

Charger Placement Project

City of Grand Rapids



11-18-2019

This study is commissioned and funded by the
Michigan Department of Environment,
Great Lakes, and Energy.



MICHIGAN DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY



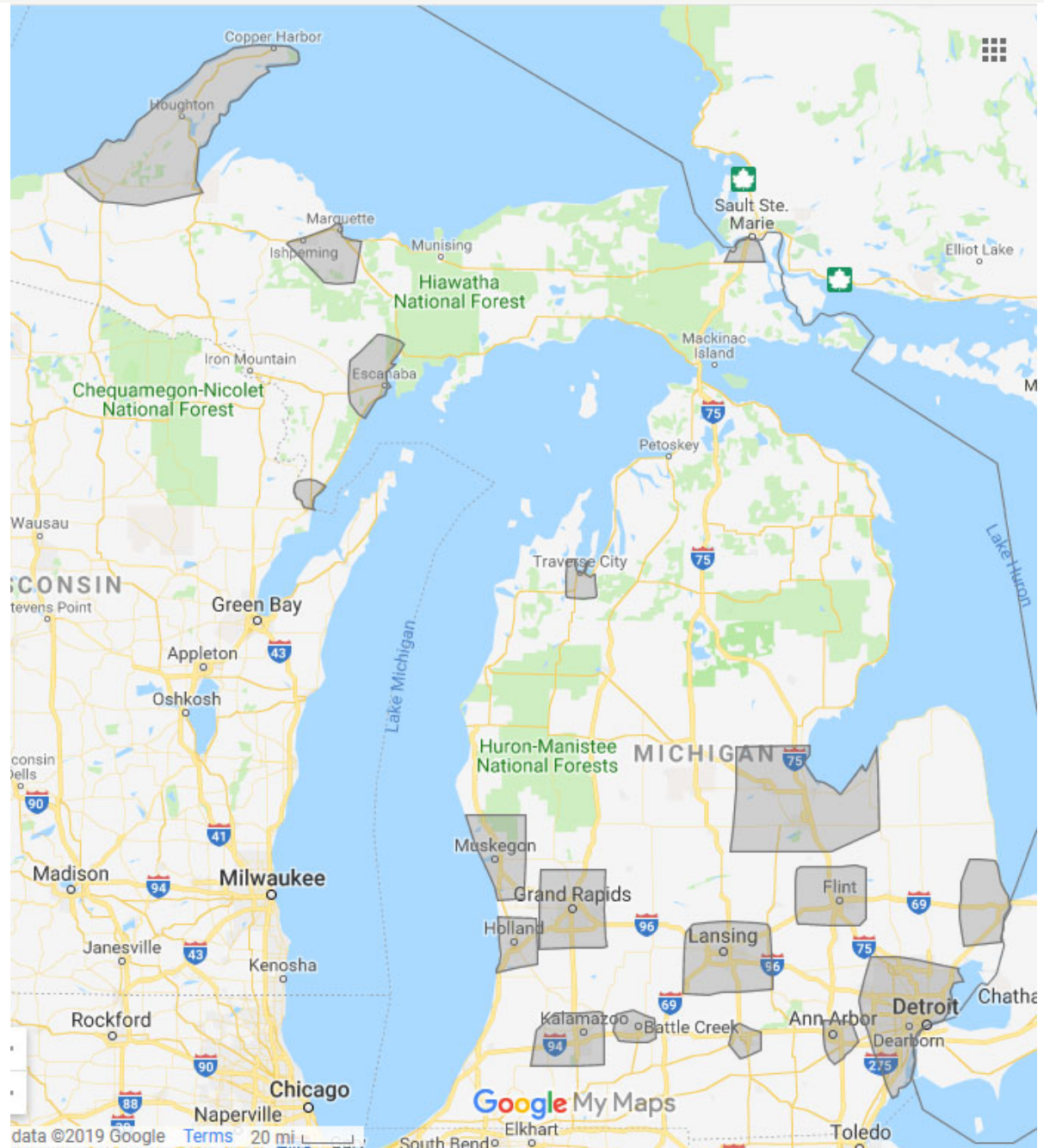
Outline

- Selected Cities
- Modeling Framework
- Data Collection
 - Candidate points
- Preliminary Results



