

**Background and Motivation: Discuss your motivations and reasons for choosing this project, especially any background or research interests that may have influenced your decision.**

My thesis research deals with modeling the transportation network impacts of inundation events on the Boston metro region. Inundation events (flooding events where networks are degraded or disabled) are serious threats to coastal cities around the world. Such events can have major impacts on regional transportation networks, as seen in NYC in the aftermath of Hurricane Sandy. I have sought to develop an understanding of potential inundation consequences on the Boston metro region by conducting two related analysis.

1. A GIS analysis- cataloging and quantifying likely impacts to transportation assets and driver of transportation demand (people & jobs)
2. A transportation modeling analysis using the Cube Voyager modeling platform to model the impact of inundation events on the regional multi-modal transportation system from 1ft to 6 ft.

This research has provided me with large amounts of data that I would like to display in an interactive web based format.

Thesis Defense PPT: Has more information on topic and outputs (If interested):

[https://www.dropbox.com/s/o6vfy2cofbsonvr/DefensePPT\\_M30.pptx?dl=0](https://www.dropbox.com/s/o6vfy2cofbsonvr/DefensePPT_M30.pptx?dl=0)

**Please note** that visualizing this data is not a requirement of my thesis and will not be broadly included in the thesis document. This visualization project is not considered a component of my thesis grade- cs171 is the only course that will consider my project for grading.

That said, it is a very interesting data set that provides information on:

- the location, number and extent of transportation assets inundated at water levels from 1 to 6ft.
  - Roads, transit stops, land use, population, etc
- Modeled traffic flows given a damaged and degraded road network
- Locations of major congestion given an inundation event
- transit ridership by all transit routes and modes,
- number of trips not able to be completed due to inundation (Lost Trips & their origins and destinations)
  - by trip purpose (work, school, shopping, etc)
- Changes in accessibility by traffic analysis zone by walk, transit and automobile.

**Project Objectives. Provide the primary questions you are trying to answer with your visualization. What would you like to learn and accomplish? List the benefits.**

I have analyzed much, but not all, of this data using python, Arcgis, TransCAD and Excel already. I understand what kinds of questions the data can answer but I am trying to find ways to communicate this data more efficiently.

Furthermore I want to find ways to communicate and share the data with others who do not have the same software packages available, or possibly the technical expertise required to deal with the data.

The primary questions I would want a user to be able to answer after interacting with the visualization would be:

- The location, count, and extent of impact given inundation at different levels
- The shifts in transit ridership caused by degradation: For example of the Red Line is disabled what are some of the buses that experience increased ridership - i.e. people who are likely changing their route
- How accessibility changes for different modes given different inundation levels.
- Congestion Hot spots given inundation
- Be able to compare the results to a non inundated scenario

**Benefits:**

- Provide people with an understanding of possible inundation impacts on the transport network
- Provide understanding of the impact to peoples personal modes, streets, routes of interested. For example: allow a user to examine if at a certain inundation level the streets or bus/train they use would be compromised
- Provide policy makers with broad metrics of the expected impacts of such inundation events:
  - Total Lost trips by inundation level
  - Changes in:
    - Vehicle Hours Traveled
    - Vehicle Distance Traveled
    - Congestion Hot Spots
  - Other metrics of interest

**Data: From where and how are you collecting your data? If appropriate, provide a link to your data sources.**

- I already have the data- most of it is in tabular format (dbf & csv).
- I also have network data that I can convert in to Shapefiles and then into GeoJSON. The only concern with the network data is that it quite large (264,000 Links). I'm not sure if D3 will be able to display this data efficiently. I don't think topojson will make much of a difference since I am dealing with links, not polygons.
- Finding a way to display this data dynamically may be a challenge.

**Data Processing. Do you expect to do substantial data cleanup? What quantities do you plan to derive from your data? How will data processing be implemented?**

I do not expect to have substantial data cleanup but there will be some.

- I will need to convert much of my data in to JSON format, but I've already been playing around with the Python Pandas.toJSON function and believe that it can be used for most of the tabular data.
- I will need to develop a strategy for dealing with matrices – suggestions would be appreciated – I assume key value pairs (O-D) in a JSON format would likely be the fastest (?)
- Again the network data – I may have to use a smaller clipped network, or remove some of the minor links in the network.
- Some of the data is output as text report files, but I have already written a few python scripts that extract this data to PANDAS Dataframes, I may need to write a few more of these scripts, as there are different formats but I am fairly comfortable doing this.
- There will also be some data formatting and aggregation but between python & JS I do not anticipate the data cleaning to require excessive amounts of time.

Visualization. How will you display your data? Provide some general ideas that you have for the visualization design. Include sketches of your design.

Accessibility Impacts of Inundation:

