Using GIS to Find Suitable Locations for Electric Vehicle Charging Stations. Portland, Oregon.

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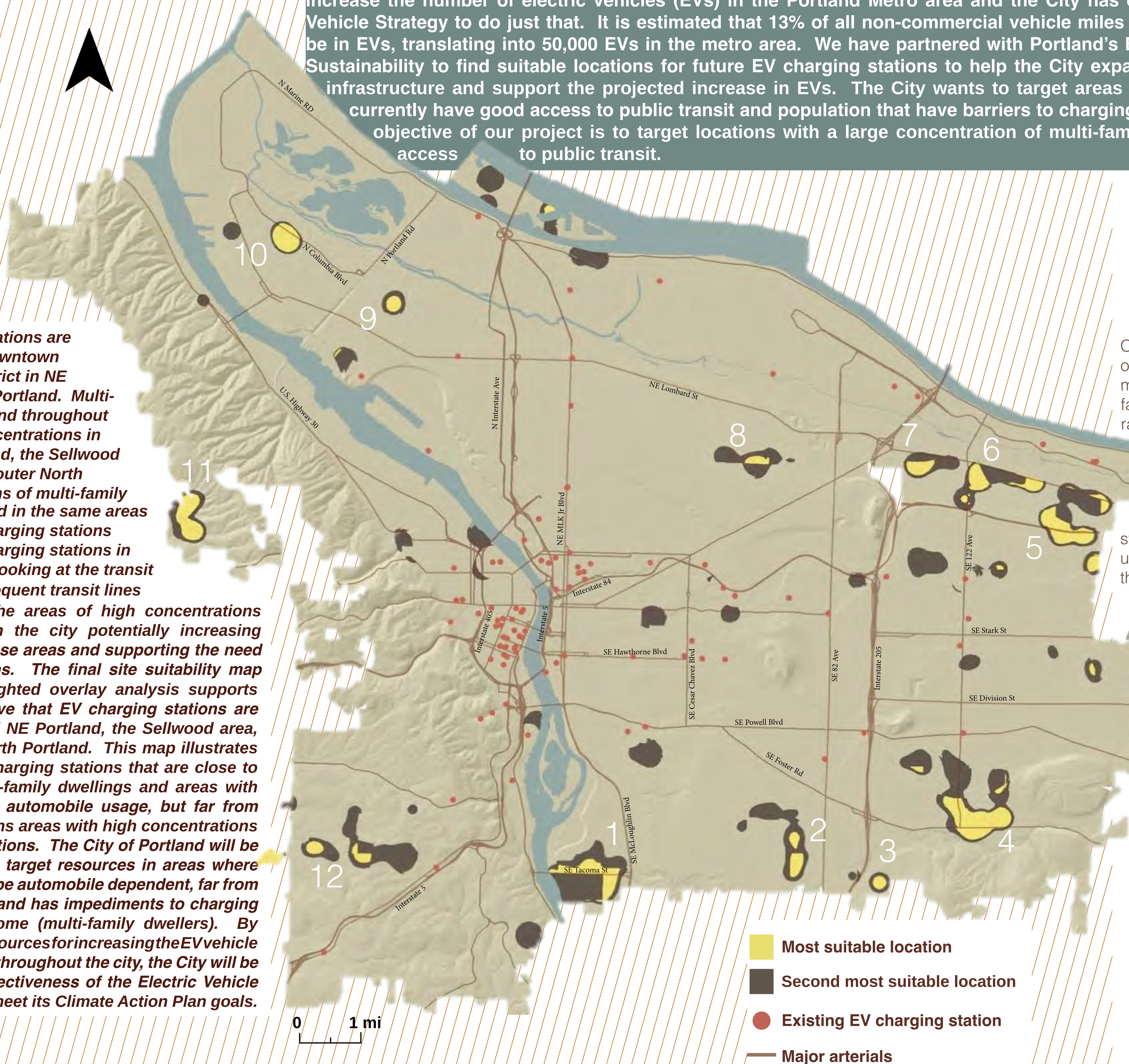
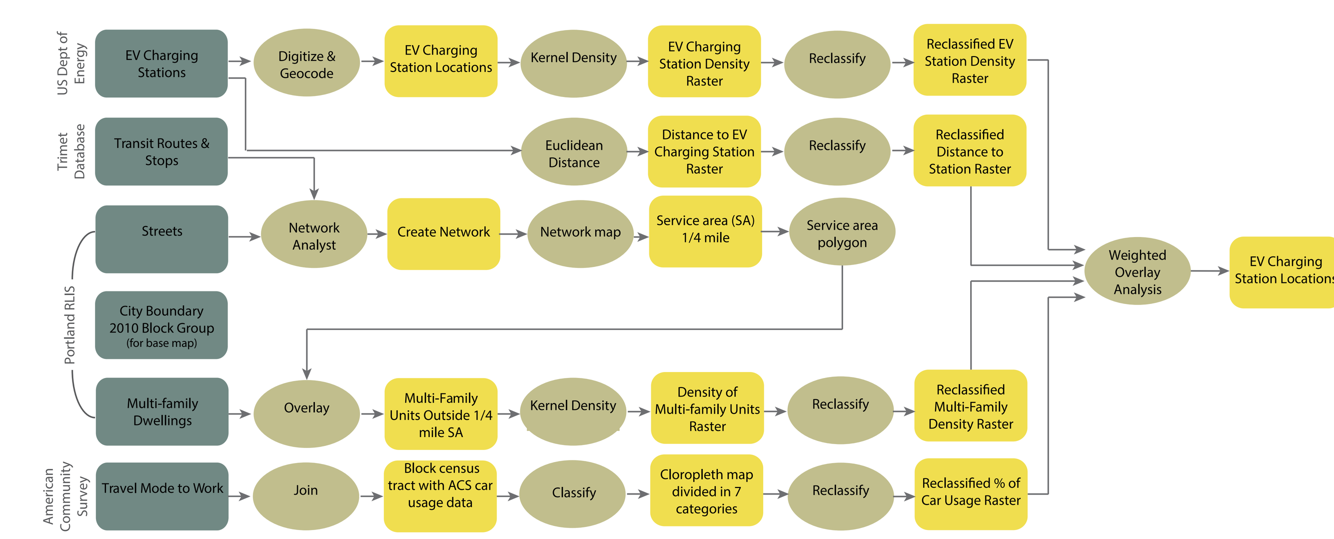
In 2009, Portland adopted a Climate Action Plan that includes the goal of reducing the city's carbon emissions 80% from 1990 levels by 2050. The transportation sector is responsible for 40% of carbon emissions in Multnomah County, and Portland is looking for ways to reduce carbon emissions from the transportation sector. One method is to increase the number of electric vehicles (EVs) in the Portland Metro area and the City has employed an Electric Vehicle Strategy to do just that. It is estimated that 13% of all non-commercial vehicle miles travelled will need to be in EVs, translating into 50,000 EVs in the metro area. We have partnered with Portland's Bureau of Planning & Sustainability to find suitable locations for future EV charging stations to help the City expand upon existing EV infrastructure and support the projected increase in EVs. The City wants to target areas where people do not currently have good access to public transit and population that have barriers to charging EVs, so the specific objective of our project is to target locations with a large concentration of multi-family dwellings without access to public transit.

