Appendix B: Screening Memo

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Technical Memorandum

January 17, 2023 Project# 27668

To: Kristine Courdy, PE
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From: Kittelson & Associates, Inc.

CC: Edgar Medina, PE; Drew Hart

RE: Roundabout Study – Final Existing Conditions and Screening Process Memo

INTRODUCTION AND PURPOSE

Kittelson & Associates, Inc. (Kittelson) is helping the City of Rancho Cordova (City) develop a Citywide Roundabout Feasibility Study and Implementation Plan. The plan will identify top locations for roundabout projects, including concepts for those locations and guidance for roundabout planning and implementation moving forward.

Top locations will be identified with a priority and feasibility screening. The screening will use data that describe existing conditions and planning priorities for the City.

This memo documents the data and planning information assembled to describe existing transportation, land use, and demographic information in the City. Each data source is desribed and visually presented in a map. Following the description of existing conditions data, this memo proposes a priority and feasibility screening methodology that will allow the City to transparently describe a roundabout prioritization process. As a next step, Kittelson and the City will test the proposed screening scenarios to identify top locations for roundabouts.

The memo is organized as follows:

- Existing Conditions Data
- Proposed Screening Methodology
- Next Steps

EXISTING CONDITIONS DATA

This section documents the data available for potential use in a citywide roundabout priority and feasibility screening process. The available data include:

- **Transportation data**
  - Roadway functional classification
  - Posted speed limits
  - Lane numbers
  - Intersection control type
  - Existing and proposed bikeway classification
  - Truck routes
  - Transit lines and stops
  - Existing and projected traffic volumes
  - Crash history
- **Land use data**
  - Planning areas
  - Land use opportunities and constraints
- **Demographic, Socioeconomic, and Environmental Data**
  - Social equity indicators
  - Hazard risk

Transportation data

This section documents assembled data that describe existing and proposed transportation conditions in the City. The transportation data are displayed in a series of maps starting on page 7.

Roadway Functional Classification

City-provided data include the following roadway functional classification designations: state highway, arterial, collector, and local. The City data also included the location of proposed future roads, shown in the figure.

Because the screening will analyze and identify intersections, Kittelson has classified intersections by their intersecting roadway functional classes, including the highest order classification each intersection serves (e.g., if an intersection connects a local and arterial roadway, the arterial roadway would be identified as the highest-order functional classification). The following roadways were changed from local to collector classification (so that they could be included in the screening) at the direction of the City.

- Georgetown Drive
- Anatolia Drive
- Cobble Brook Drive
- Dawes Street
- Country Garden Drive
- Laurelhurst Drive
- Rockingham Drive
- Peter A McCuen Boulevard

Posted Speed Limits

City-provided data include posted speed limits.

Roundabouts are a proven safety treatment that force slow driving speeds (typically entry speeds no higher than 30 miles per hour and circulating/exiting speeds ranging from 15 to 25 miles per hour). Roundabouts built on higher-speed roadways (45 miles per hour or higher) may require some additional traffic calming measures in advance of the intersection or design features to promote slow speeds on approach. The desirable maximum entry design speed for a roundabout is dependent upon the roadway operational context, which may impact the roundabout design. At a high level, NCHRP Report 672 Exhibit 1-9 recommends desirable entry speeds for different roundabout types.

- Mini Roundabout (1 lane): 15 - 20 mph
- Single-Lane Roundabout (1 lane): 20 – 25 mph
- Multilane roundabout (2+ lanes): 25 – 30 mph

Roundabouts have successfully been built in higher speed environments with additional speed-reduction elements (e.g., extending splitter islands on the approaching roadway).

Lane Numbers

City-provided data include information on the total number of through lanes for each roadway (which does not include turn lanes at intersections).

Existing roadway lane numbers do not necessarily indicate how many lanes a roundabout would require but do provide an indication of existing curb-to-curb and right-of-way space and the relative amount of traffic a road may carry (streets with more lanes typically carry more traffic)[1]. In the absence of traffic volume data at any location, the number of lanes on a roadway is a starting point for an assumption about whether a single- or multilane roundabout would provide adequate capacity. The City and Kittelson have agreed that a feasibility screening will screen out six-lane roadways (total through lane number) from further consideration. Ultimately, traffic volumes are necessary to plan roundabout lane number and sizing.

Intersection Control Type

City-provided data include intersection locations and control type. The control type data include the following values: 1 way stop, 2 way stop, 3 way stop, 4 way stop, traffic signal, or uncontrolled. Existing traffic control data provide helpful context.

Existing and Proposed Bikeways by Classification

Kittelson obtained existing and proposed citywide bikeway network data as identified in the Bicycle Master Plan.[2]

These data indicate the City's priorities for people biking; existing and proposed bikeways will determine how people biking are to be served at the intersection for any roundabout project (e.g., shared or separated dedicated lane on approach or exit). A separated, dedicated lane will typically require more space at the intersection, so the desired bikeway type helps to determine planning-level size estimates.

Truck Routes

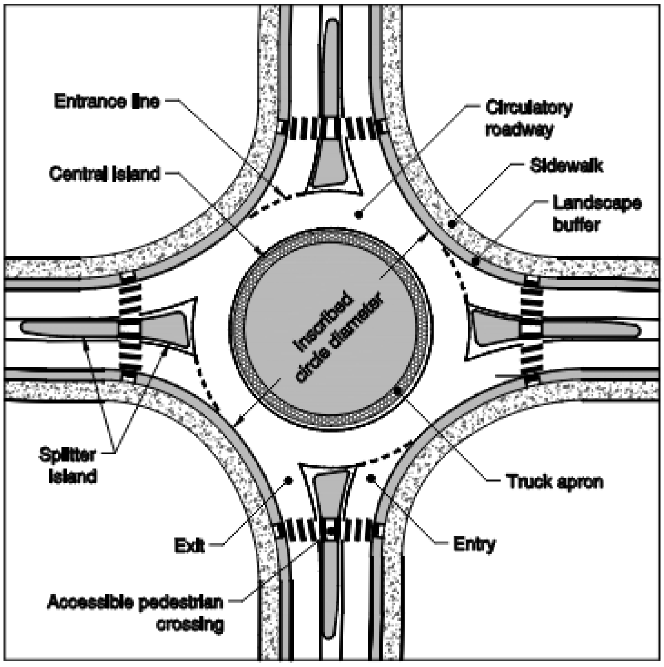
The City provided data on the federal and local truck routes, as well as other roadways along which trucks frequently travel to serve commercial businesses. More detailed information will become available with the City's ongoing freight study.

Truck volume and size is a key design input for roundabouts. Large trucks and buses typically dictate a roundabout's dimensions: if either vehicle frequently uses the intersection, the roundabout will need to be larger than it otherwise would be. At any location, the largest vehicle frequently using the intersection, or the **design vehicle**, should be able to make all movements in-lane without striking curbs or crossing outside its travel lane. Less frequent larger vehicles can be accommodated through the design (e.g., with use of a truck apron for the rear wheels of a larger truck (see Exhibit 1).

[1] Many City roadways are built to accommodate anticipated future (2040) volumes, further reinforcing that lane numbers are a rough proxy for traffic volume data.

[2] Available at https://www.cityofranchocordova.org/home/showpublisheddocument/11416/635996042085130000 (as of July 27,2022)

Exhibit 1: Basic Geometric Elements of a Roundabout



Source: Reproduced from NCHRP Report 672

Transit Lines and Stops

Kittelson obtained transit routes and stop locations within the City from the Sacramento Regional Transit (SacRT) website. Transit stop location is helpful in the design of a roundabout but would typically not affect its feasibility.