Selected Cities

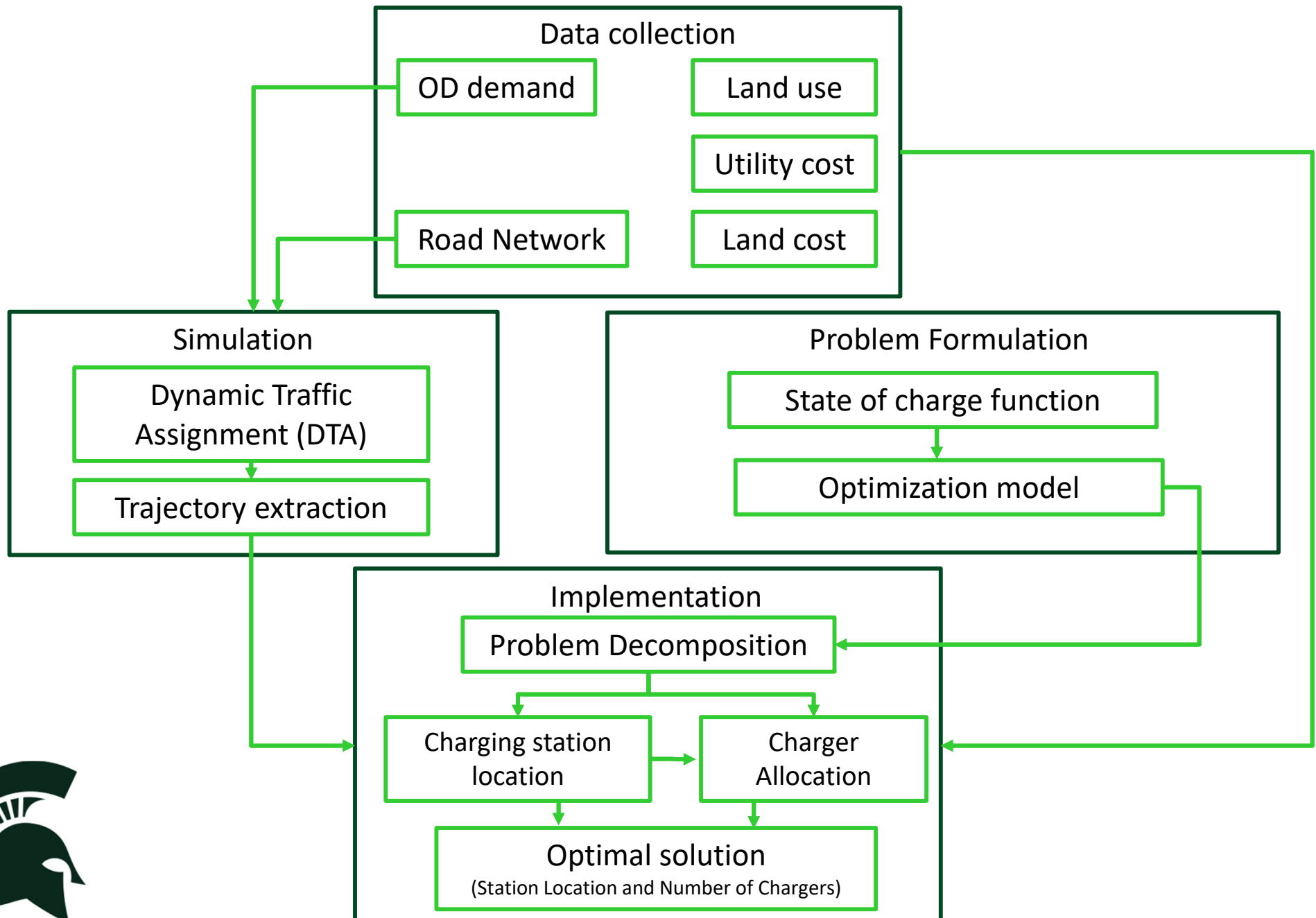
Muskegon
Ann Arbor
Kalamazoo
Flint
Saginaw
Lansing
Grand Rapids
Detroit
Marquette (UP)



Summary of Information

Cities/Parameter	No. of Nodes	No. of Zones	Generated Demand	Generated Demand (without Intra-Zone)	Lane Length (mi)	Miles Traveled
Marquette	62	21	178,741	142,042	336	931,957
Muskegon	387	52	535,443	410,954	916	3,161,057
Ann Arbor	413	36	624,618	503,611	789	3,894,950
Kalamazoo	369	55	712,796	534,587	1128	4,085,052
Flint	694	84	985,411	787,699	1557	6,760,436
Saginaw	783	116	1,054,842	808,925	2726	7,122,931
Lansing	896	91	1,086,242	890,079	2030	7,183,037
Grand Rapids	1031	82	1,726,732	1,353,026	2045	10,447,668
Detroit	5461	301	8,185,778	6,568,349	8776	52,293,864