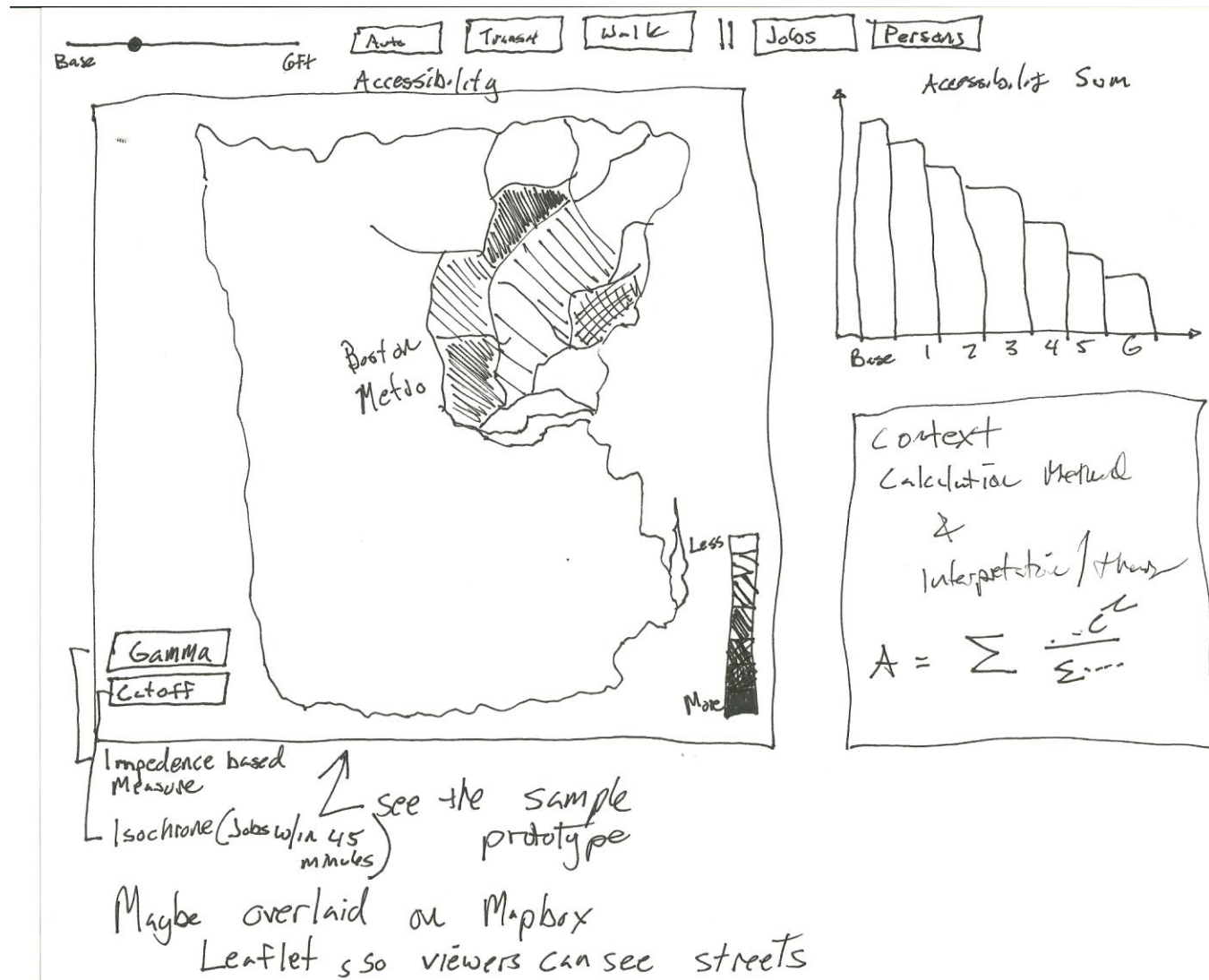


Figure 1: Accessibility Visualization Example

See Prototype Example: <http://mdgis.github.io/>, still needs a lot of work but I've already started trying to create this design.