Existing and Projected Traffic Volumes

Existing approach roadway traffic volumes will help identify at a planning level whether a single-lane roundabout would suffice or whether some portions of a roundabout would need multiple lanes. Future projected traffic volumes will allow the project team to test the resilience of roundabout sizing decisions against projected future growth.

Two sources of traffic volume data were available to the project team:

- **Existing and future model volumes from SACSIM.** SACSIM is the Sacramento Area Council of Governments (SACOG) activity based model that represents the Sacramento County area and provides existing and future calibrated hourly and daily volumes.
- **City Fee Study projected future (2055) volumes.** The City has prepared future volumes for its recent traffic impact fee study.

For this screening Kittelson recommends used existing (2016) SacSIM volumes to screen locations that could not feasibly be served by single or multilane roundabouts. Because future volumes in Rancho Cordova show anticipated growth, a feasibility assessment would only rule out locations that would be over capacity with existing volumes and would therefore continue to exceed capacity into the future.

Crash History

Reported crash history for the City for 2017-2021 was obtained from the online Statewide Integrated Traffic Reporting System (SWITRS) database maintained by California Highway Patrol and the Transportation Injury Mapping System (TIMS) maintained by SafeTREC at the University of California, Berkeley. The crash datasets were combined into a single geocoded dataset. The dataset was then filtered to include intersection-related crashes on local roadways (i.e., not state highways).[3]

The crash dataset was then used to develop crash severity scores. Severity scores are calculated based on Caltrans estimated costs of crash outcomes and are normalized to be expressed in terms of equivalent property damage only collisions (PDOs).[4] The relative severity values are as follows:

- Fatal/severe injury collisions are 119.9 equivalent PDOs at signalized intersections and 190.8 at unsignalized intersections.
- Moderate injuries are 10.7.
- Minor injuries are 6.1.

For example, a signalized intersection with an annualized crash severity score of 48, for example, would represent the equivalent of 48 PDO collisions per year, two fatal/severe injury collisions over 5 years (119.9*2/5 = 48), or some combination of severity levels resulting in the same score.

Figure 9 on page 15 shows the crash severity scores at each intersection.

Because roundabouts are a proven safety treatment and have been demonstrated to drastically reduce fatal and injury crashes, the screening can prioritize locations with a high severity score that would see a substantial safety benefit from a roundabout project.

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[3] Intersection-related crashes are those recorded as occurring within 250 feet of an intersection. This distance is a typical value used to consider the influence area of the intersection and is the definition used by Caltrans.

[4] Caltrans Local Road Safety Manual (April 2022).