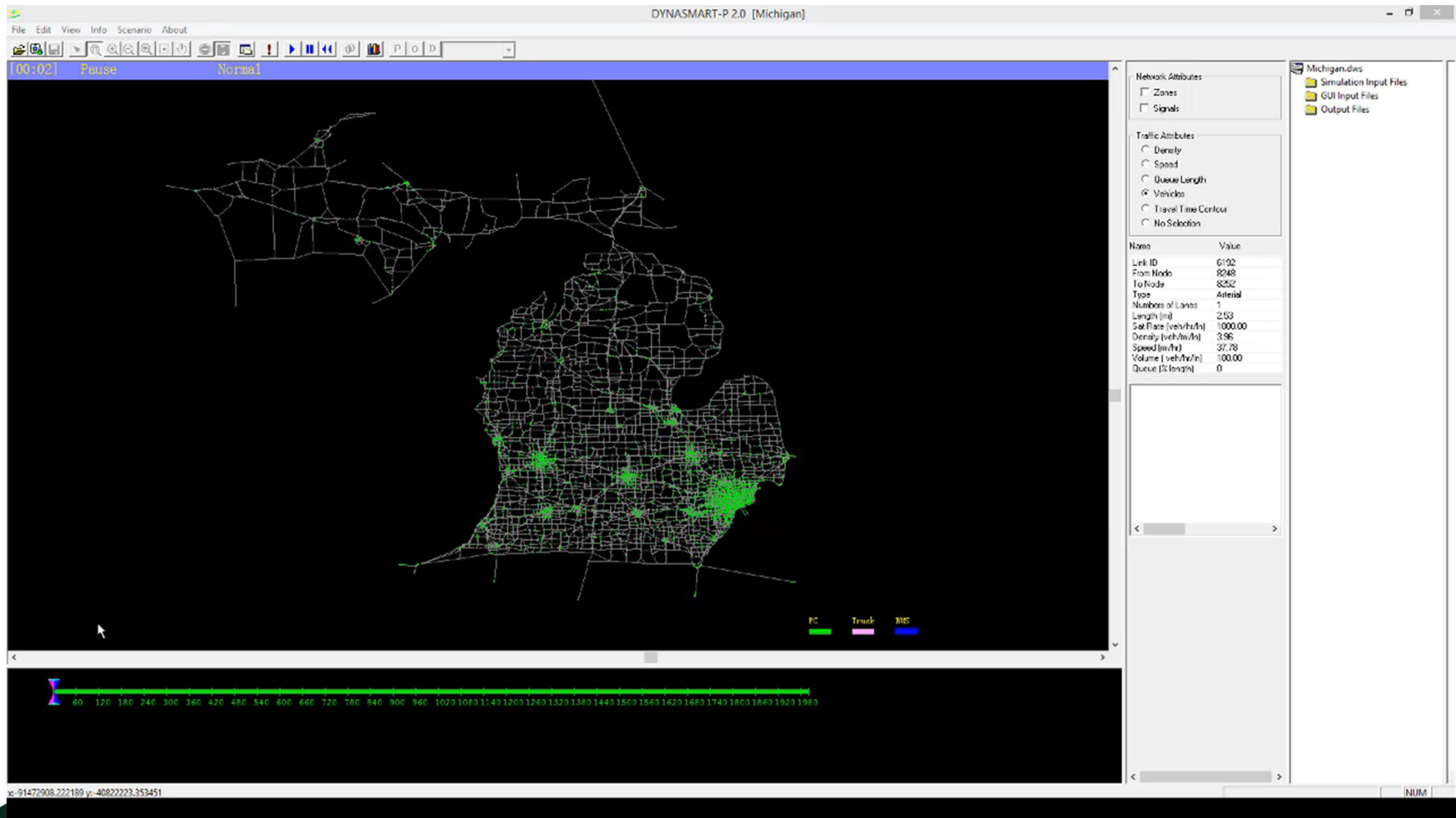


The required inputs to the model include:

**Stakeholder
Meetings**

- Road network (Michigan Department of Transportation)
- Traffic Analysis zones (Michigan Department of Transportation)
- Travel demand matrix (Michigan Department of Transportation)
- Electricity Provision Costs (Utilities)
- Land Use (Michigan Department of Transportation and MPOs)
- Average Land Cost (MPOs)
- Car Companies
- Charging station and charger costs (Charging Station Companies)





The modeling framework considers:

- Origin-Destination travel demand (input)
- Simulated trip trajectories
- Minimizing charging station investment cost
 - Cost of charger
 - Land cost
 - Electricity provision cost
- Minimizing travelers' detour

The required inputs to the model include:

- Road network
- Traffic Analysis zones
- Travel demand matrix
- Electricity Provision Costs
- Land Use
- Average Land Cost

This phase focuses on investing in DC fast chargers for urban trips of EV users



Land use and trip purpose

Trips start point are classified as:

- Single family homes
- Multi-family residential
- Work places
- Other (i.e. commercial)

Affects initial state of charge (i-SOC)

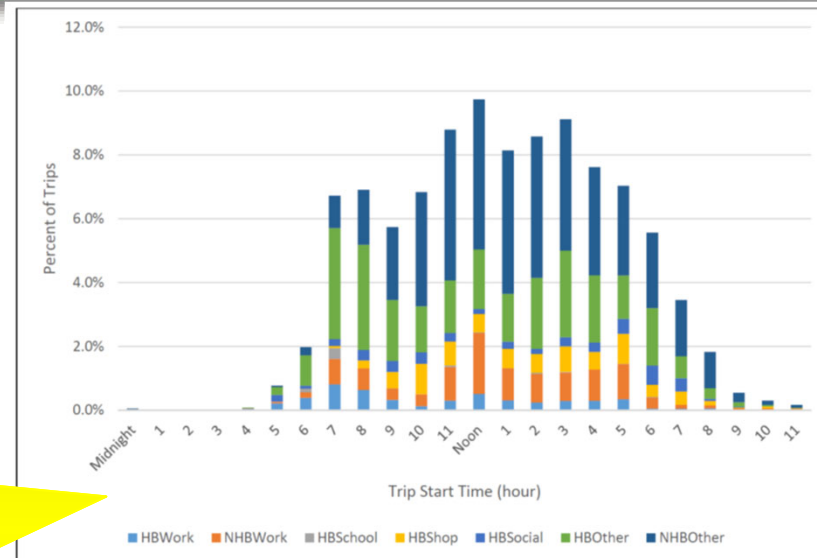
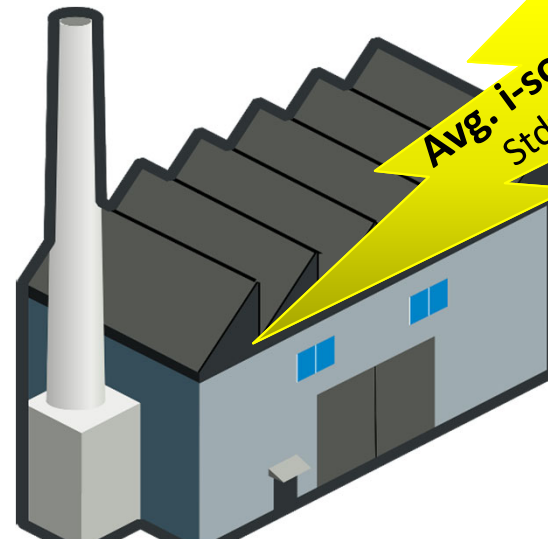
Avg. i-soc: 50%
Stdv. 0.2