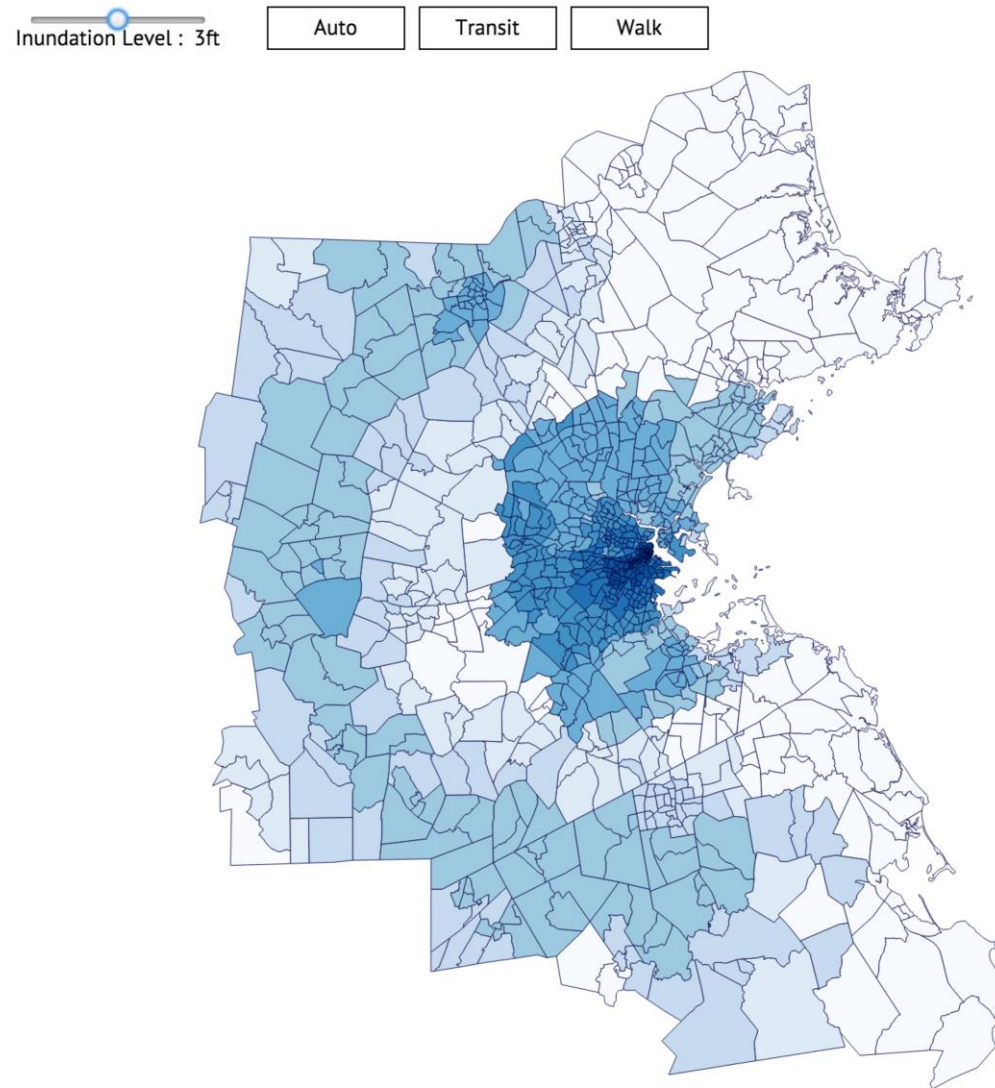


Figure 2: Screenshot of current prototype

This design will include information on the side about the how accessibility was calculated, the accessibility sum (a measure of regional accessibility) and a chart showing the change over the different inundation levels.