Figure 1: Roadway Functional Classification

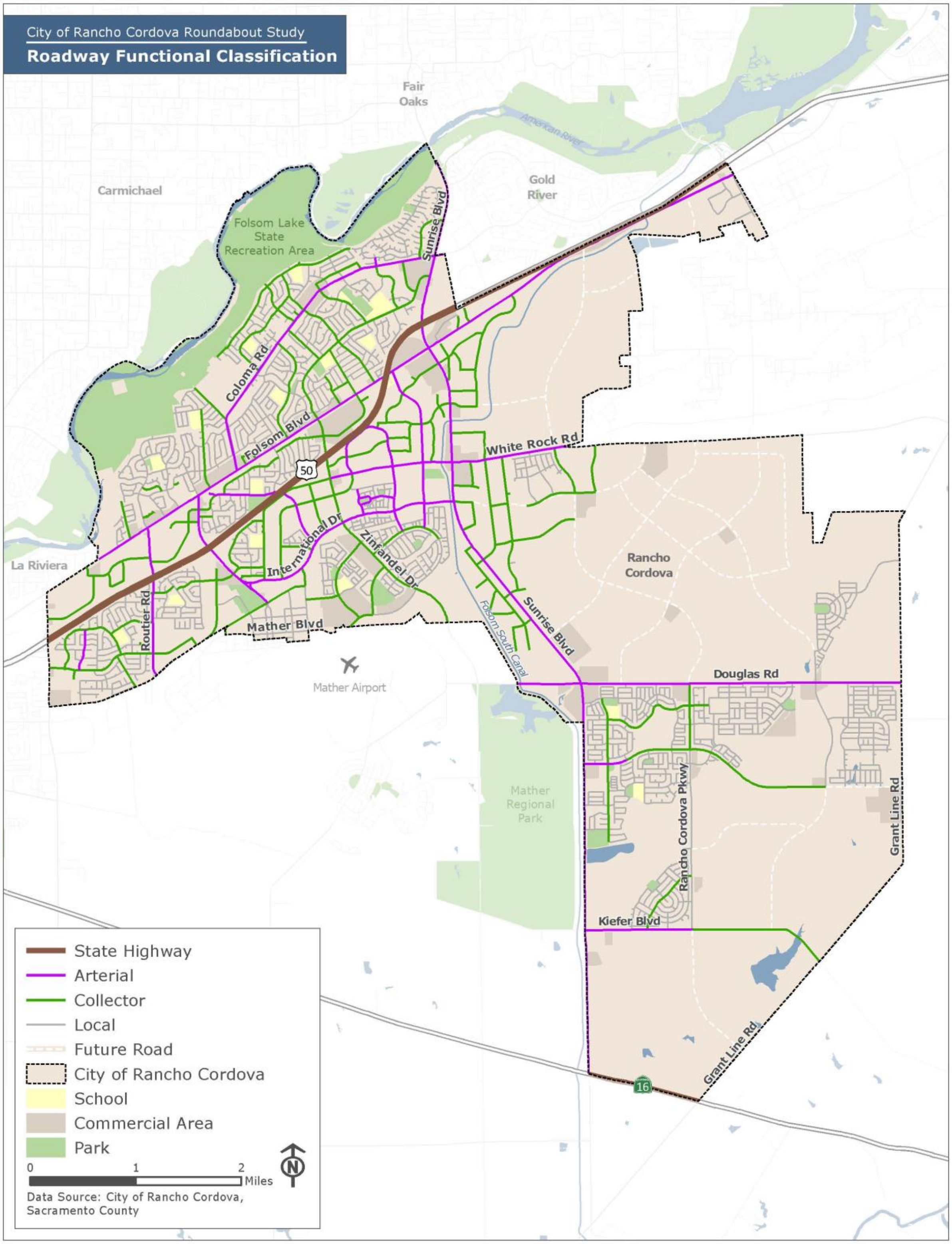


Figure 2. Posted Speed Limits

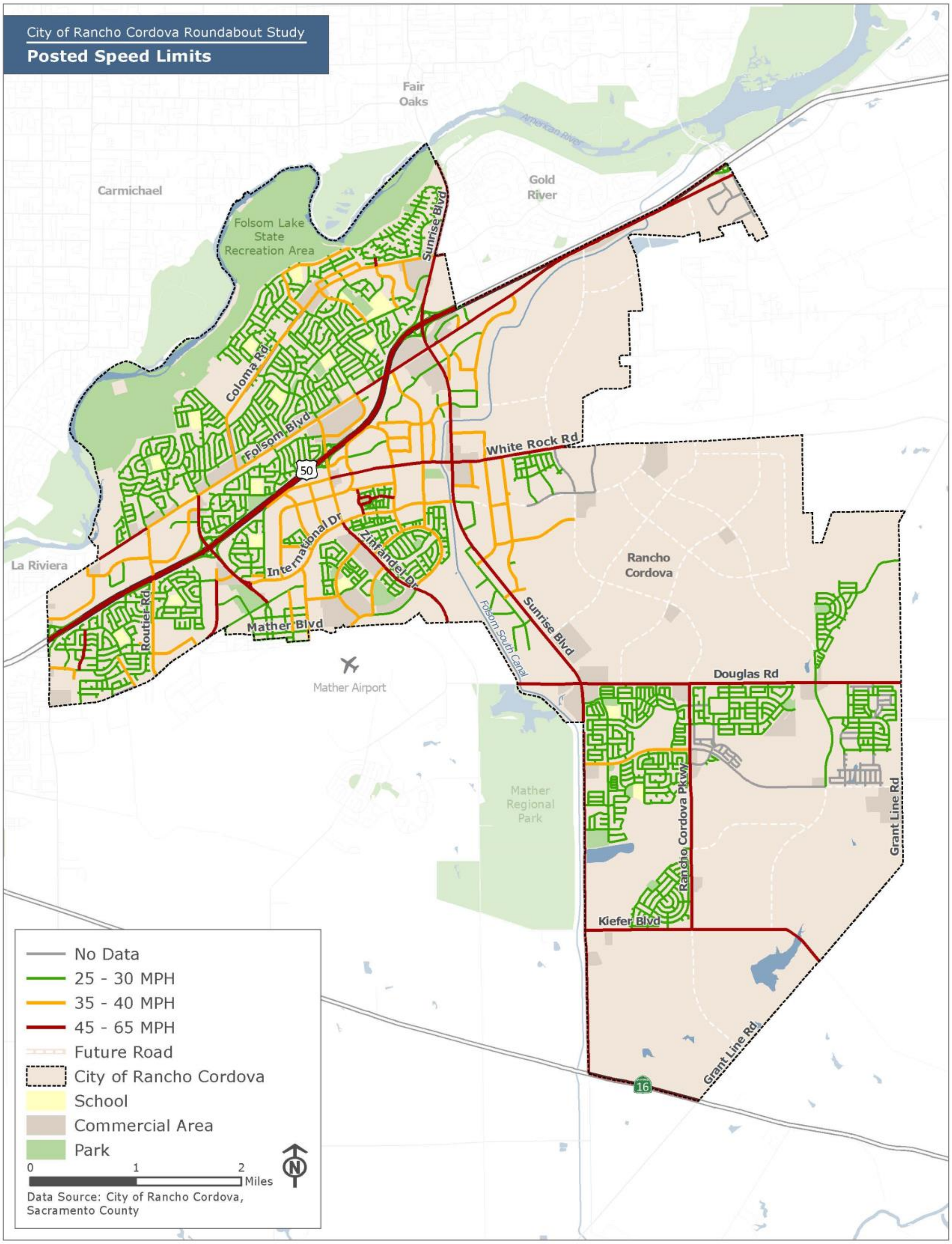


Figure 3. Number of Lanes

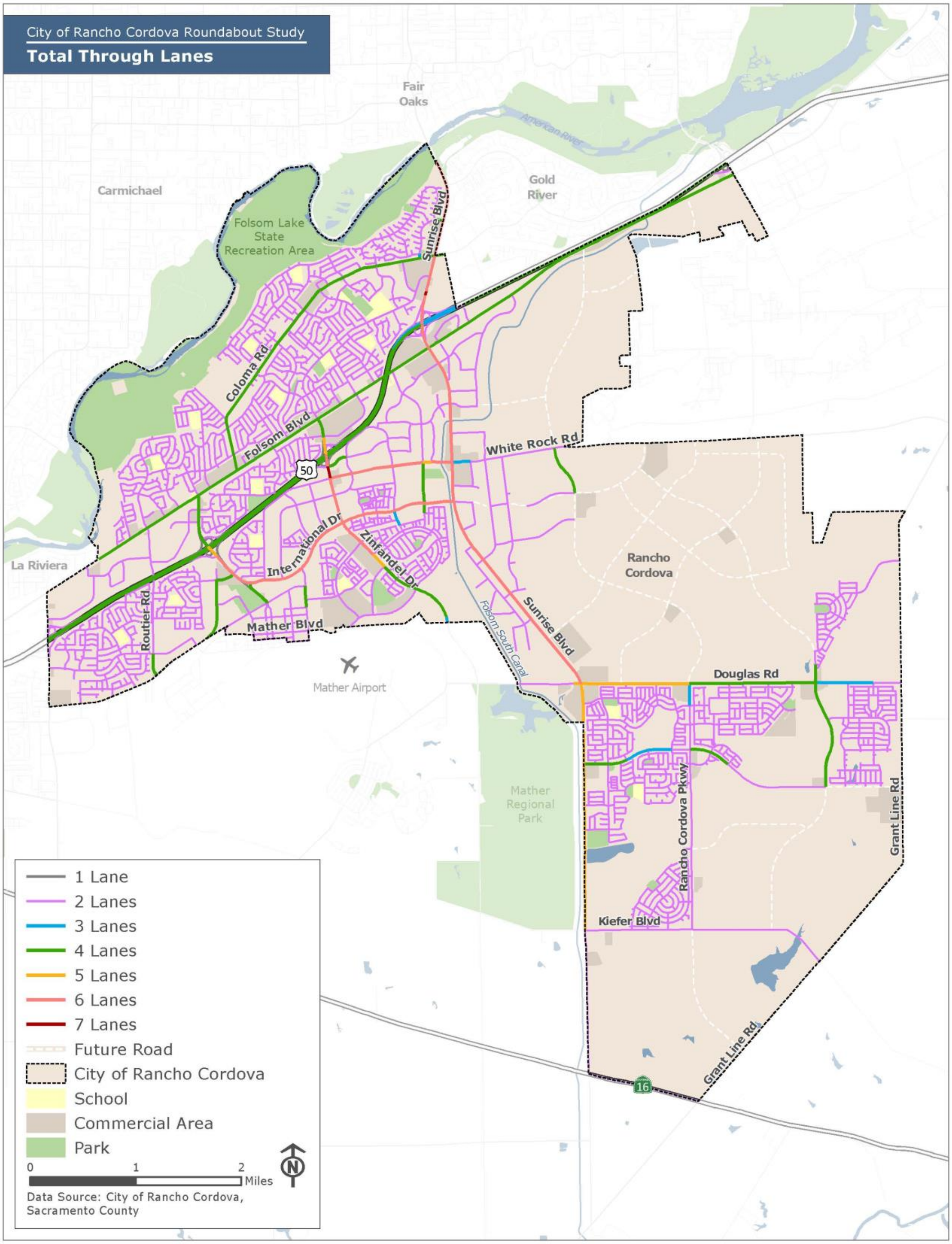


Figure 4. Intersection Control Type

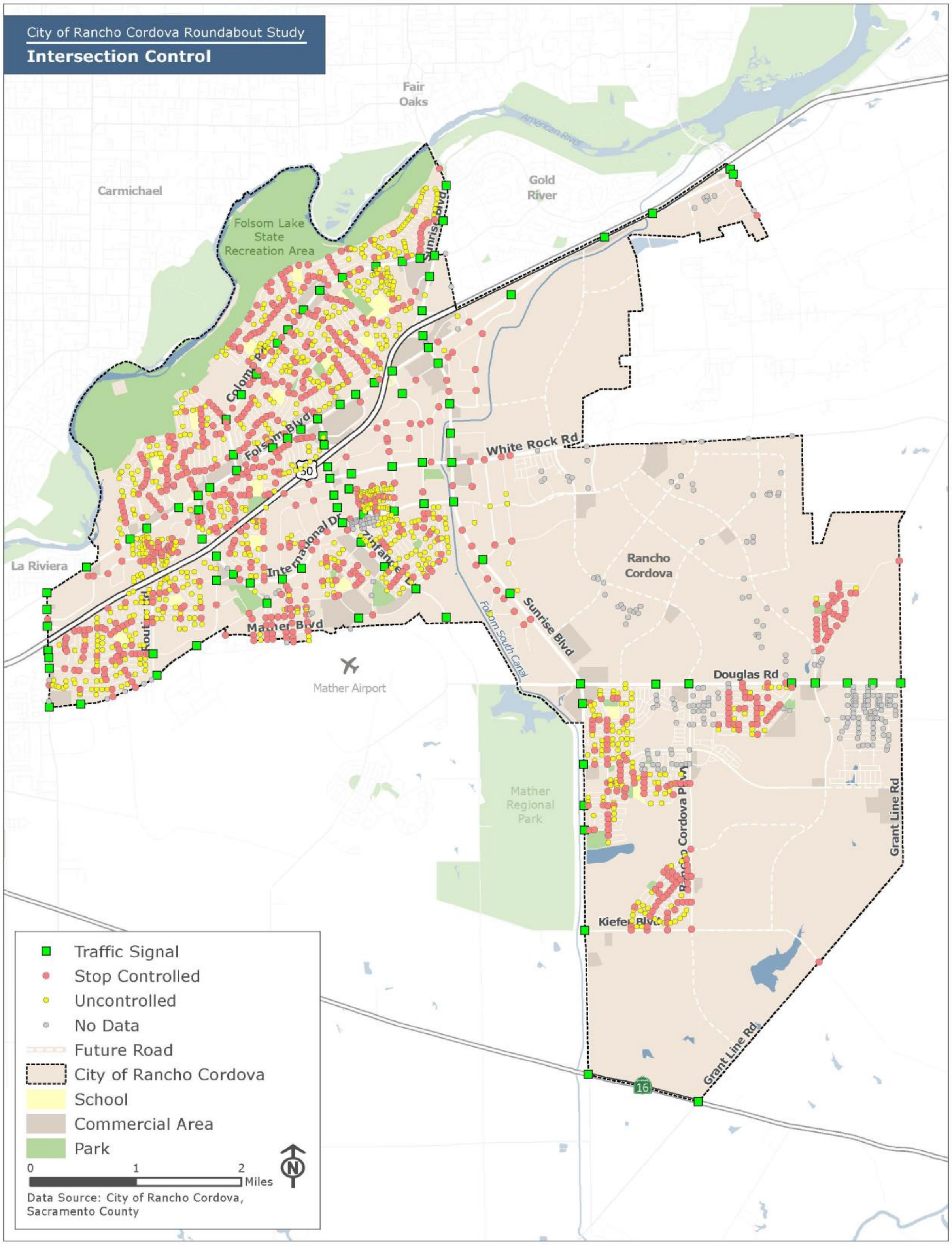