Avg. i-soc: 80%
Stdv. 0.05



Avg. i-soc: 60%
Stdv. 0.2



Time dependent trip purpose in Michigan

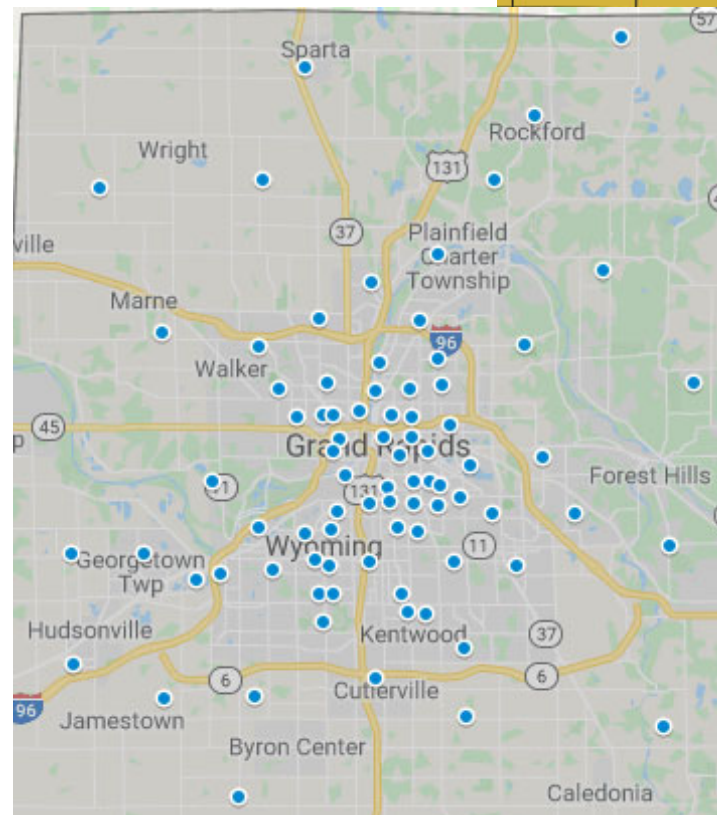
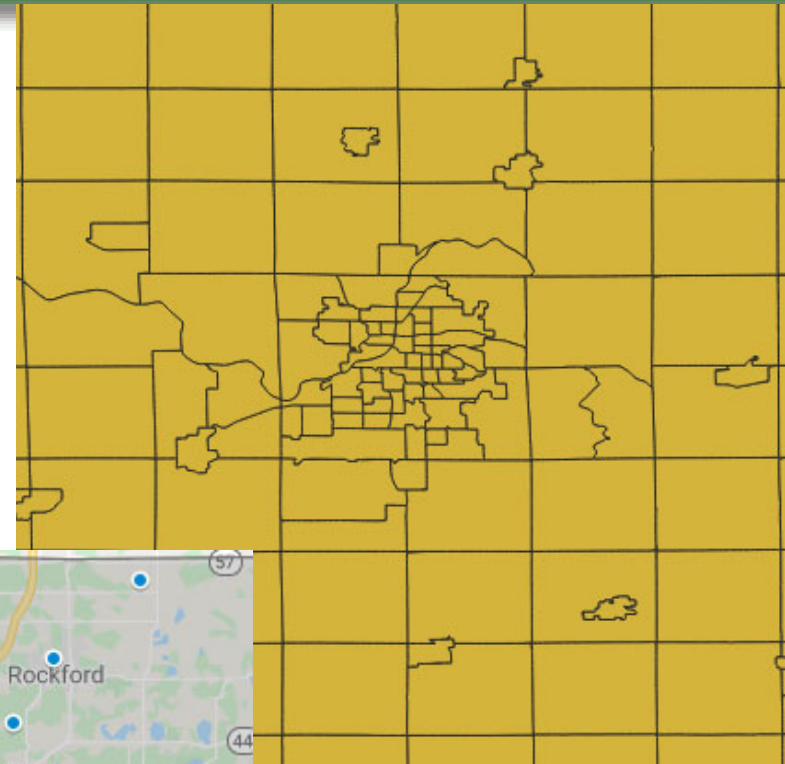
Source: Nancy McGuckin, Jesse Casas, Martha Wilaby, (September 2016),
MI Travel Counts III Travel Characteristics Technical Report

Traffic Analysis Zones (TAZ)

Unit area defined to be used in transportation planning.

