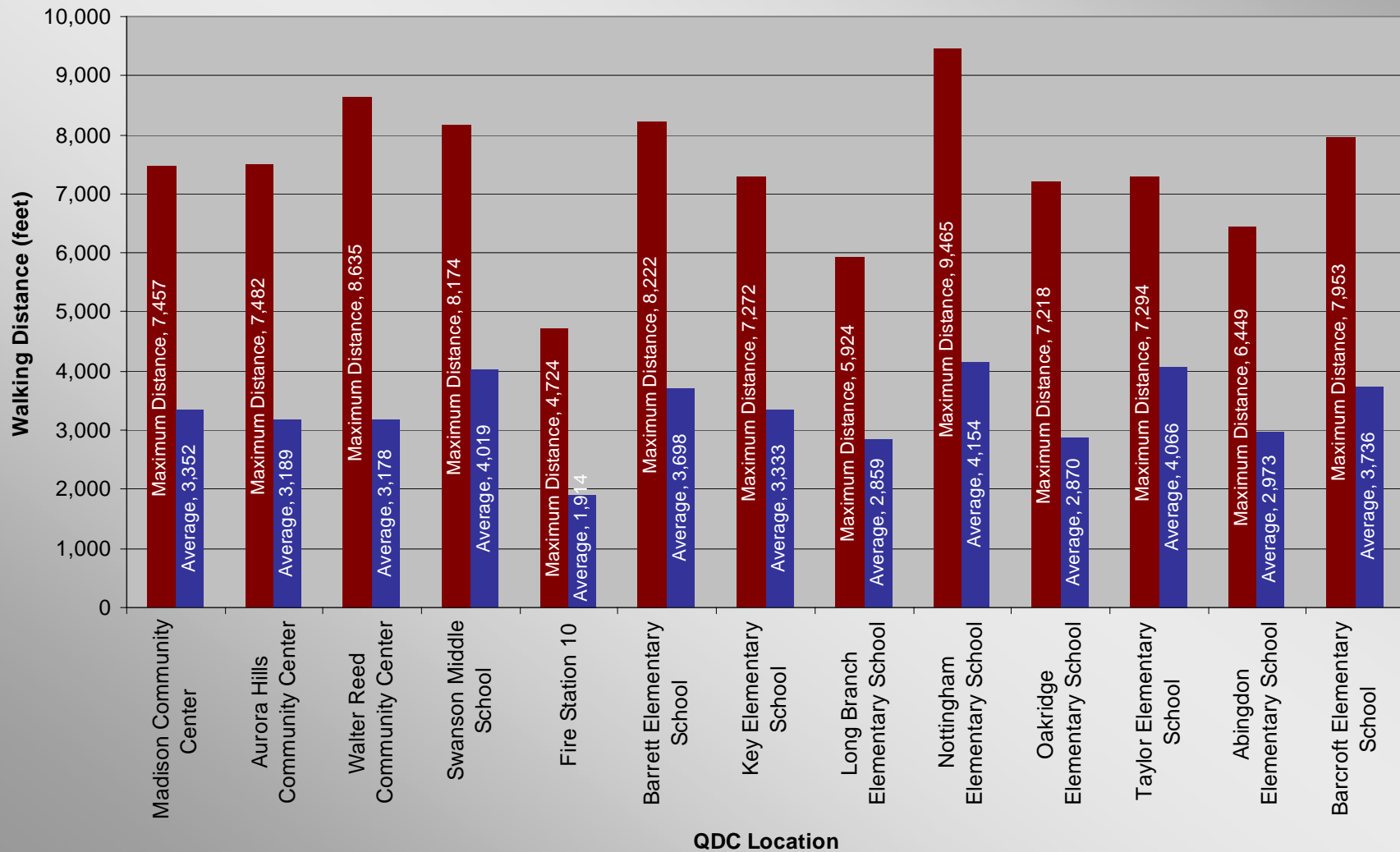
- Medication Centers
 - Elementary School only model would not provide the coverage that is needed.
 - Medication Centers were selected primarily by the County's Health Planner-
 - Community Centers were identified as prime locations due to the fact that they are County Property and there is no need for a legal agreement between the County and the Owner of the facility.
 - Elementary Schools were also identified as prime locations since they are also County Property, but they hold certain restrictions to the use of the building, and thus, they are secondary to Community Centers.
 - Polling Places were considered as possible Medication Centers, but due to the fact that Arlington County does not own all the Polling Places in the county could make it difficult to open the facility in an medical emergency event.