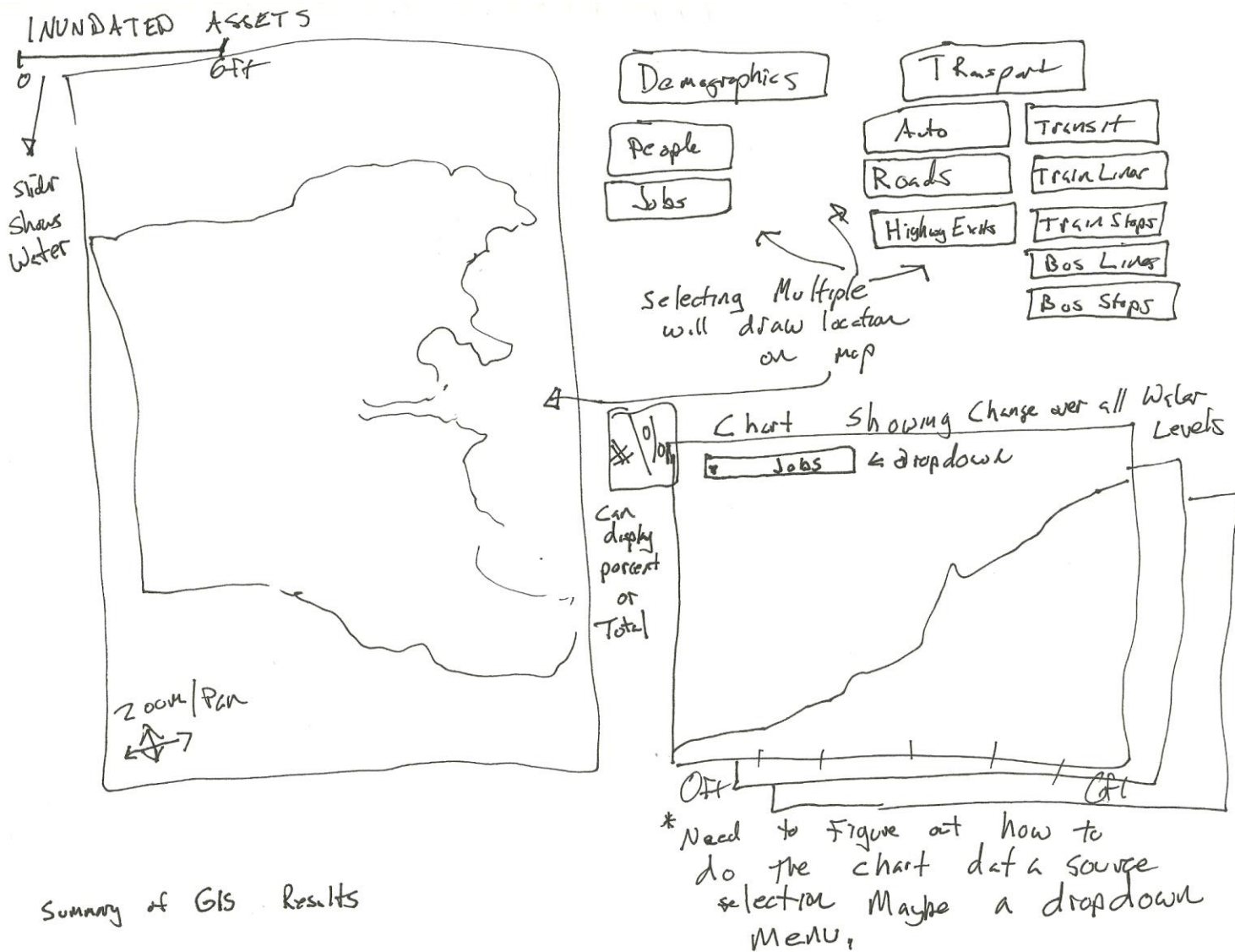


Figure 3: Inundated Assets



## Results: Transit (Supply Side)

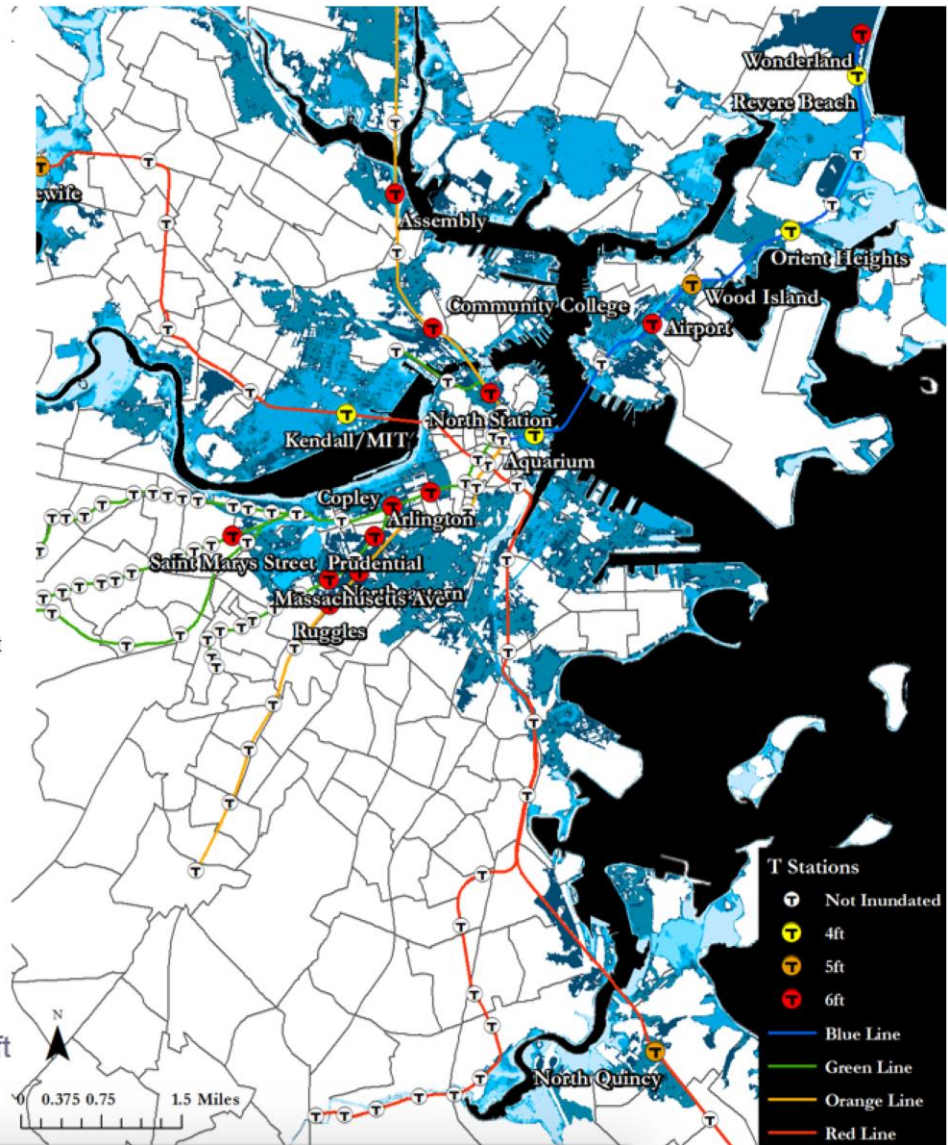