Figure 5. Existing and Proposed Bikeways

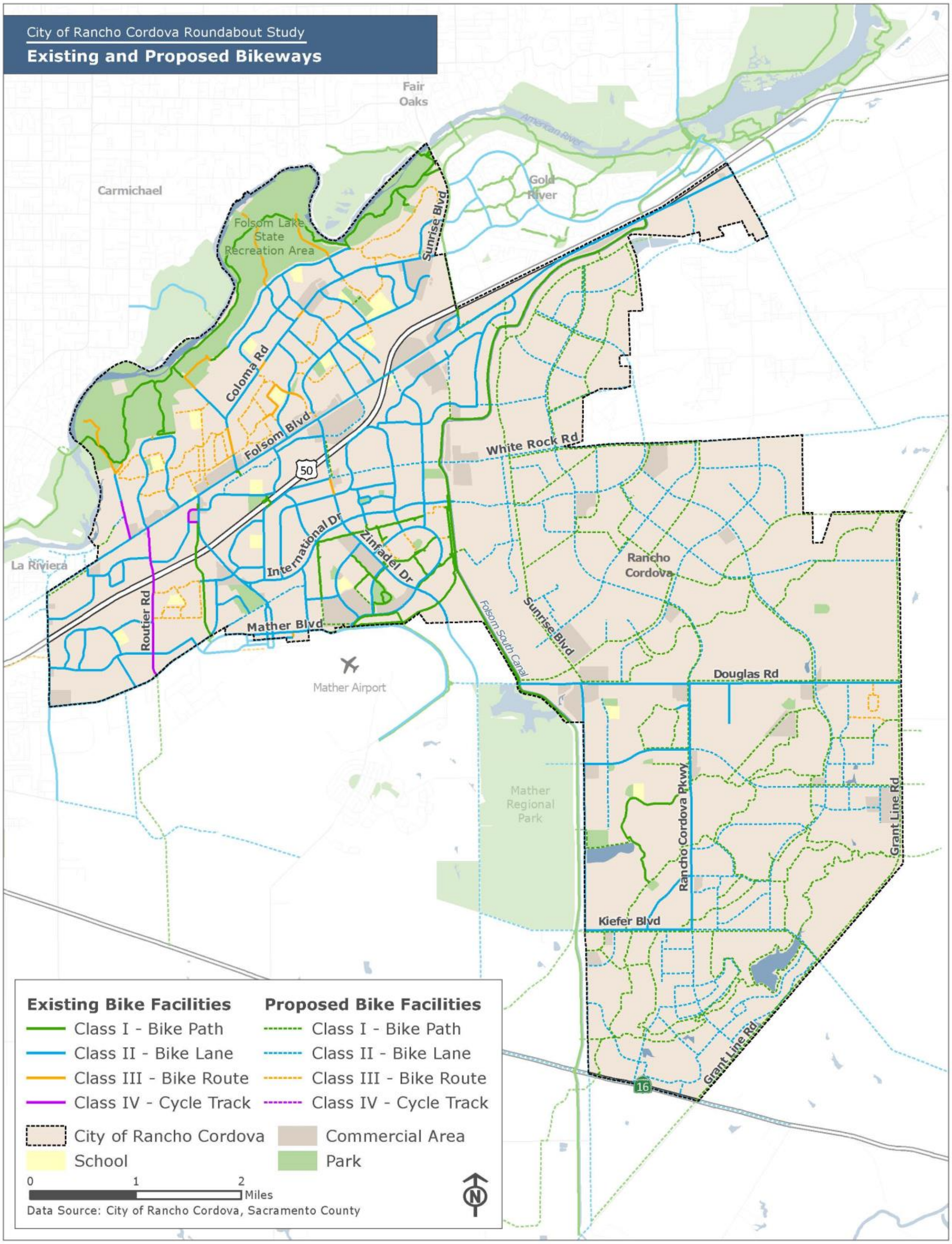


Figure 6. Truck Routes

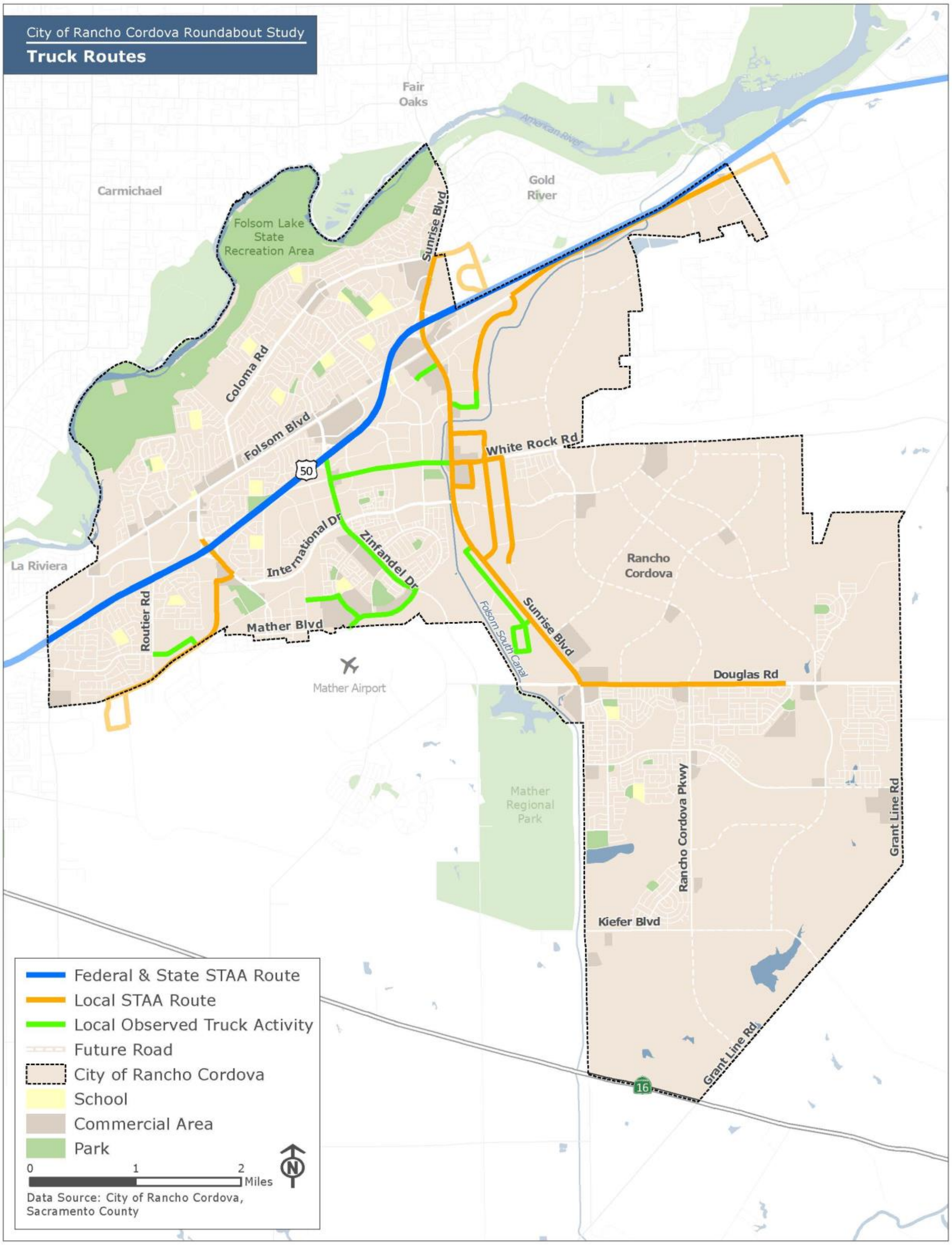


Figure 7. Transit Lines & Stops

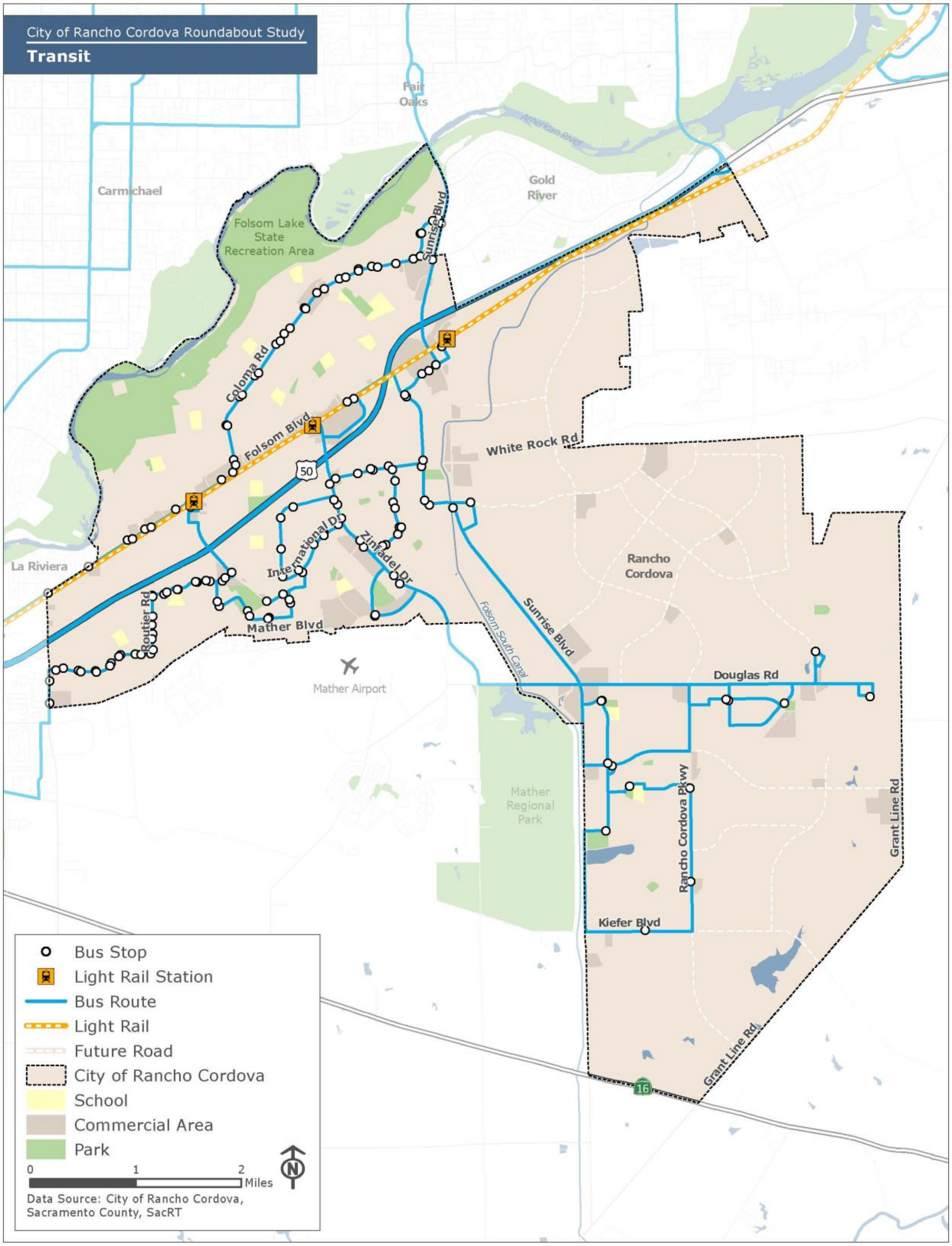


Figure 8 Intersection Volumes

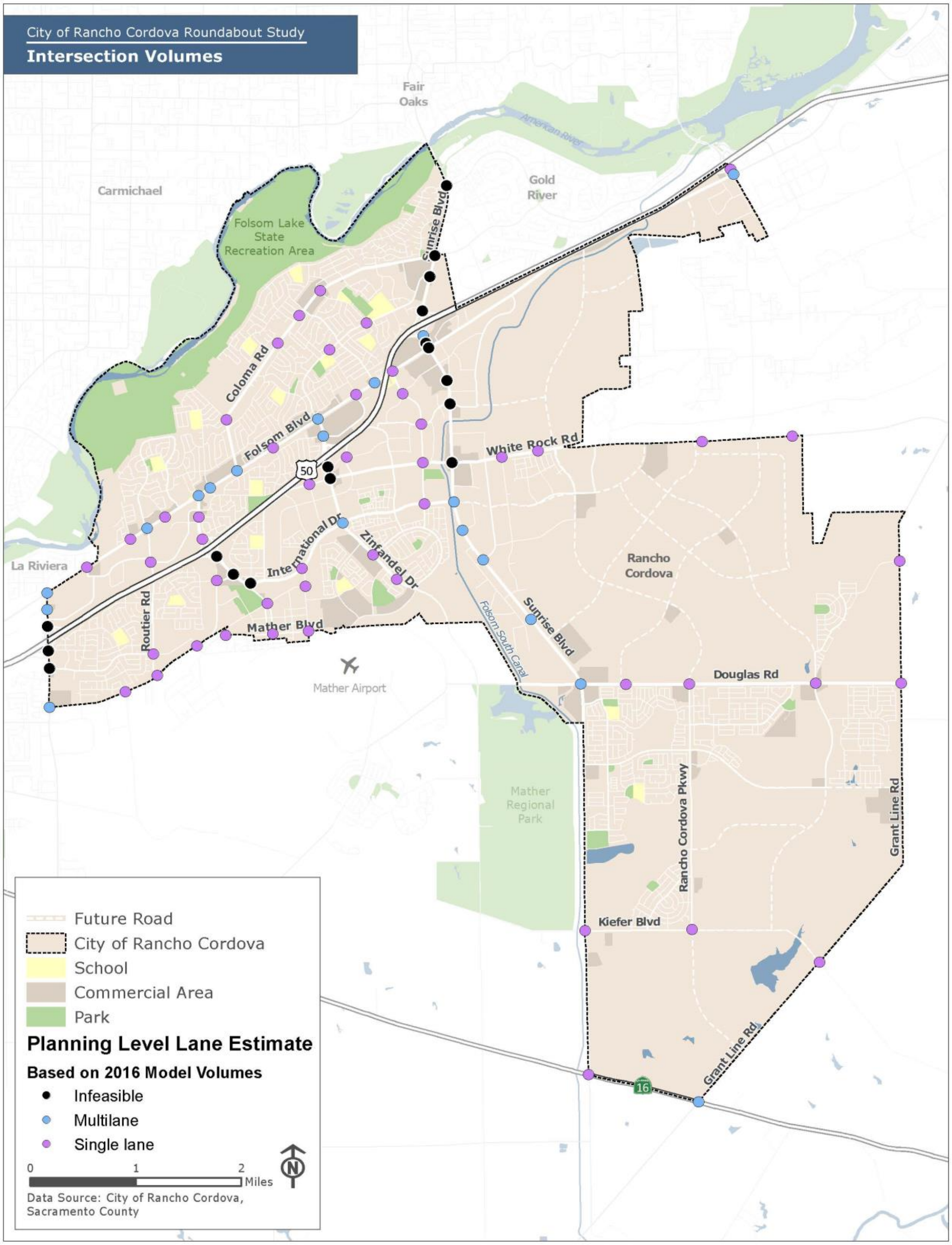
