

# EVALUATING THE SUITABILITY OF LOCAL BUSINESSES FOR ELECTRIC VEHICLE CHARGING STATIONS

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# PROJECT SUMMARY

- ▶ Develop a model that uses optimization techniques to select the best locations for public EV charging stations
- ▶ Feed model publicly available data so that it can be used for any area of study
- ▶ Model would be used by local governments
  - ▶ Restrict the number of charging stations installed with a fixed budget amount

# DEFINING THE PROBLEM

- ▶ What does the driver do while charging their EV?
- ▶ Few “destination based” charging stations have been installed, and the ones that exist are not in optimal locations
- ▶ National charging networks are being built as standalone destinations with no adjoining restaurants or businesses
- ▶ Few existing studies have approached site selection for charging stations from the driver’s point of view

**“EV TRAVELERS ARE MORE LIKELY TO EAT AT A RESTAURANT WITH CS INSTALLED THAN ONE WITHOUT.”**

**X. Zhang**

**“The Design of the Electric Vehicle Charging Network” (2016)**

# CHARGING STATIONS CONSIDERED

## Level 2

ChargePoint  
CT4013

8-12 h

\$6,990



## Level 3

ChargePoint  
CPE200

15-30 m

\$56,800



# AREA OF STUDY: MOON TOWNSHIP

- ▶ Suburb
- ▶ Large number of diverse businesses
- ▶ Above-average income
- ▶ Few existing charging stations

# LOCATIONS CONSIDERED CANDIDATES

- ▶ Only businesses open to the public were considered
  - ▶ No private workplaces
  - ▶ No schools, parks, or other non-business locations
  - ▶ No hotels
- ▶ Had to have at least 20 parking spaces
- ▶ The average visit must be at least 15 minutes