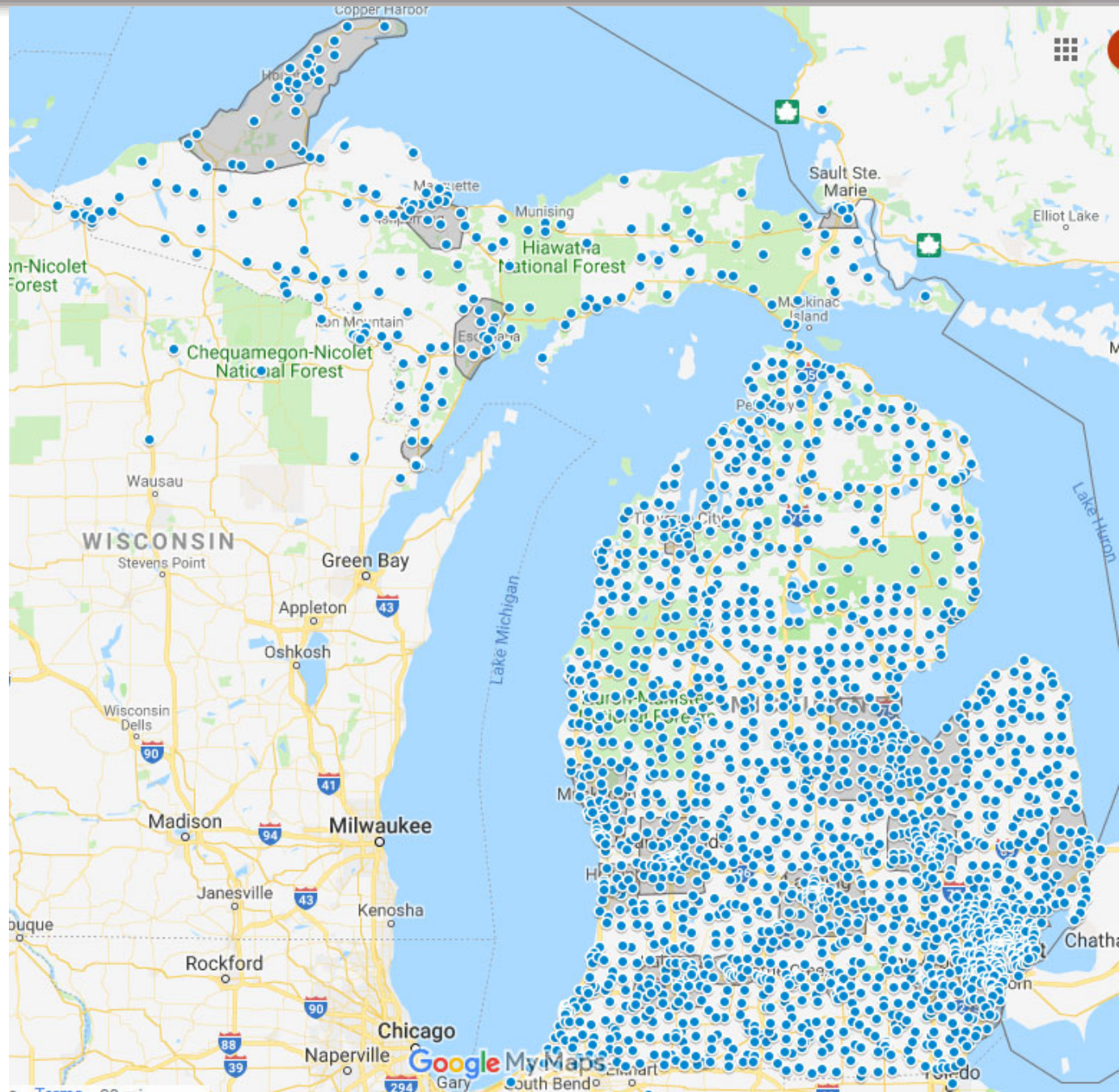
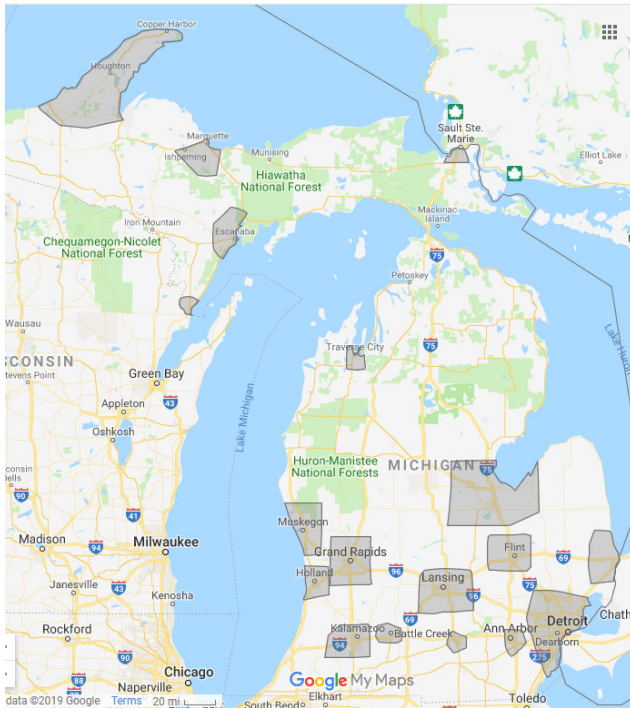
Important factors:

- Size of area
- Density
- Land use
- Geographic features



Candidate Points

MICHIGAN STATE
UNIVERSITY



Source:

<https://www.google.com/maps/d/viewer?mid=1tOVyNqg6TWeYNq1hyFLWapQ3bMXDDU3&ll=44.614258938290696%2C-86.93730349321822&z=7>

