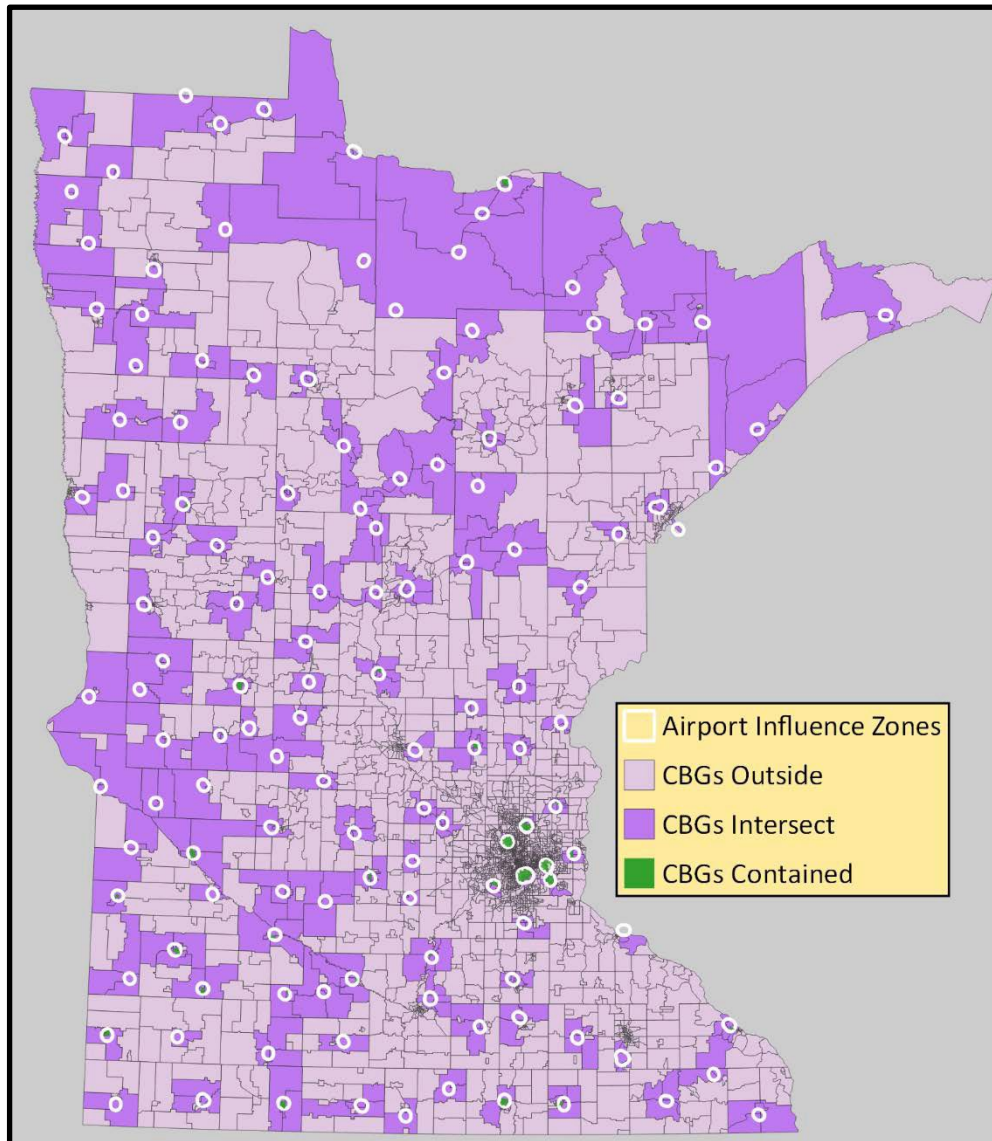


Statewide Analysis

For an initial spatial comparison, I classified Minnesota's 4,107 census block groups into three categories based on their relationship to airport influence zones: entirely outside the zones, partially intersecting them, or entirely contained within them. Most census block groups were outside airport influence zones (77%), while 18% partially intersected them and approximately 5% were contained within them.

As the map to the right shows, census block groups outside or intersecting airport influence zones occur throughout Minnesota. The largest census block groups in northern Minnesota tend to intersect airport influence areas more often because of their large spatial extents and the relatively even distribution of airports. The metro area has a lower percentage of intersecting census block groups because census block groups in these more densely populated areas are smaller. However, these smaller and high-density urban



census block groups at airport influence zones are far more likely to be contained by these zones where aviation directly impacts land use options. Contained census block groups are spread across southern Minnesota, in Jackson and Albert Lea, up to the Canadian border at International Falls.

By placing the census block groups into these categories based on their spatial relationship to airport influence zones, we could aggregate demographics for comparison against each other and Minnesota statewide averages.