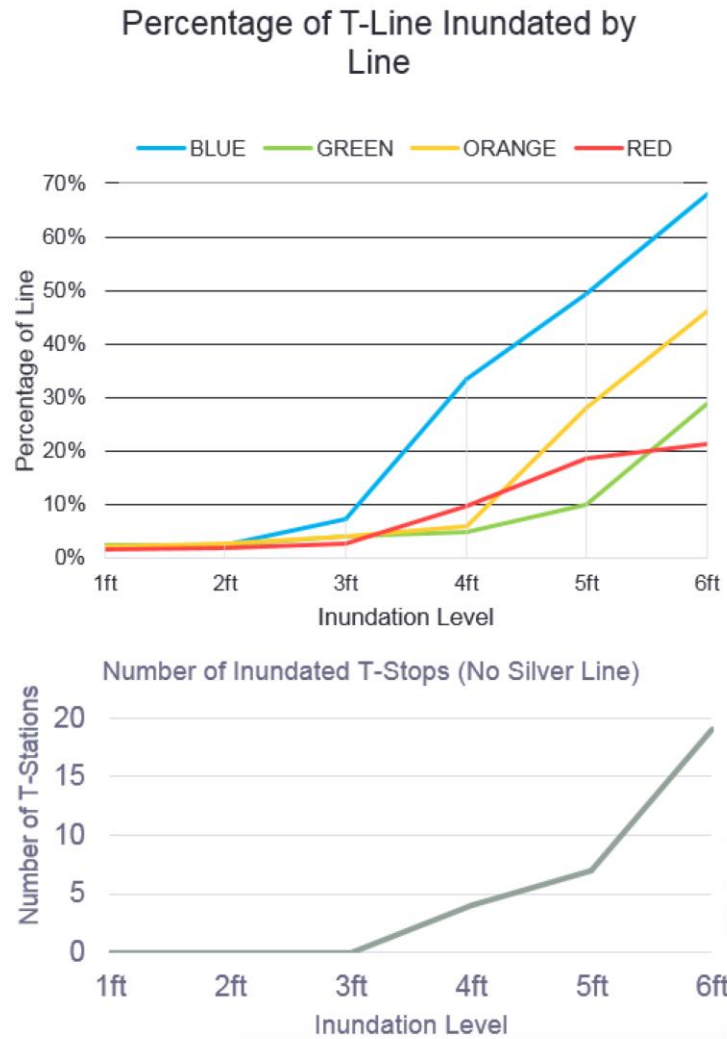


Figure 4: Example of Inundation Layers / Inundated Transit Assets / Change over Inundation Level