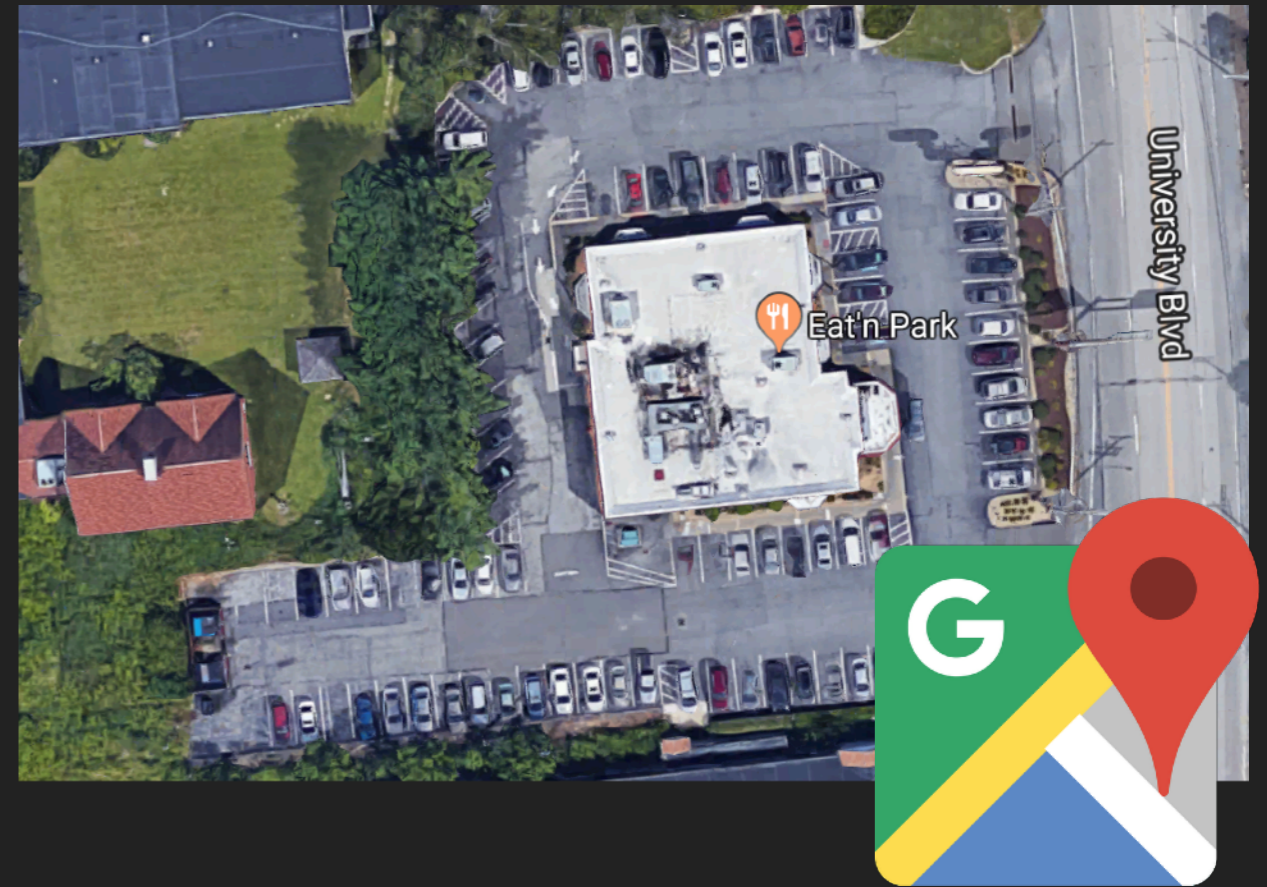
# CANDIDATE DATA

- ▶ Number of Parking Spaces
- ▶ Average Time Spent
- ▶ Weekly Hours of Operation
- ▶ Weekly Overnight Hours of Operation
- ▶ Distance from Interstate Highway
- ▶ Population within 1 mile
- ▶ Number of Businesses sharing lot



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# Walmart Supercenter

[Website](#) [Directions](#) [Save](#)

4.1 ★★★★★ 1,296 Google reviews

\$ · Department store

**Address:** 7500 University Blvd, Moon, PA 15108

**Departments:** Walmart Bakery · Walmart Garden Center · Walmart Grocery Pickup and Delivery · Walmart Money Center · Walmart Pharmacy · Walmart Photo Center · Walmart Vision & Glasses · Jackson Hewitt Tax Service · minuteKEY · 1 more

**Hours:** Open 24 hours

[See more hours](#)

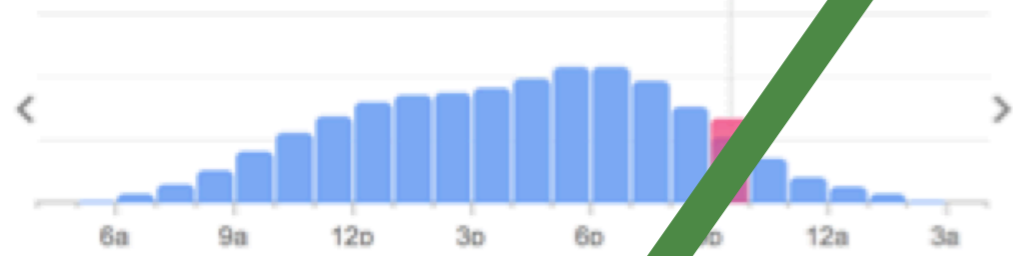
**Phone:** (412) 893-0143

[Suggest an edit](#)