Table 1: Demographic Analysis Based Upon Spatial Relationships to Airport Influence Zones

	n of CBGs	Population	Pop %	Households	HH %	Urban	Poverty HHs	0 Veh HHs	Non White	Hispanic
All CBGs	4,107	5,490,737	100.00%	2,153,202	100.00%	78.23%	4.25%	6.95%	16.25%	5.18%
Outside APIZs	3,180	4,323,115	78.73%	1,686,942	78.35%	79.31%	4.06%	6.90%	16.31%	4.85%
Intersect APIZs	734	946,095	17.23%	377,314	17.52%	68.39%	4.58%	6.29%	12.81%	5.11%
Contained by APIZs	193	221,527	4.03%	88,947	4.13%	97.93%	6.34%	10.75%	29.87%	11.97%

	Limited English HHs	No High School Diploma	< 5 YO	> 64 YO	Disabled HHs	Per Capita Income	Single Parent HHs
All CBGs	2.41%	7.22%	6.37%	14.64%	21.77%	\$34,205.80	28.06%
Outside APIZs	2.42%	6.80%	6.32%	14.17%	21.15%	\$35,104.50	27.39%
Intersect APIZs	1.94%	8.18%	6.33%	16.97%	23.75%	\$31,469.60	28.47%
Contained by APIZs	4.16%	11.27%	7.60%	13.77%	25.01%	\$29,210.00	38.87%

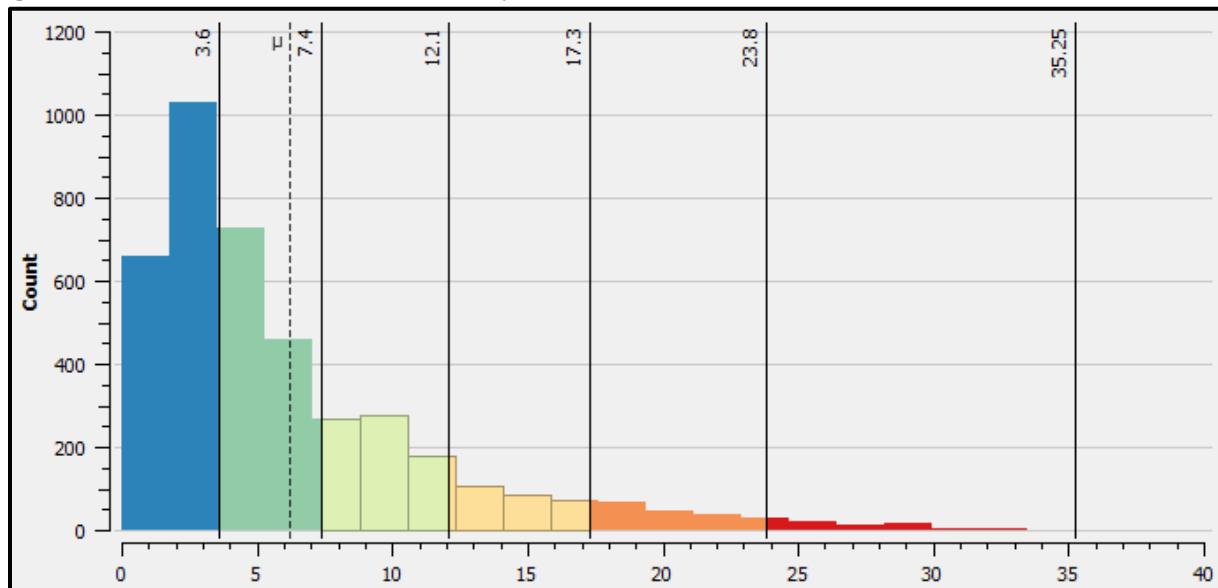
As Table 1 illustrates, some patterns emerge when comparing demographics across these three census block group categories.

The census block groups outside the airport influence zones have demographics that all show less social vulnerability compared to Minnesota statewide, with slightly higher per capita incomes and lower percentages of poverty, no vehicle access, non-white and Hispanic populations, limited English households, low educational attainment, young children and elderly, and households with disabilities and single parents.

In contrast, census block groups entirely within airport influence zones show a demographic profile indicating higher levels of social vulnerability. Per capita income is nearly \$5,000 less than the statewide average, which can negatively affect financial stability. In addition, rates of poverty, no vehicle access, racial minorities, language barriers, low educational attainment, families with young children, and households with a disabled member are notably higher. The one exception is that the highest concentration of elderly residents occurs in census block groups that are only partially within airport influence zones.

After scoring all fourteen demographic indicators for each census block group, we summed the scores to produce each block group's SoVI value. The maximum score possible under this SoVI methodology was 44 ((10 indicators x 4) + (4 indicators x 1)). The highest value among Minnesota census block groups was 35.25 for a census block group in Minneapolis' Phillips neighborhood.