Arlington Model Differences

- Arlington County Medication Center Model
 - Arlington County's Model is based on the Model created by Alexandria
 - Major differences are the method of which we selected our Medication Centers.
 - Arlington relied heavily on Human Input for the selection of the Medication Center that would be used (Alexandria relied on a large collection of sites and used iteration to select Medication Centers)
 - Arlington's physical landscape is different from Alexandria's, and thus, created a barrier to use the original Model from Alexandria
 - Large number of parcels in the County are Zoned for Single Family Residential in the Northern Arlington, and Multiple Family Residential (i.e. Condos and Apartment Buildings)

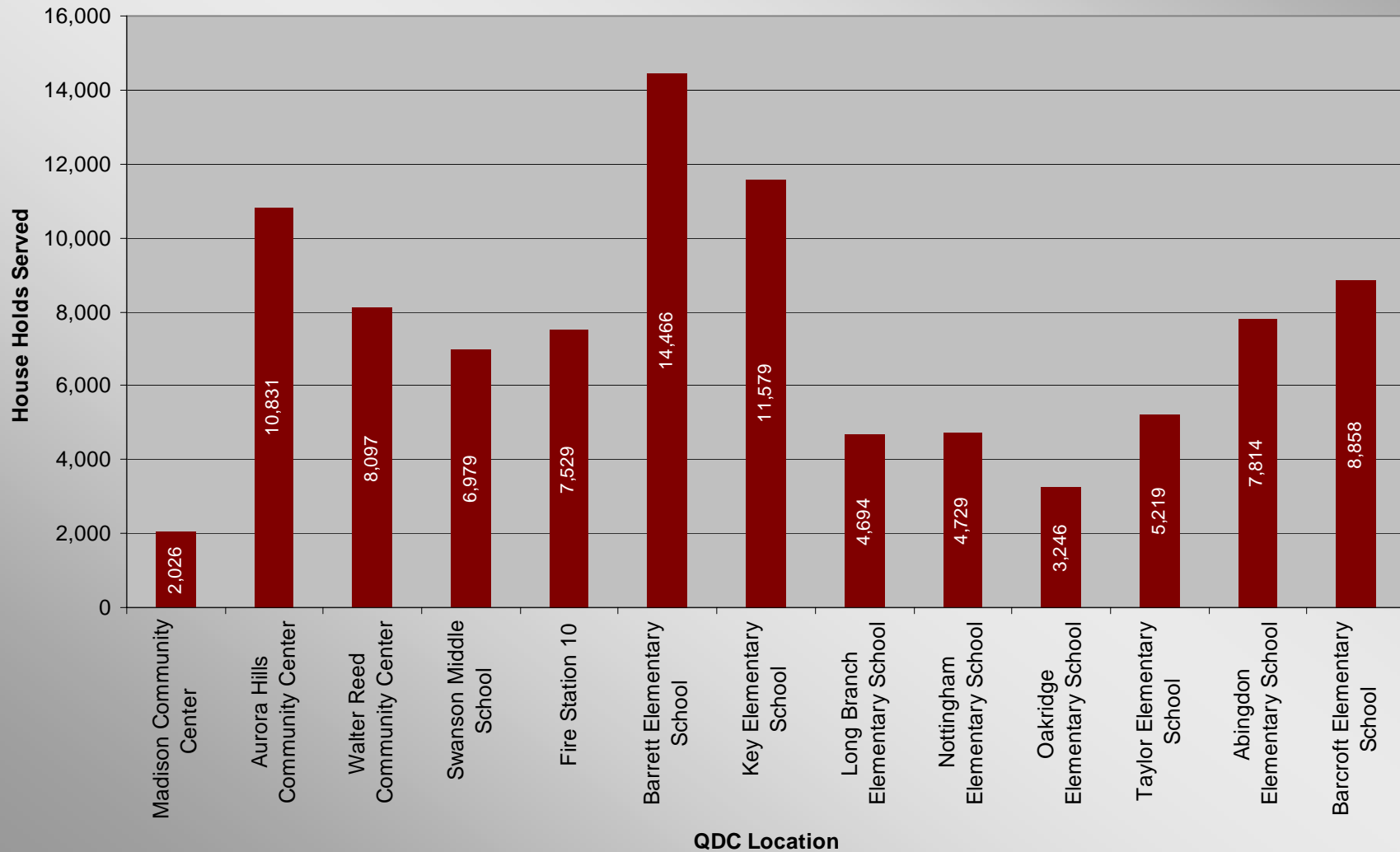
Arlington Model Results

Average & Maximum Walking Distance per QDC Phase 1A

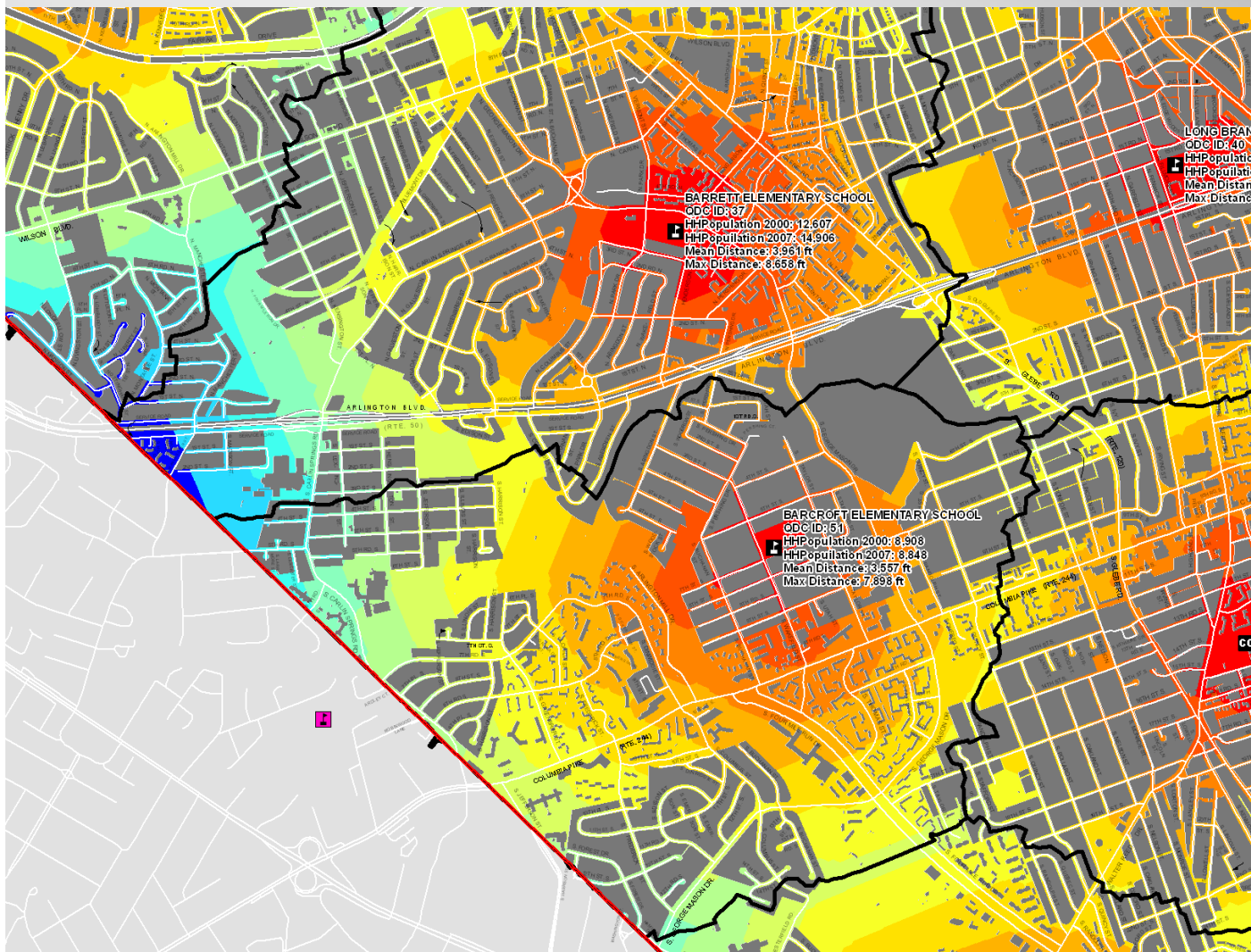


Arlington Model Results

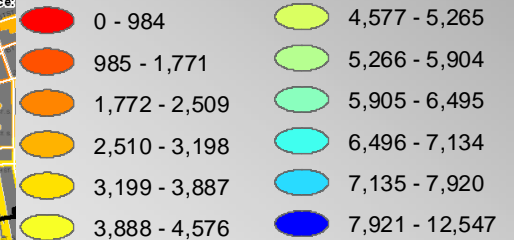
Total House Holds Served (2008) per QDC Phase 1A



Arlington Model Results



Distance from QDC
distance in feet



Key Similarities and Differences

- Similarities
 - Both adopted essentially the same raster cost allocation model, built in ModelBuilder
 - Both used an extensive and detailed cadastral/planimetric database to derive areas accessible by walking
- Differences
 - Alexandria identified a large universe of sites and used model iteration to select an “optimal” distribution of sites
 - Arlington used local knowledge and human inputs to identify sites and evaluate site distribution

Model into Reality

- With many geospatial analysis projects, we rarely get the opportunity to witness their model being implemented in the real world.
- This coming Fall, Arlington County and the City of Alexandria will be conducting a joint cross jurisdictional public health exercise to test the validity of the Medication Center Models.
- The participants of this joint exercise will be asked to fill out a survey to identify certain key questions, such as:
 - The Beginning Location of their trip
 - Did they walk or utilize public transportation
 - Route taken to reach medication center
 - Was this an easy trip to make
 - Was the center easily found
- With the Survey we will be able to better model the real world in our GIS Models for the Future.

- For best optimization, identify a large universe of potential sites (but don't forget that each site adds hours of run time)
- Start with good data (e.g., spatially explicit population data)
- Make performance a key concern – changing scenarios ideally should not induce days of computer crunching
- Gather literature to backup key assumptions

Future Developments

- Update population data (2000 Census does not capture some of our new and growing population centers)
- Test the sensitivity of model assumptions to metric weighting and review the process
 - Performance is a big concern
- Refine assumptions on walking behavior through field testing and literature review
 - The “perceptual” component is difficult to capture
- Incorporate terrain and/or barrier gradient into the cost allocation analysis

How is this being applied?

- Sometimes GIS people don't get to see how their work is applied
- This fall, there is going to be an exercise to apply and test the selected sites

Questions???

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