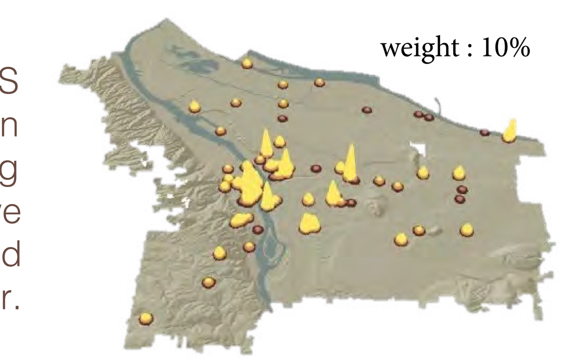


Existing EV charging stations are concentrated around downtown Portland, the Lloyd District in NE Portland, and inner SE Portland. Multi-family dwellings are found throughout the city with higher concentrations in outer SE and NE Portland, the Sellwood area, SW Portland, and outer North Portland. Concentrations of multi-family dwellings are not located in the same areas as concentrations of charging stations indicating a need for charging stations in these locations. When looking at the transit map, one can see the frequent transit lines largely do not reach the areas of high concentrations of multi-family units in the city potentially increasing automobile usage in these areas and supporting the need for EV charging stations. The final site suitability map resulting from our weighted overlay analysis supports our initial findings above that EV charging stations are needed in outer SE and NE Portland, the Sellwood area, and locales in outer North Portland. This map illustrates potential sites for EV charging stations that are close to concentrations of multi-family dwellings and areas with a higher percentage of automobile usage, but far from existing charging stations areas with high concentrations of existing charging stations. The City of Portland will be able to use this map to target resources in areas where the population tends to be automobile dependent, far from frequent public transit, and has impediments to charging EV vehicles at their home (multi-family dwellers). By intelligently targeting resources for increasing the EV vehicle charging infrastructure throughout the city, the City will be able to increase the effectiveness of the Electric Vehicle Strategy in an effort to meet its Climate Action Plan goals.

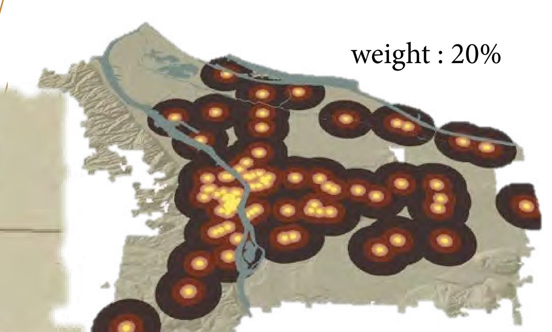
Methodology



Our study area is the city of Portland, Oregon. We determined the cell size for all rasters created would be 30ft x 30ft in order to capture street-level data. In order to implement our weighted overlay analysis, we needed to process the four main parameters in our model: density of EV charging stations, proximity to existing EV charging stations, density of multi-family dwellings, and percentage of car usage. Because the Weighted Overlay tool in ArcMap only accepts integer rasters as input, we reclassified each of our rasters prior to completing the analysis; details for each parameter follows.