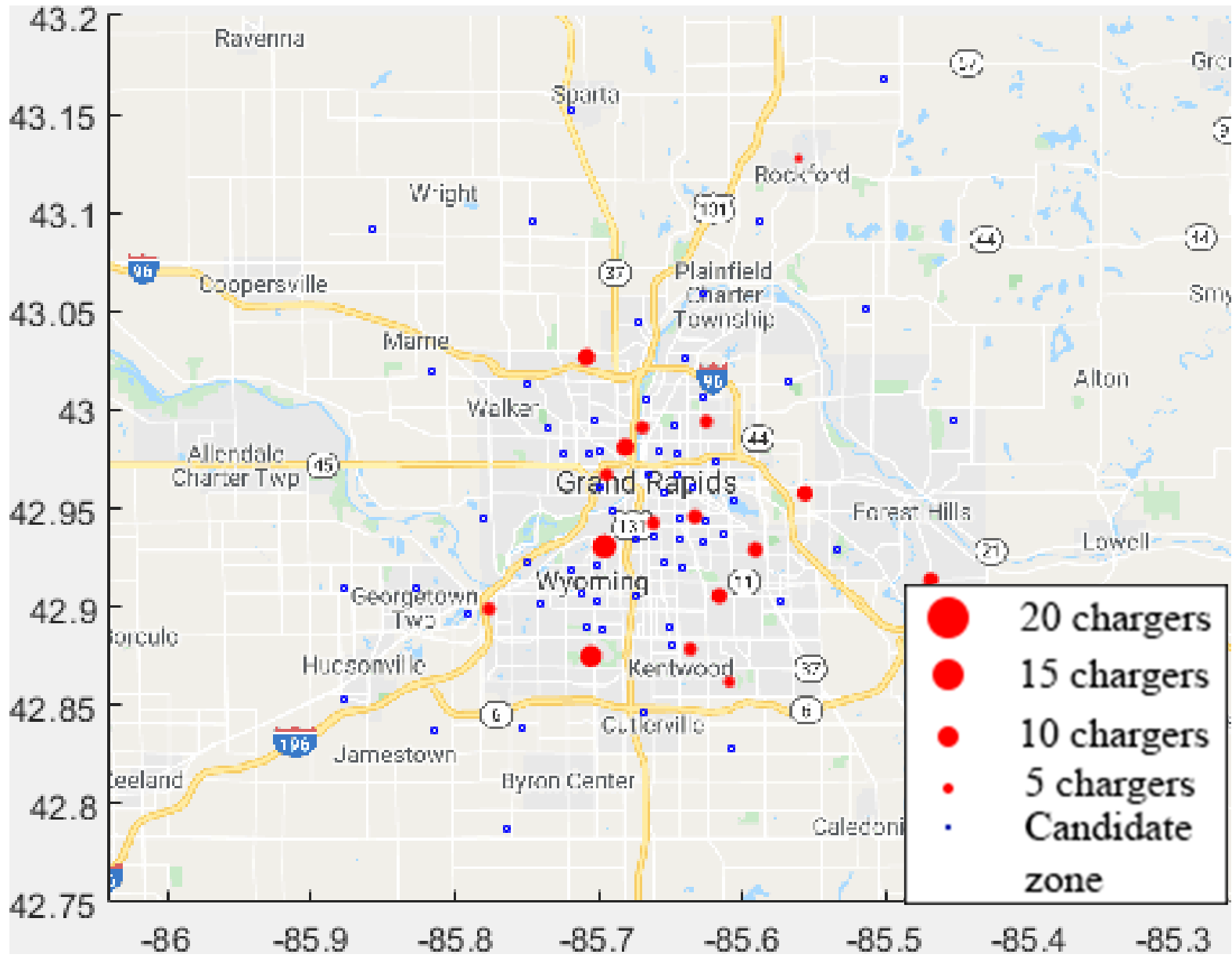


Results

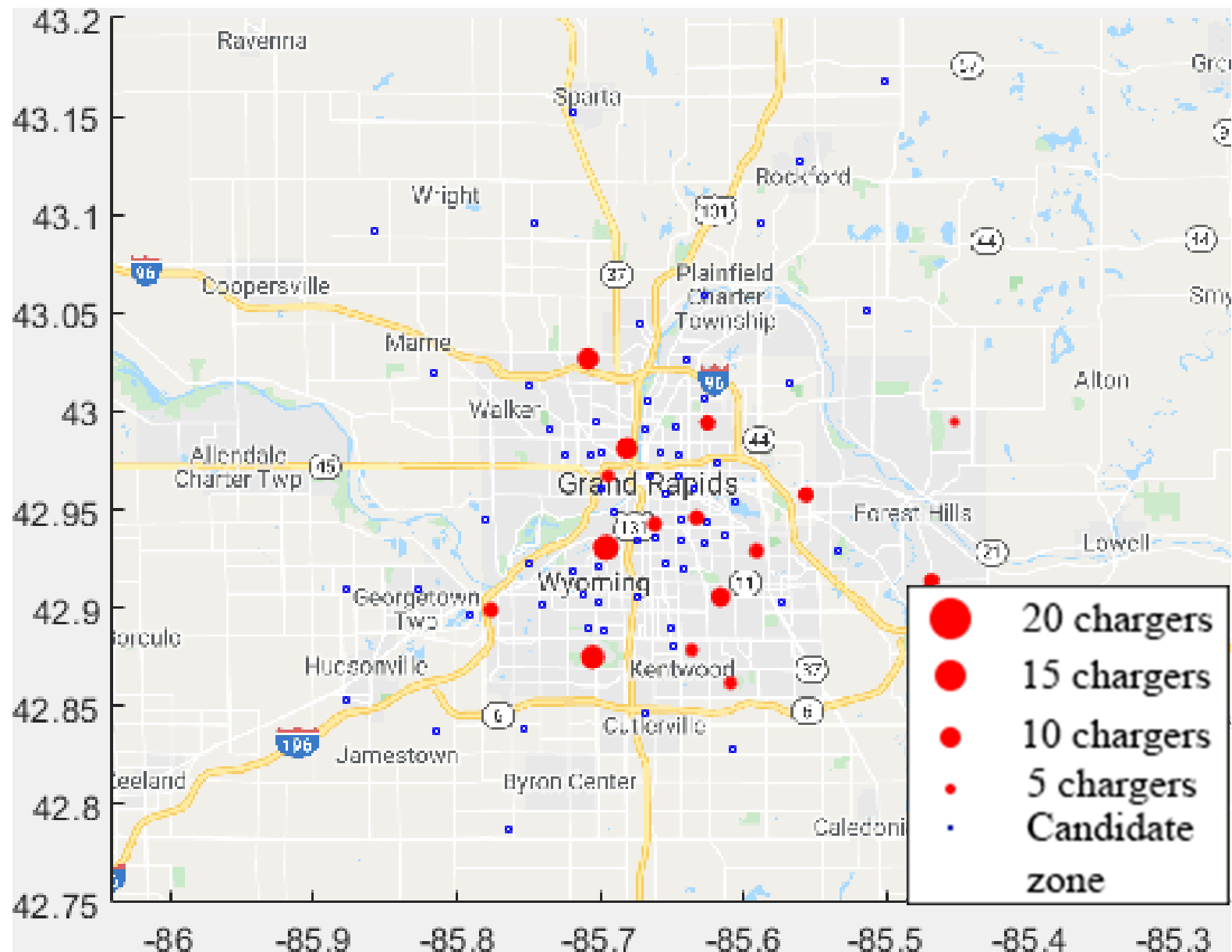
Scenario	Small battery and low tech charger	Large battery and small battery and low tech charger	high tech charger	large battery and high tech charger
Battery size (kWh) =	70	100	70	100
Charging station (kW)	50	50	150	150
Number of zones =	82	82	82	82
Electric trajectories =	42383	42383	42383	42383