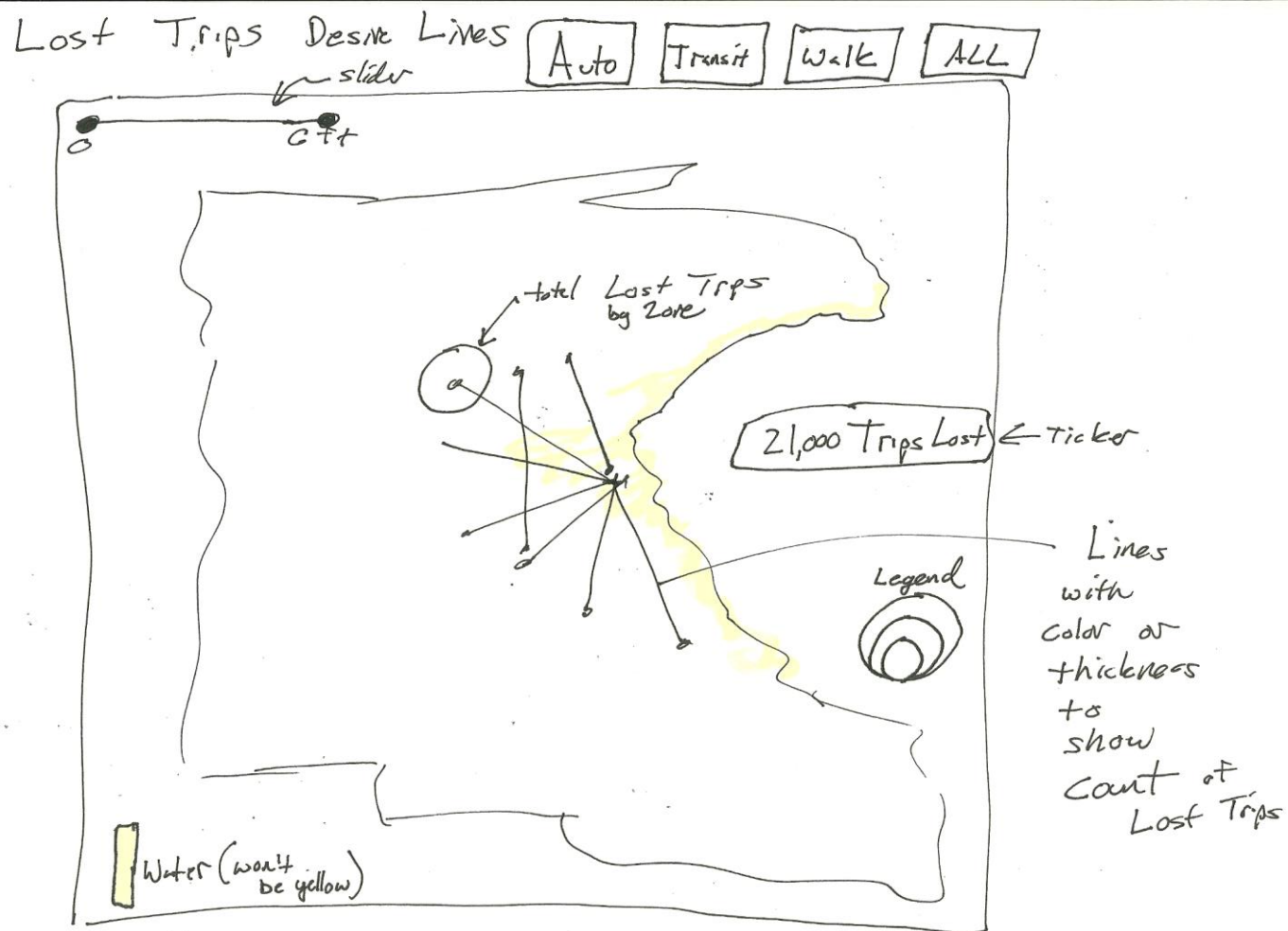
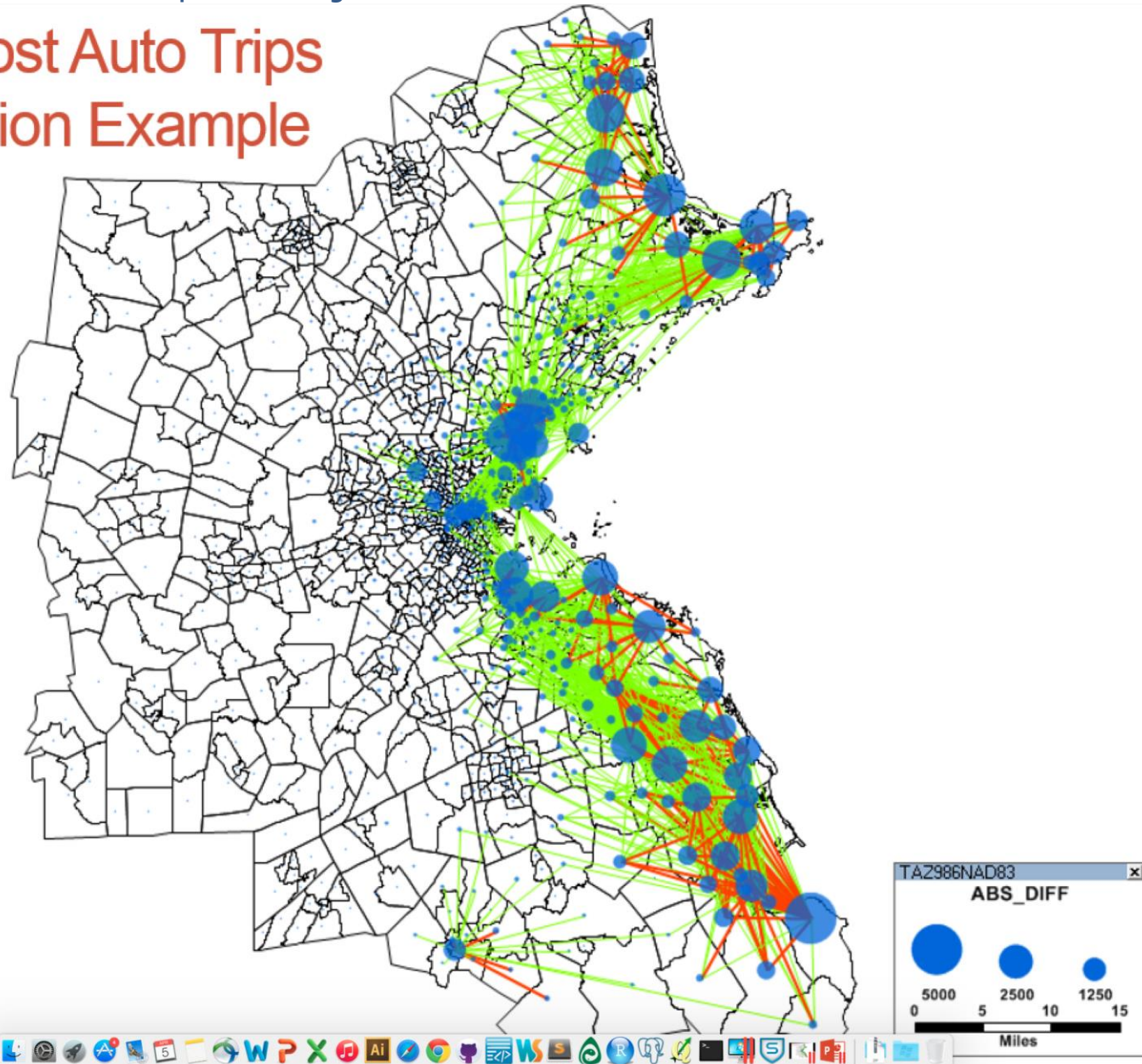