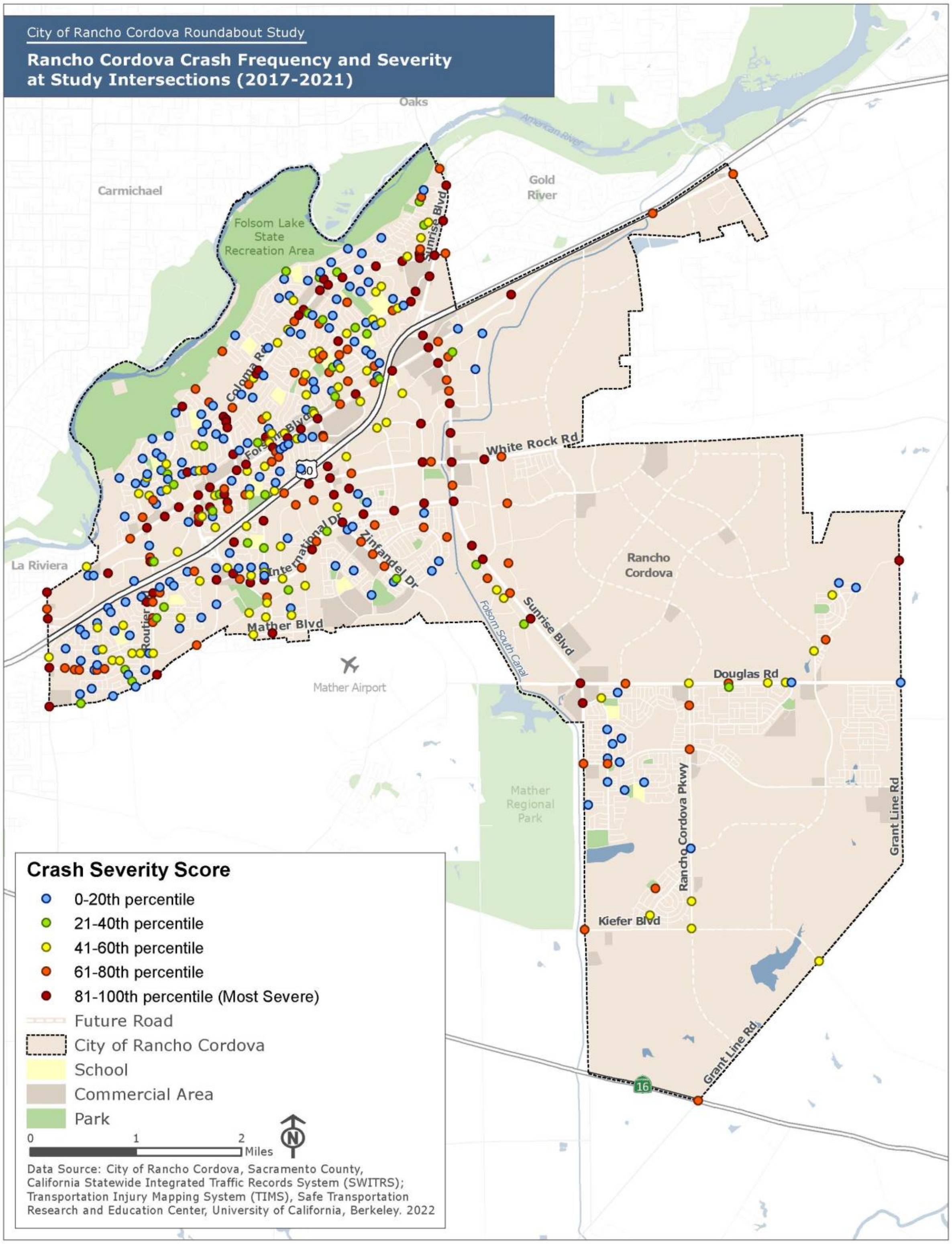


Figure 9. Crash Frequency and Severity (2017-2021)



Land Use Data

This section includes the data that describe existing and proposed land use in the City.

Planning Areas

The City's website provides the spatial boundaries of Special Planning areas, which allow for creative implementation of the City's General Plan. Special Planning Areas may have unique standards to achieve certain planning outcomes. However, planning Areas would not be a part of the screening. Their location and relation to potential roundabout sites will be retained for future City decision making.