Histogram of Minnesota Census Block Group SoVI Scores



The mean was 6.18, and the median was 4.25, indicating a right-skewed distribution with many low values and notable outliers representing particularly vulnerable populations, as shown in the histogram above.

After calculating numerical SoVI scores for all 4,107 Minnesota census block groups, I used Jenks natural breaks to classify the scores into six vulnerability categories. The resulting classification reflected the right-skewed distribution, with most census block groups showing relatively low vulnerability and fewer representing high-vulnerability outliers.

	n of CBGs	Mean SoVI	Mean SoVI Category	Median SoVI	SoVI SD
All CBGs	4,107	6.1818	Low (2nd lowest)	4.25	5.6934
Outside APIZs	3,180	5.9476	Low (2nd lowest)	4.00	5.7332
Intersect APIZs	734	6.2970	Low (2nd lowest)	5.00	4.9197
Contained by APIZs	193	9.6023	Somewhat Low (3rd lowest)	8.25	6.5814

The chart above shows vulnerability trends for census block categories outside airport influence zones, intersecting airport influence zones, or contained by airport influence zones. Census block groups outside airport influence zones are slightly less vulnerable than Minnesota averages according to the index. Census block groups that intersect airport influence zones are mildly more vulnerable, but have less variance than statewide averages. The 193 census block groups entirely within airport influence areas have notably higher social vulnerability and variance, though this may reflect their status as the smallest subset of all census block groups. These trends align with and are expected given the previous analysis in Table 1, which shows the contained group as most vulnerable across most individual demographics used to create SoVI scoring.

High Social Vulnerability and Minnesota Airports

After calculating the social vulnerability index, we identified census block groups within airport influence zones with the highest SoVI scores. By examining which airports are associated with these aviation-impacted census block groups with high social vulnerability, we can draw broader conclusions about social vulnerability in relation to Minnesota's airport system. The chart below tabulates the number of census block groups categorized as high or very high social vulnerability. These highly vulnerable census block groups are not evenly distributed across the aviation system. In the Twin Cities metro, St. Paul and Crystal have the most socially vulnerable census block groups, and Worthington has the highest number in Greater Minnesota.

Airport	High SoVI CBGs	% of 58 CBGs
St. Paul	26	44.83%
Crystal	14	24.14%
MSP	7	12.07%
Worthington	5	8.62%
Austin	2	3.45%
Albert Lea	1	1.72%
Bagley	1	1.72%
Bemidji	1	1.72%
South St. Paul	1	1.72%

Together, these 58 high- or very-high-vulnerability census block groups were associated with just nine airport influence zones, demonstrating that socially vulnerable populations were not evenly distributed across Minnesota's aviation system.

Composite SoVI Scoring for Airport Influence Zones

After calculating SoVI values for all census block groups, I wanted to create a composite scoring methodology to compare the 134 airport influence areas for overall social vulnerability. I started by joining the scored census block groups with the airport influence zones by location. This created a new shapefile of census block groups that fell within or intersected airport influence zones, clipped to the zone boundaries. The census block group file already included individual SoVI scores, census block group populations, and census block group area (square miles), which remained in the associated data table. The join-by-location added an attribute column indicating which airport influence zone each census block group belonged to for classification and data aggregation.

Another key calculation was the proportion of census block group area within the airport influence zone. To derive that value, I calculated the area of census block groups clipped within airport influence zones while retaining the area values for the entire census block group. To derive the proportion of area in the airport influence zone, I divided the clipped census block group area by the census block group's total area. For each census block group, this created a proportional decimal value larger than 0.0, but no larger than 1.0, for census block groups entirely contained within an airport influence zone.

By multiplying each aviation-impacted census block's overall population by its percentage of area within the airport influence zone, we estimated how many residents lived within the airport influence zone. For census block groups entirely within airport influence areas, this estimate equaled the full population because it was multiplied by 1.0. For those partially in airport influence zones, the population estimate was proportionally lower than the census block group's total population, depending on the ratio of the airport influence zone to the entire area. This modeling approach assumed population densities were evenly spread across census block groups. This would be a tenuous assumption for an individual census block group, but it could be justified when applied to 937 clipped census block group features within Minnesota's airport influence zones.

After calculating population estimates for census block group residents within airport influence zones, I could use them to weight the corresponding SoVI scores. Because census block groups vary widely in population (from less than 100 to nearly 10,000 in some cases), I considered population size alongside the SoVI score to identify the largest socially vulnerable populations that aviation zoning could impact. This composite index was intended to identify airport influence zones with the greatest combined concentration and estimated population of socially vulnerable residents, rather than measure average vulnerability or establish the presence of adverse environmental impacts.