Figure 5: Lost Trips / Desire Line: Data taken from matrices with information on the trips that cannot occur because of network inundation.



Example Generated in TransCAD Transport Modeling Software:

## Results: Lost Auto Trips 4ft Inundation Example



General Metri

Figure 6: Example of lost trip by Auto Desire Lines – Line color indicates number of trips and circles indicate the total number of lost trips by Traffic Analysis Zone.

Lost Trips For Public Transit:

## Results: Lost PT Trips 4ft Inundation Example

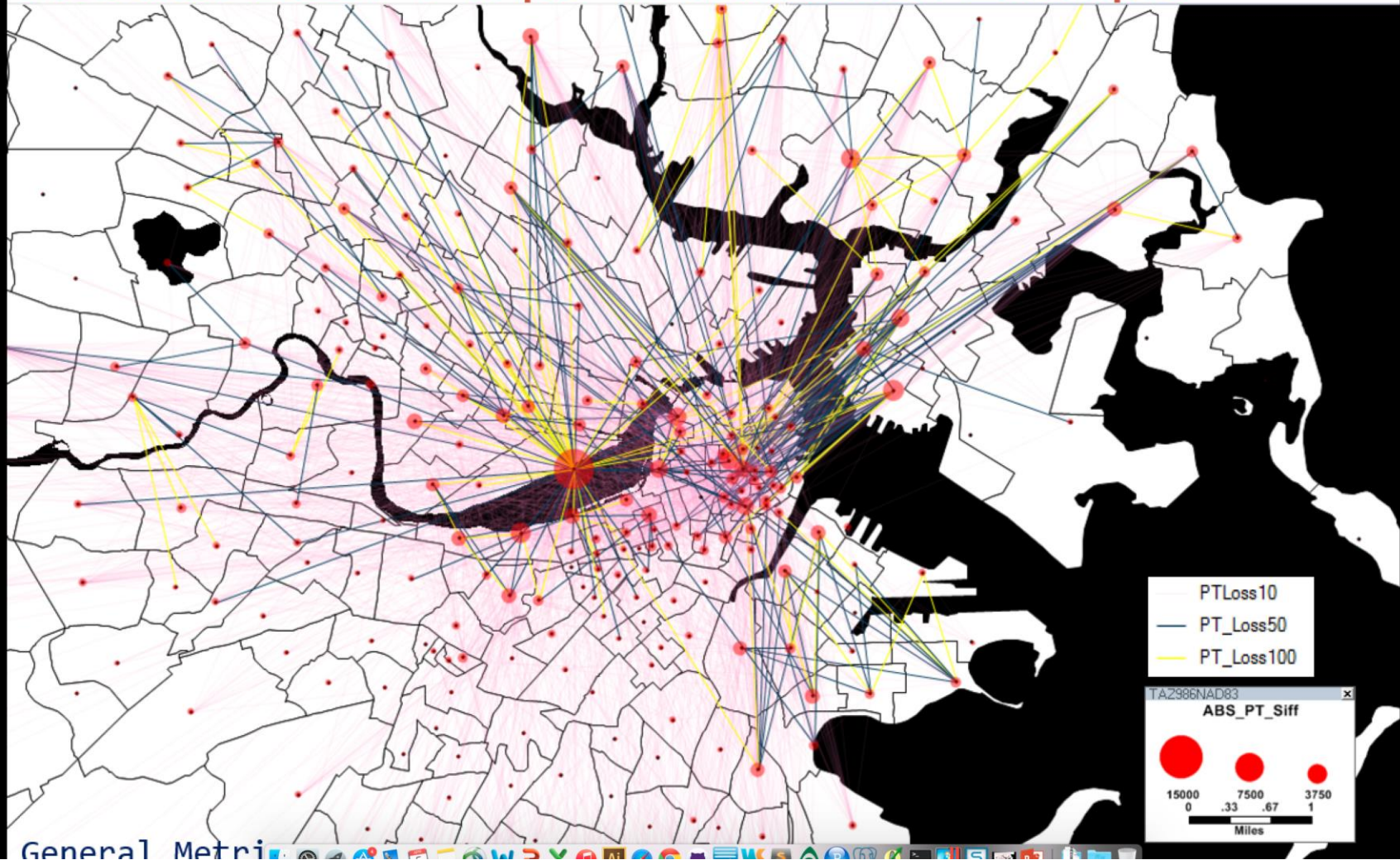


Figure 7: Same as previous but transit trips



## Auto Summary

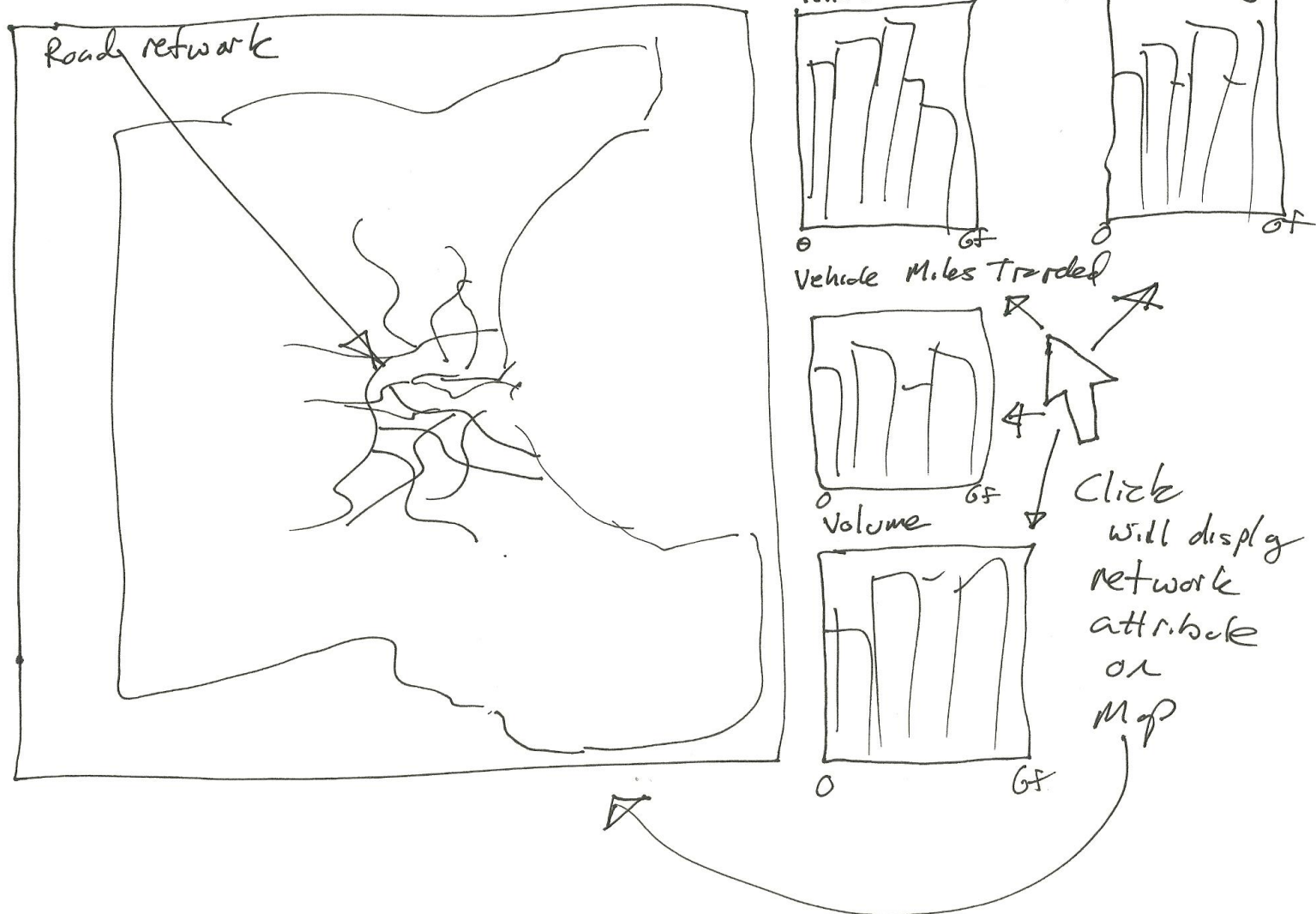


Figure 8: Auto Network Summary

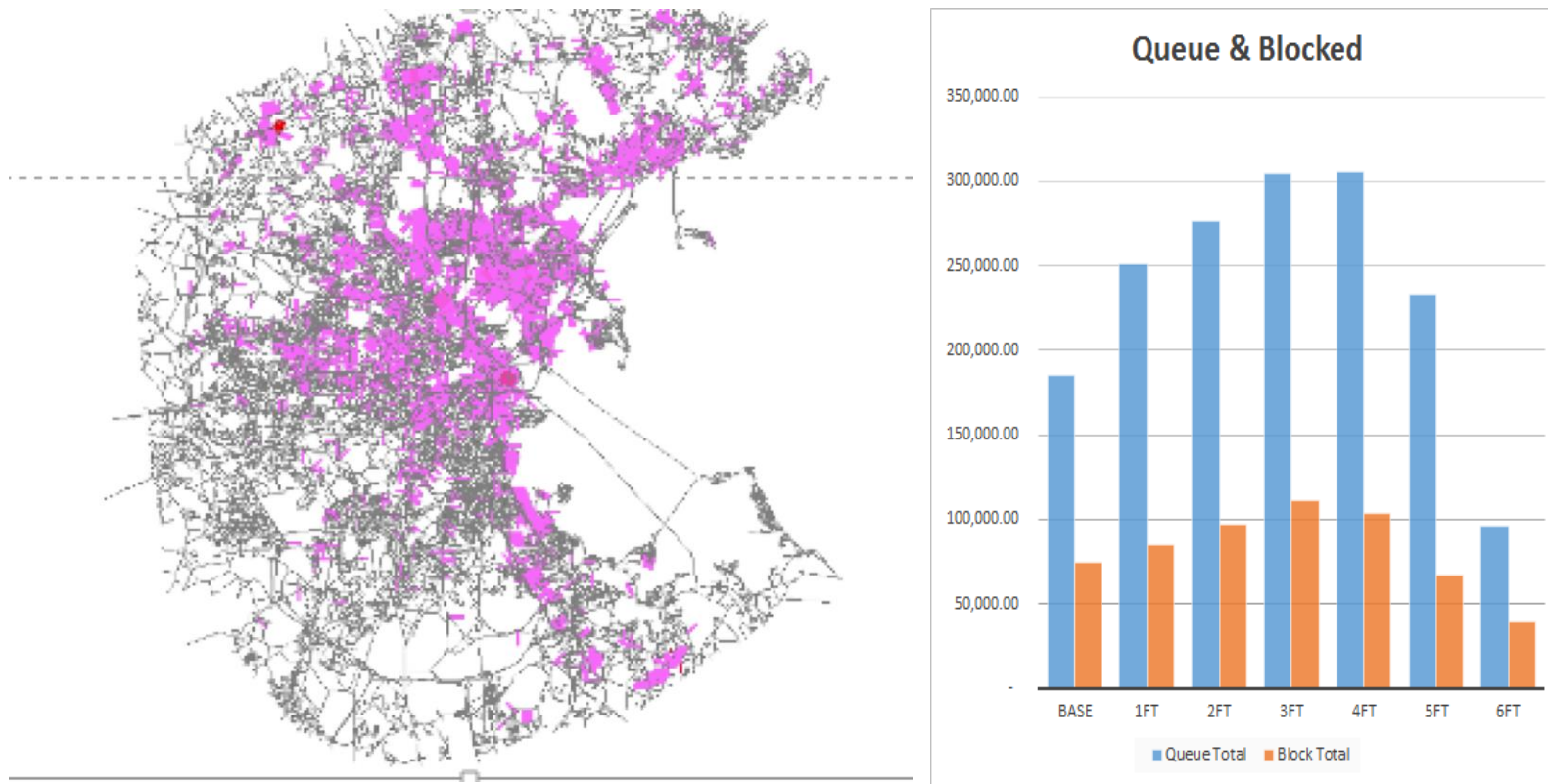


Figure 9: Network (Smaller Extracted Network) Congestion Hot Spots & Queued Vehicle Chart

**Must-Have Features. These are features without which you would consider your project to be a failure.**

- Transportation Assets inundated at 6 different inundation levels. This would be a map with charts on the side showing at each water level (1-6ft) where certain assets were located and in the chart showing the extent of the impact, likely showing both totals & percentages.
- Accessibility impact maps for walk, transit and auto.
- Network impacts charts – description of the congestion impact – if animated network visualization is problematic then a simplified version with more linked charts could be used.
- Some visualization of the number of trips lost by zone – if desire line are problematic then I may do it by simple circle shapes overlaid on the geography.

**Optional Features.** Those features which you consider would be nice to have, but not critical.

- Desire line chart
- Another visualization showing the changing ridership of different transit lines over the different inundation levels.