## Popular times ?

Friday

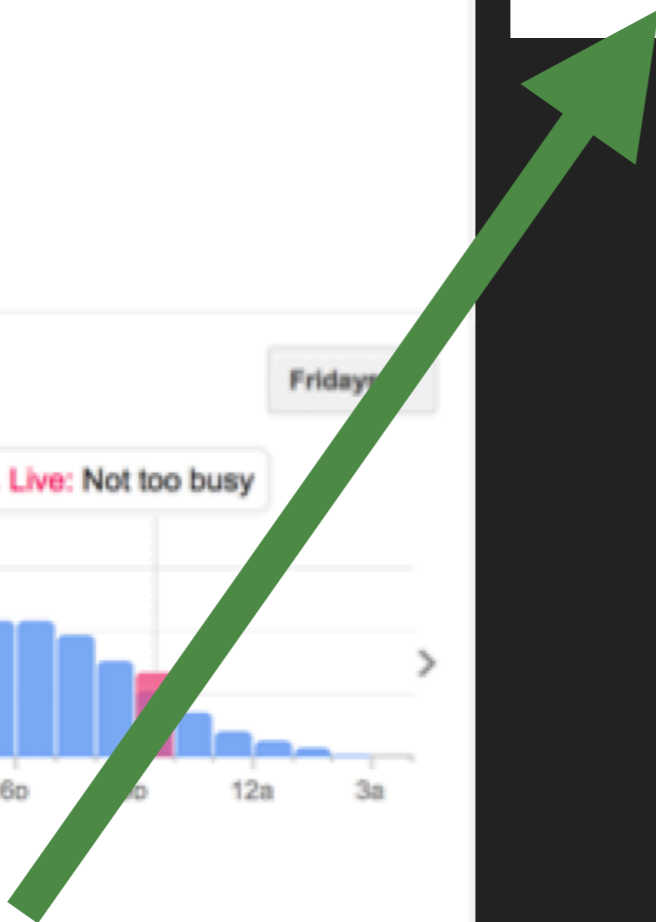
Live: Not too busy



## Plan your visit

People typically spend 15-45 min here

People typically spend 15-45 min here



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**Missouri Census Data Center**

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# LINEAR PROGRAMMING FORMULATION

$$y_l = n_{cs}(x_{lot} + x_{time\ spent} + \frac{x_{pop}}{100} + x_{hours} + x_{night\ hours} - 10 * x_{distance})$$

$$\text{Value to maximize} = \sum_{l=1}^{141} y_l$$

$$\text{Total amount spent} = \sum_{l=1}^{141} n_l c_l$$



# THE MODEL

- ▶ Microsoft Excel Solver plug-in
- ▶ 141 candidate locations
- ▶ Took 0 - 3 minutes to solve depending on size of budget
- ▶ Each location was assigned 0, 1, or 2 charging stations
- ▶ Total amount spent was limited by budget

The screenshot shows the 'Solver Parameters' dialog box in Microsoft Excel. The 'Set Objective' field is set to '\$D\$153'. The 'To' options are 'Max' (selected), 'Min', and 'Value Of:'. The 'By Changing Variable Cells' field is set to '\$O\$2:\$O\$142'. The 'Subject to the Constraints' list contains three constraints: '\$D\$156 <= \$D\$149', '\$O\$2:\$O\$142 <= \$L\$2:\$L\$142', and '\$O\$2:\$O\$142 = integer'. The 'Make Unconstrained Variables Non-Negative' checkbox is checked. The 'Select a Solving Method' dropdown is set to 'Simplex LP'. The 'Solving Method' section provides instructions on selecting the appropriate engine for different problem types. The 'Close' and 'Solve' buttons are visible at the bottom.

Solver Parameters

Set Objective:

To:  Max  Min  Value Of:

By Changing Variable Cells:

Subject to the Constraints:

- 
- 
- 

Make Unconstrained Variables Non-Negative

Select a Solving Method:

**Solving Method**  
Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

# RESULTS

Amount Budgeted	Amount Spent	Sites Selected for Installation	Level 2 CS Installed	Level 3 CS Installed	Average Time Spent
\$50,000	\$48,930	4	7	0	156 minutes
\$100,000	\$97,860	8	14	0	128 minutes
\$500,000	\$497,170	43	63	1	81 minutes