Number of stations =	17	16	14	12
Number of spots=	122	132	47	48
Average charging and queuing delay (min) =	2.79	2.63	2.74	2.35
Total station cost (m\$) =	4.33	4.68	3.66	3.74
Total spot cost (m\$) =	7.12	7.31	6.41	6.09
Total infrastructure cost (m\$) =	10.53	14.65	3.79	5.20



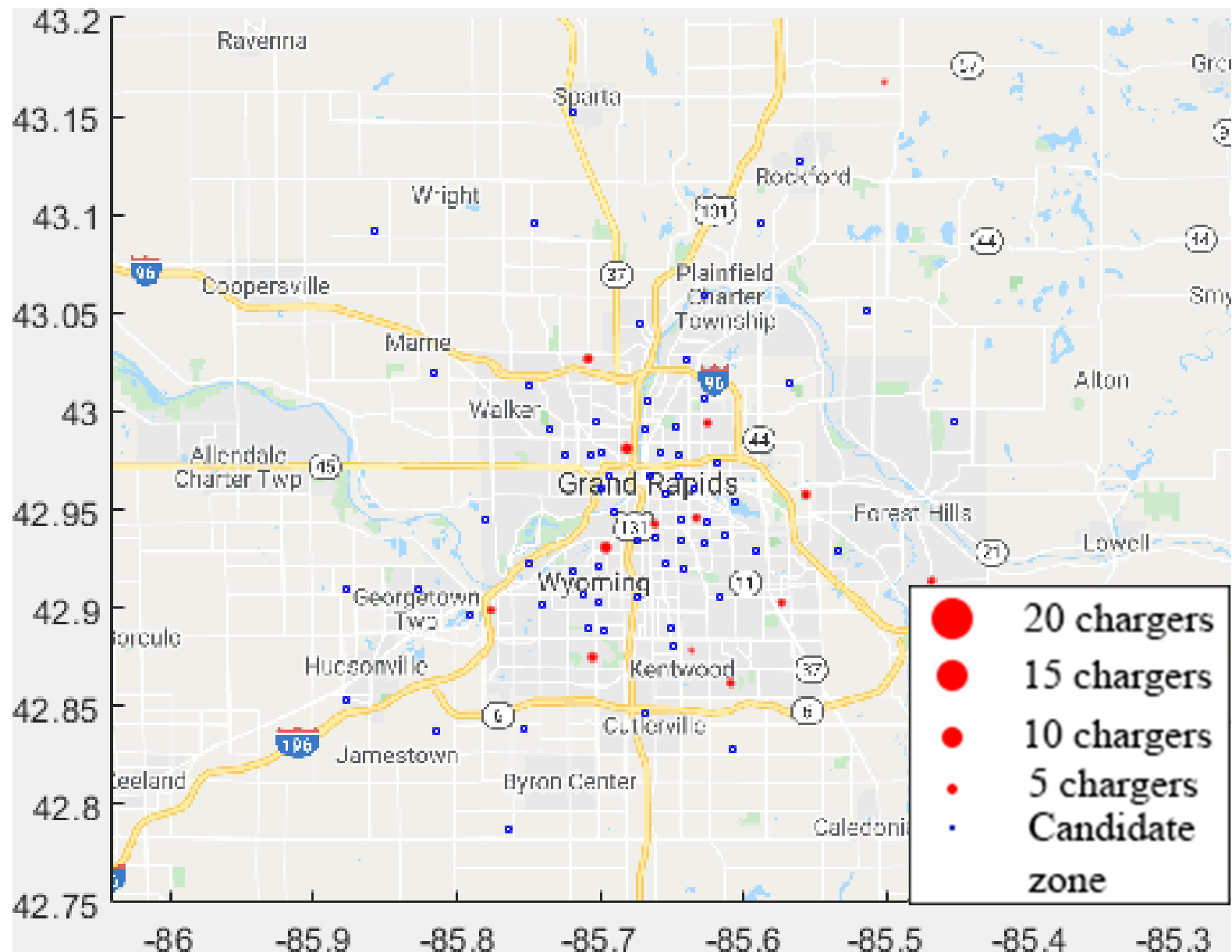
Scenario 1- 70kwh battery, 50 kw charger