Land Use Opportunities and Constraints

Kittelson obtained parcel-level data identifying existing land use categories. These data indicate potential opportunities (e.g., vacant parcels or city-owned parcels where right-of-way impacts may be accommodated) and "fatal flaw" right-of-way impacts (e.g., sensitive land uses on the corner of an intersection). Figure 11 on page 18 shows the following land uses as opportunities:

- Vacant parcels, where a project with a right-of-way impact may be feasible).
- Parcels identified as flood plains, where a roundabout project may provide an increase in pervious area or may include rain garden features to help guard against flooding.

Conversely, the figure shows the following as constraints, where a project with right-of-way impacts would likely be infeasible:

- Cemeteries
- Utilities
- Drainage ditches
- Levees
- Adjacent rail tracks

Figure 10: Planning Areas

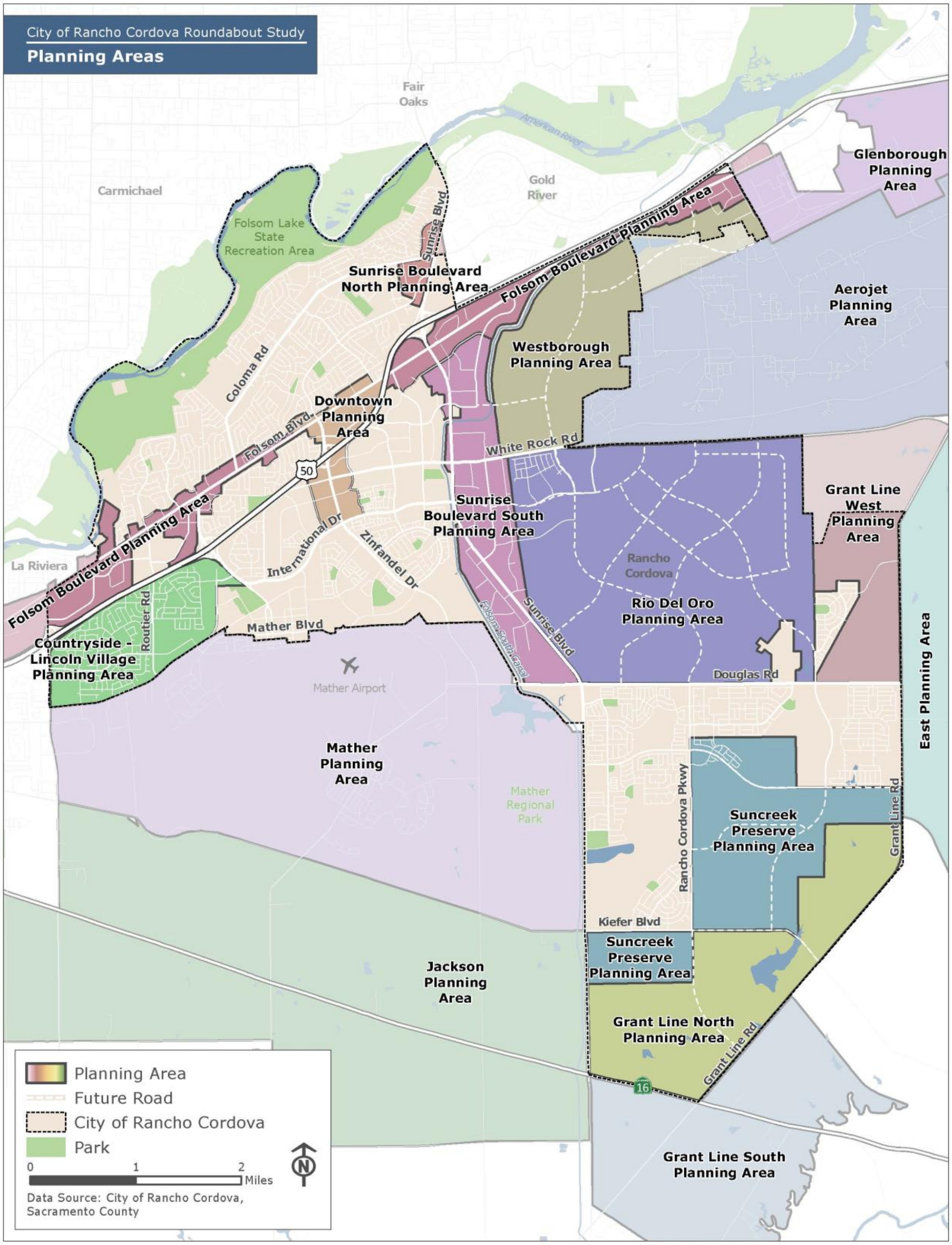
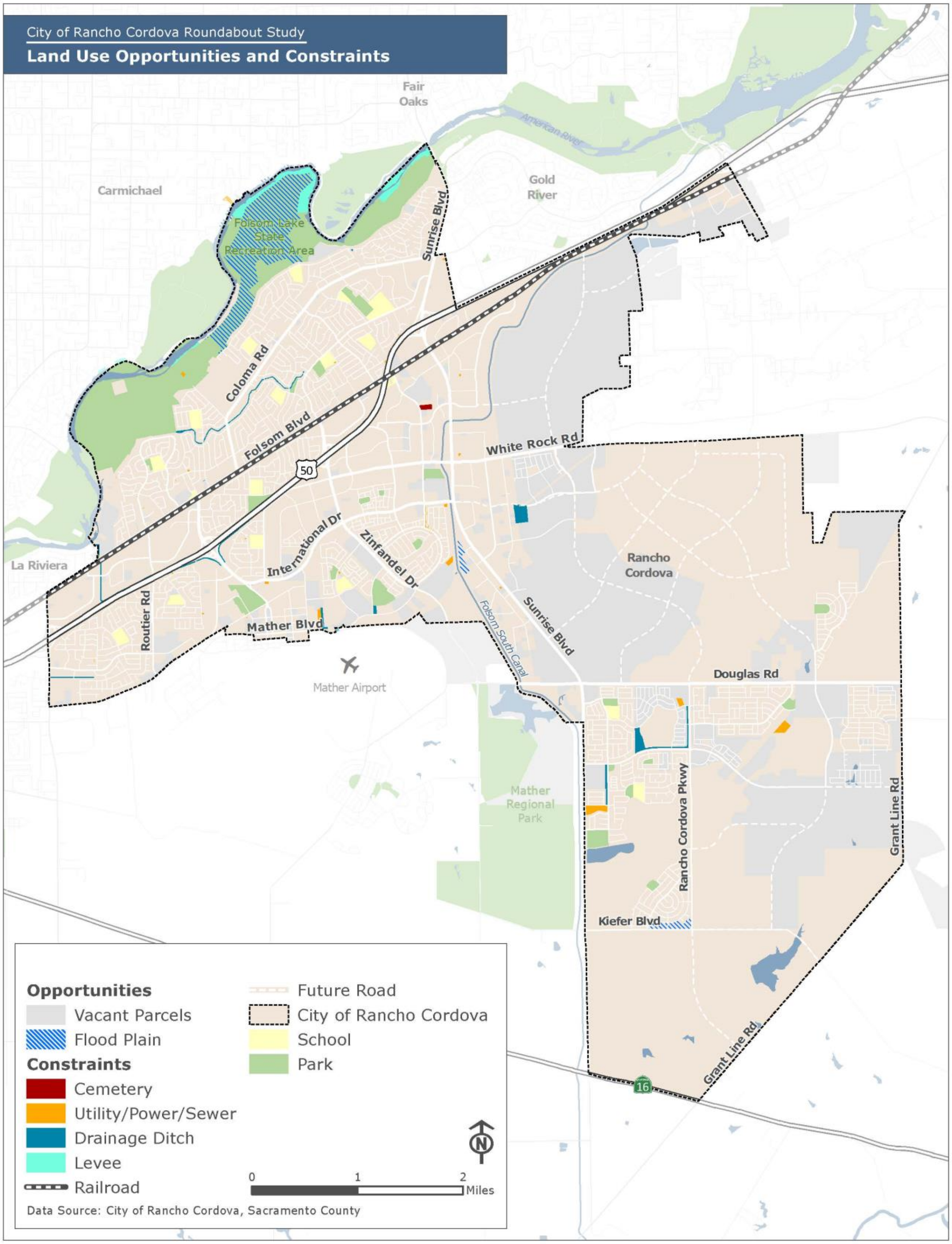