After generating population-weighted SoVI scores for aviation census block groups, I aggregated them by airport influence zone to compare relative social vulnerability across Minnesota's 134 airport influence zones. I did this by summing all weighted aviation census block SoVI scores within each airport influence zone to produce a composite score. Because this airport-level index represents a population-weighted composite rather than a directly observed demographic percentage, I classified the numerical scores into six ordered vulnerability categories using Jenks natural breaks: very low, low, somewhat low, somewhat high, high, and very high.



Fig 1

Figure 1 to the left shows census block groups with their SoVI scores based on per capita income and demographic percentages at Holman Field in St. Paul, Minnesota



Fig 2

Figure 2 to the right labels each census block group by its population in the entire area, some of which may be outside the airport influence zone



Fig 3

Figure 3 to the left labels census block groups with the proportion of their area that is within the airport influence zone of Holman Field



Fig 4

Figure 4 to the right shows SoVI values weighted by population and area by multiplying the values for each area in Figures 1-3. All of these adjusted SoVI scores are summed up to create a composite airport SoVI score of 882,184, the highest for any Minnesota airport.

After performing this composite SoVI scoring for all 134 Minnesota airport influence areas, I generated comparison scores across the entire state aviation system. To identify coherent data breaks, I again used Jenks natural breaks to create six data classes ranging from very low to very high. The data distribution was again right-skewed, with most airport influence zones ranking low in vulnerability and several high outliers.

Airport	SoVI	Vul Category	CBGs
St. Paul Downtown Airport - Holman Field	882,184	Very High	74
Crystal Airport	773,031	Very High	70
Minneapolis-St.Paul Int'l-Wold Chamberlain	482,312	High	88
South St. Paul Municipal Airport - Fleming Field	192,573	Somewhat High	37
Anoka County/Blaine Airport - Janes Field	142,817	Somewhat High	32
Worthington Municipal Airport	98,625	Somewhat High	10
Austin Municipal Airport	91,331	Somewhat High	13
Flying Cloud Airport	79,865	Somewhat Low	19
Albert Lea Municipal Airport	62,422	Somewhat Low	13
Grand Rapids/Itasca Co-Gordon Newstrom Fld	58,946	Somewhat Low	11
Bemidji Regional Airport	57,704	Somewhat Low	6
Fairmont Municipal Airport	53,507	Somewhat Low	11
Little Falls-Morrison County Airport	50,512	Somewhat Low	11
Falls International Airport	49,609	Somewhat Low	10
Winona Municipal Airport - Max Conrad Field	48,395	Somewhat Low	10
Forest Lake Airport	47,717	Somewhat Low	13
Park Rapids Municipal Airport - Konshok Field	45,590	Somewhat Low	5
Southwest Minnesota Regional-Marshall/Ryan Field	43,586	Somewhat Low	12
Owatonna Degner Regional Airport	42,865	Somewhat Low	7
Faribault Municipal Airport	41,817	Somewhat Low	8
Buffalo Municipal Airport	41,752	Somewhat Low	9
Hutchinson Municipal Airport - Butler Field	38,969	Somewhat Low	9
New Ulm Municipal Airport	37,764	Somewhat Low	14
Alexandria Municipal Airport - Chandler Field	36,005	Somewhat Low	10
Princeton Municipal Airport	34,965	Somewhat Low	8
Mora Municipal Airport	34,733	Somewhat Low	8

The chart above shows the 26 airports with the highest SoVI scores that the Jenks algorithm classed into the four highest of six categories. Holman Field and Crystal Airport hold the top category, with scores over 750,000. The state's international airport, MSP, is alone in the fifth-highest category, with a significant empirical gap between very high and somewhat high. The somewhat high category includes four airports, including those outside the Twin Cities metro, with high SoVI scores in Austin and Worthington in southern Minnesota.

The last column lists the number of census block groups that each airport influence area contains or intersects, which also serves as an imprecise proxy for the population size within the airport influence zone. As shown in the table above, airports with more census block groups tend to have higher scores. This indicates that the composite scoring methodology places heavy weight on social vulnerability and the size of those vulnerable populations. This happens when the census block group SoVI score is weighted by population, and the final summation gives empirical heft to airport influence zones with many census block groups.

To the right 134 airport influence zones are mapped across Minnesota with their composite SoVI class highlighted. The three airports in the two categories of highest social vulnerability are in the dense and populous Twin Cities metropolitan area. The somewhat high category has two more metro airports, South St Paul and Anoka/Blaine, but extends to southern Minnesota with Worthington southwest and Austin south east. The three low categories are comprised of far more airports which helps explain its more even distribution across the state of Minnesota.