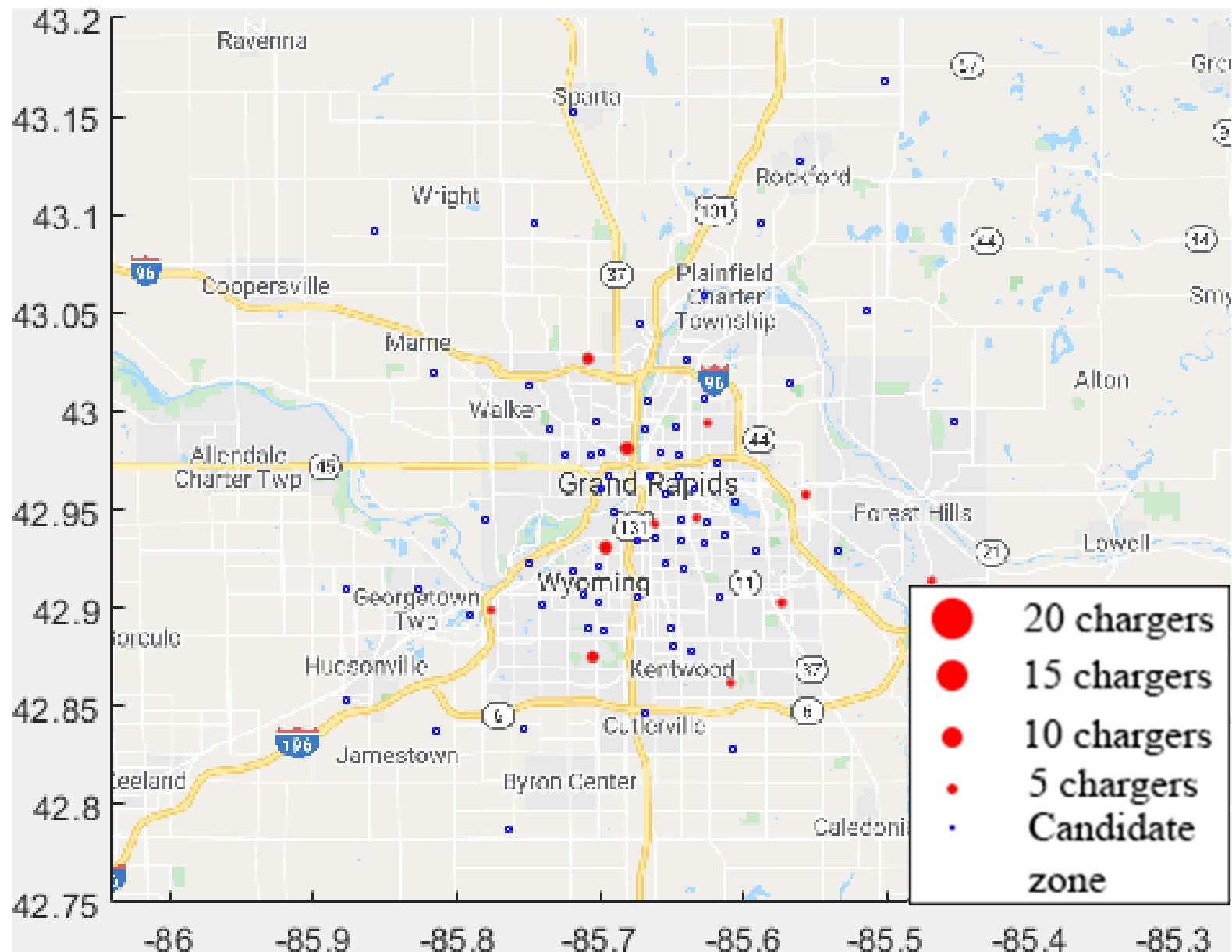
Scenario 2- 100kwh battery, 50 kw charger



Scenario 3- 70kwh battery, 150 kw charger



Scenario 4- 100kwh battery, 150 kw charger



Thank You