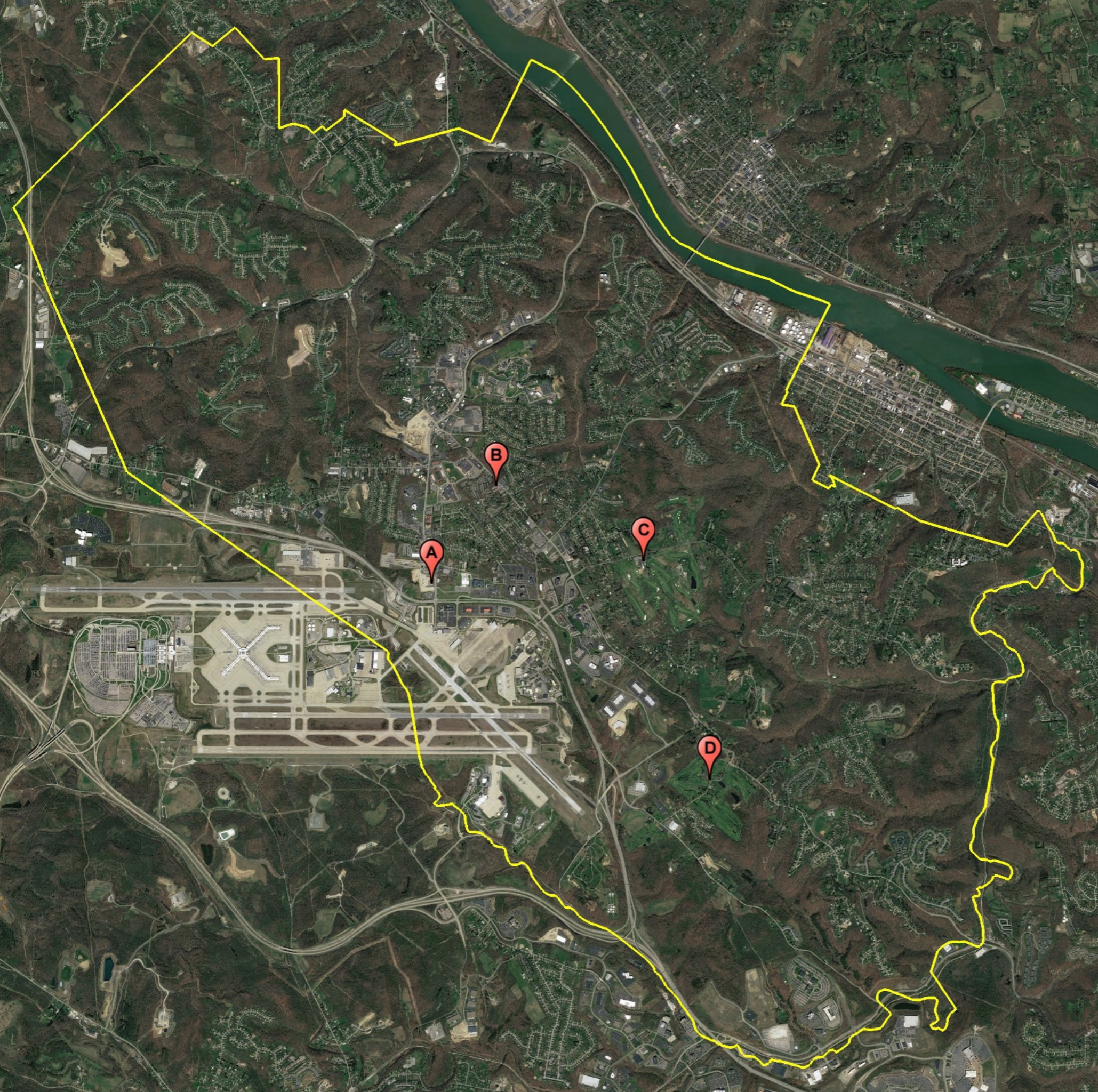
# \$50,000 Model

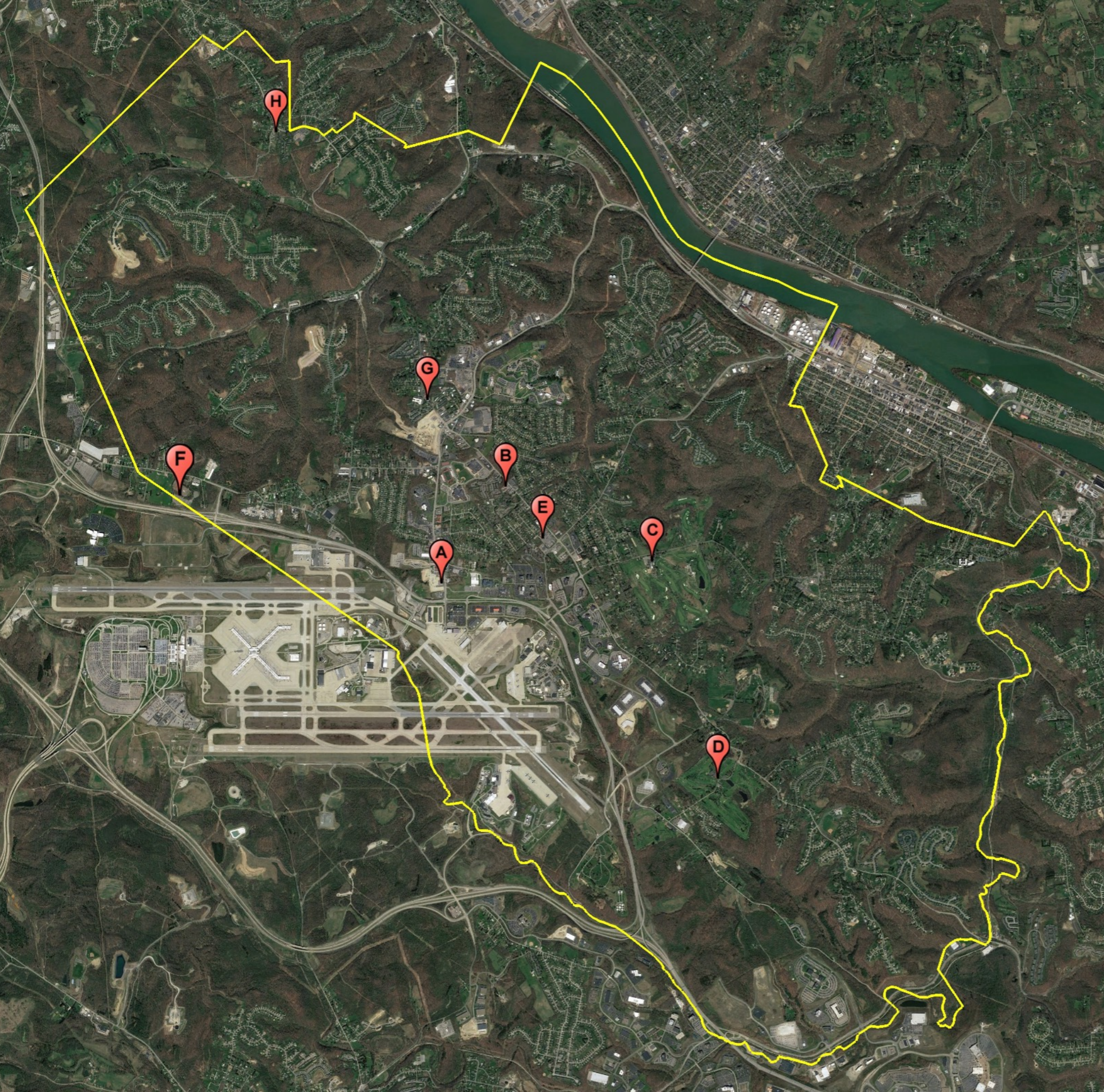
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2 Golf Courses