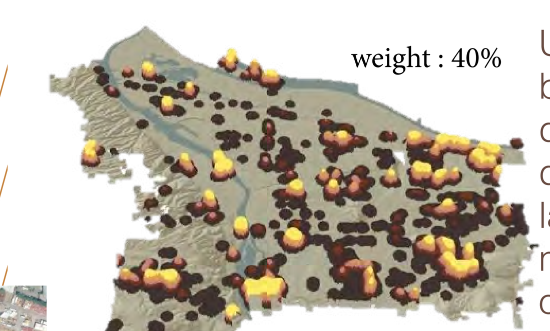


We first digitized and geocoded all EV charging stations in Portland from the US Department of Energy's website and ended up with a total of 105 charging stations in our study area. Using this source data, we calculated the total number of charging stations per location. The number of charging stations was used in the population field and we used a search field of 1320 ft (1/4 mile) in creating our kernel density raster. We then reclassified the raster to 1/2 standard deviations and labelled the resulting values 1-7 in ascending order.



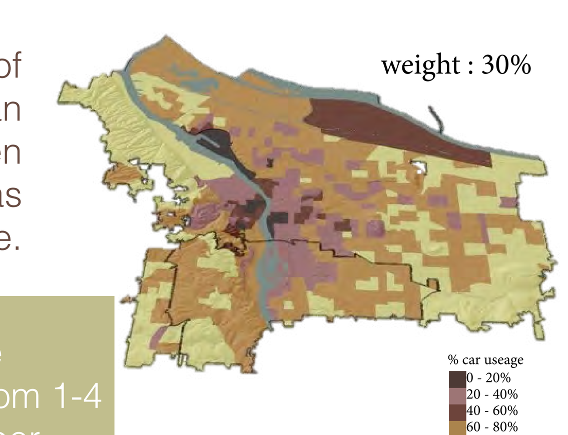
Using the geocoded EV charging station layer, we ran the Euclidean Distance tool to create a raster with the distance to the nearest charging station for each 30ft x 30ft cell. The output was reclassified into the following categories and labelled 1-6 in ascending order; 0-528, 528-928, 928-1320, 1320-2640, 2640-5280, 5280 and up. The logic behind these values (in feet) is that we wanted a few categories within 1/4 mile and a few categories greater than 1/4 mile, since we had previously determined access would be within 1/4 miles.

Using Network Analyst in ArcMap, we created a pedestrian network from Portland RLIS's street shapfile. Service areas were created around transit stops within 1/4 mile (that we determined would represent pedestrian access to transit). We used the transit routes and stops source data from TriMet's database, and decided to only use those routes designated as frequent service routes. In an initial analysis using simple buffers around all transit routes, we found that the area outside of the buffer was too small to be useful in our site suitability analysis. We are arguing that people living in areas without access to frequent transit lines are more likely to use a personal vehicle than those living with access to frequent transit options. The cost of the network was defined as 'distance of walking', and a buffer was created with the resulting output of the network analysis.



Using the 1/4 mile buffer around transit stops outlined above, multi-family dwellings outside of this buffer were selected from which we created a new multi-family shapefile. This new multi-family dwelling shapefile was used to create a centroid point layer that could be used to determine density of multi-family dwellings. We created a kernel density raster using the centroid point layer of multi-family dwellings farther than 1/4 mile from frequent route transit stops using the number of units in the 'population' field and a search radius of 1320 ft. The kernel density output was reclassified using 1/2 standard deviations and labelled 1-7 in ascending order.

In order to make sure that our analysis would prioritize areas with higher percentages of automobile usage, we calculated the percentage of automobile usage from American Community Survey data. This information was joined to the block census tract shape. Then it was transformed to raster splitting the data in 7 equal intervals. The raster output was reclassified, being 7 the block tracts with the highest percentage of automobile usage.



We used Paul Bolstad's methodology from GIS Fundamentals (pp. 531-533) to determine weight percentages to be used in the Weighted Overlay tool. We ranked our variables from 1-4 with the most important variable being 1 as follows: density of multi-family dwellings (1); percentage of automobile usage (2); proximity to EV charging stations (3); and density of charging stations (4). We calculated the relative weights according to the following equation (Bolstad, 2012):

$$w_i = \frac{n - r_i + 1}{\sum_{k=1}^{n}(n - r_k + 1)}$$

where wi is the wighting criterion for variable i, n is the number of criteria, and k is a counter for summing across all criteria.