- My data has information on queues on network links for every 5 minutes totaling 90 minutes. Some sort of animation of these queues would be really interesting but may not be possible
- I also have information in “packets” of vehicles and the path they use on the network, the data comes in as a list of sequential nodes that packet used to complete its trip. Some sort of animation of these would also be wonderful, but I think it might be too challenging.

**Project Schedule.** Make sure that you plan your work so that you can avoid a big rush right before the final project deadline, and delegate different modules and responsibilities among your team members. Write this in terms of weekly deadlines.

April 5 <sup>th</sup> – April 11 <sup>th</sup>	<ul style="list-style-type: none"><li>• Data wrangling</li><li>• Working prototype of accessibility maps</li><li>• Early prototype of inundated asset maps w/chart</li></ul>
April 12 <sup>th</sup> – April 18 <sup>th</sup>	<ul style="list-style-type: none"><li>• Strategy and prototype of network impacts:<ul style="list-style-type: none"><li>◦ Figure out how to display the network while maintaining speed of visualization, highlight areas of congestion at different water levels.</li></ul></li><li>• Early prototype of Desire Line Lost Trips visualization</li></ul>
April 19 <sup>th</sup> – April 25 <sup>th</sup>	<ul style="list-style-type: none"><li>• Decide on Final List of Designs / if some of the optional features are not working at this point – they may have to be abandoned.</li><li>• Finished Accessibility / Inundated Assets Visualization</li></ul>
April 26 <sup>th</sup> – May 2 <sup>nd</sup>	<ul style="list-style-type: none"><li>• Finalizing Designs / Polishing</li></ul>
May 3 <sup>rd</sup> – May 5 <sup>th</sup>	<ul style="list-style-type: none"><li>• Polish things up / Screen cast</li></ul>