1 Restaurant

1 Bar/Pub





# \$100,000 Model

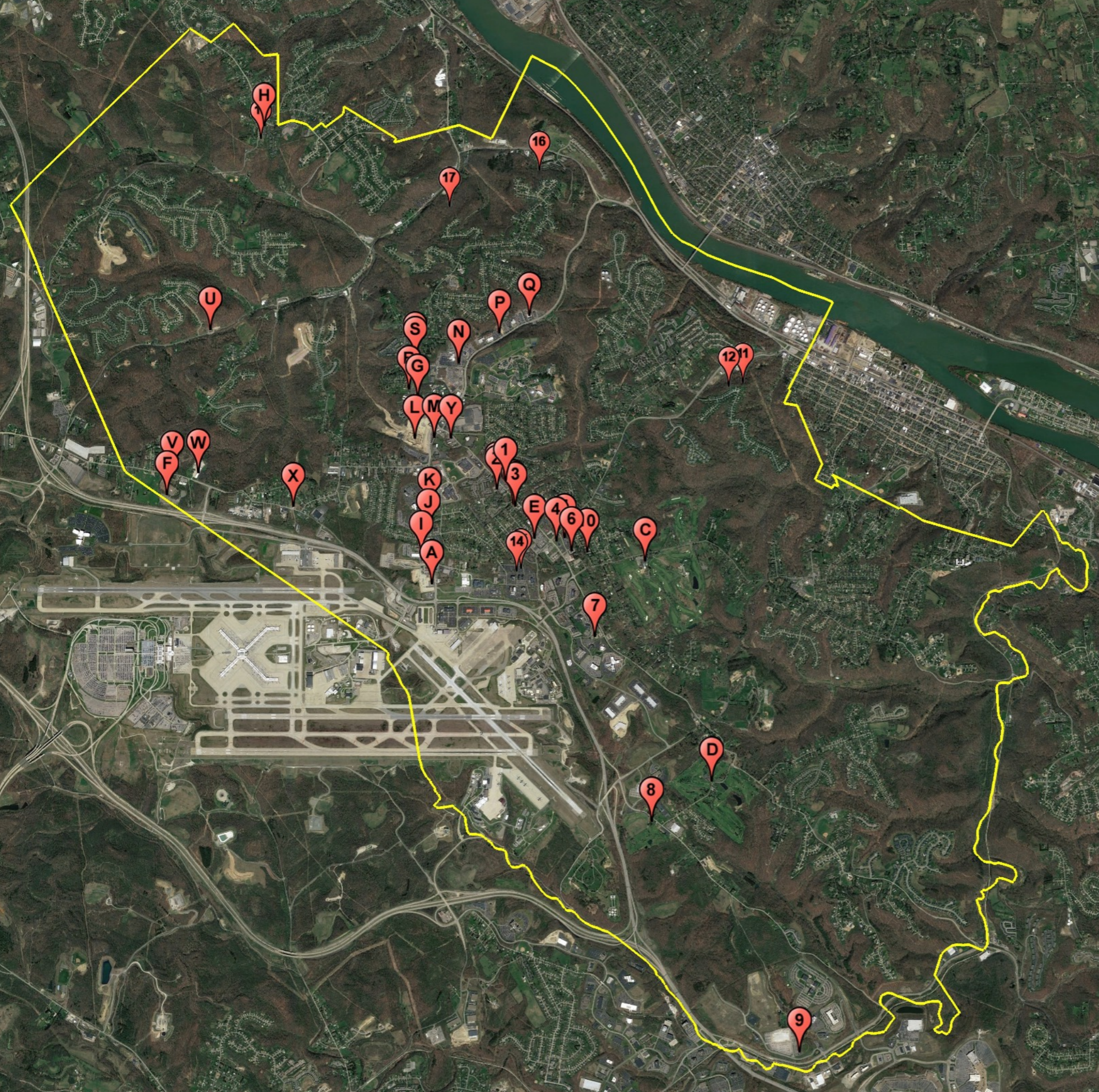
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- 3 Bars/Pubs
- 2 Golf Courses
- 1 Restaurant
- 1 Drive-in Theater
- 1 Shopping Center

# \$500,000 Model

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- 8 Doctors/Medical
- 6 Restaurants
- 6 Car Dealer/Repair
- 4 Bars/Pubs
- 4 Golf Courses
- 4 Karate/Dance Studios
- 2 Shopping Centers
- 2 Retail Stores
- 2 Spa/Beauty
- 1 Drive-in Theater
- 1 Tattoo Parlor
- 1 Realtor Office
- 1 Library
- 1 Auction House



# OPTIMAL LOCATIONS



# FUTURE APPLICATIONS

- ▶ “Compatibility Checker” tool for business owners wondering if a charging station would suit them
  - ▶ Calculate their own score value and compare to known successful values
- ▶ Integrate with Google Business Listings to automatically pull relevant data

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THANK YOU!  
QUESTIONS?