Figure 11. Land Use Opportunities & Constraints



Demographic, Socioeconomic, and Environmental Data

Social Equity Indicators

A number of social equity indicators are available at the national, state, and regional level to characterize population characteristics and environmental conditions. The following social equity indicators compiled were obtained or compiled:

- USDOT Historically Disadvantaged Communities (Figure 12)
- USDOT Areas of Persistent Poverty (Figure 13)
- CalEnviroScreen 4.0 (Figure 14)
- Healthy Places Index (Figure 15)
- SACOG Disadvantaged Communities and Communities of Concern (Figure 16)
- TDP index, calculated from US Census ACS data (Figure 17)

In addition to several national, federal, and regional social equity focused indicators which provide data at the Census tract level, Kittelson has supplemented with ACS data to incorporate a number of demographic and socioeconomic factors at the more granular Census block group level to identify populations with overlapping determinants of economic disadvantage.

Table 1 summarizes the social equity datasets Kittelson has compiled. Several of these indicators have historically been included as social equity critiera in grant programs such as the federal Rebuilding American Infrastructure with Sustainability and Equity (RAISE) and the state Sustainable Communities Planning Grant programs.

Table 1. Social Equity Indicators

Social Equity Indicator	Associated Governmental Level	Granularity	Inputs	Application
Areas of Persistent Poverty	Federal (USDOT)	Census tract (2010)	■ Poverty	■ Y/N
Historically Disadvantaged Communities	Federal (USDOT)	Census tract (2010)	■ Transportation Access ■ Health ■ Environmental ■ Economic ■ Resilience ■ Social ■	■ Y/N
CalEnviroScreen 4.0	State	Census tract (2010)	■ Pollution burden ■ Environmental quality, ■ Socioeconomic ■ Public health conditions	■ Percentile scores
Healthy Places Index 3.0[2]	State	Census tract (2010)	■ Economic ■ Education ■ Social ■ Transportation ■ Healthcare Access ■ Housing ■ Clean Environment	■ Percentile scores
SACOG Disadvantaged Communities	Regional	Census block groups (2010)	■ Minority ■ Low-income ■ "other" vulnerable communities -- measures such as individuals over age 75, linguistically isolated households, and concentrations of households with at least one person with a disability.	■ Y/N
Transportation Disadvantaged Populations Index	Custom (Kittelson & Associates)	Census block (2020)	■ Demographic factors (race/ethnicity, poverty status, English proficiency, vehicle access, age, disability, single-parent families)	■ Percentile scores

[1] **A census tract is considered historically disadvantaged by USDOT if it meetings 4 or more of the social equity indicators. More information on this dataset can be found at** https://www.transportation.gov/equity-Justice40
[2] More information on the HPI methodology can be found at: https://www.healthyplacesindex.org/learning-center#first-time

The City can use this data to be intentional in the prioritization of legacy and disadvantaged communities for improvement. Kittelson has associated the socialequity scores with each intersection so that any of them may be used in the screening or recalled in the future for reference or reprioritization (for example, when grant opportunities arise and reference a certain indicator).

Figure 12 Historically Disadvantaged Communities

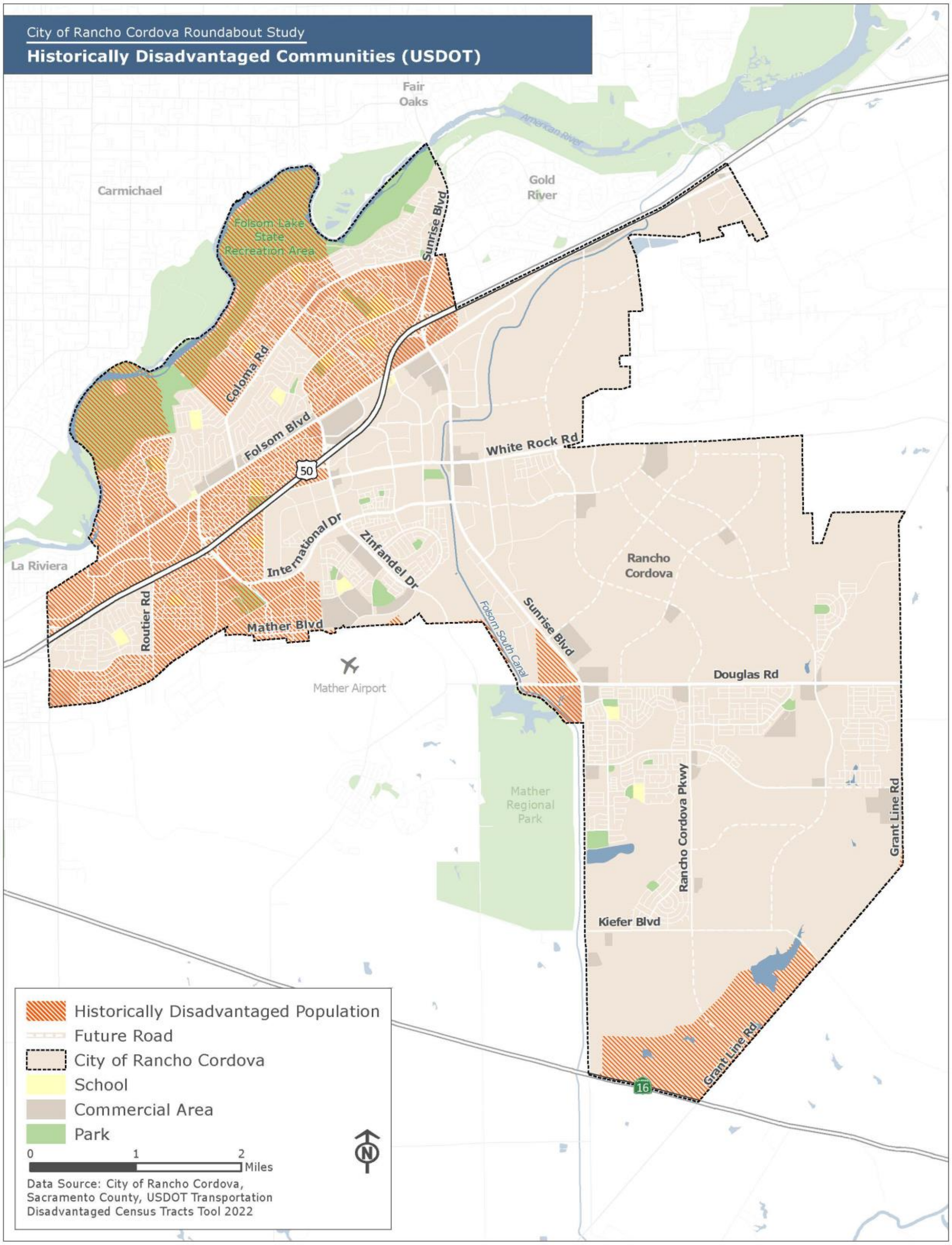


Figure 13. Areas of Persistent Poverty

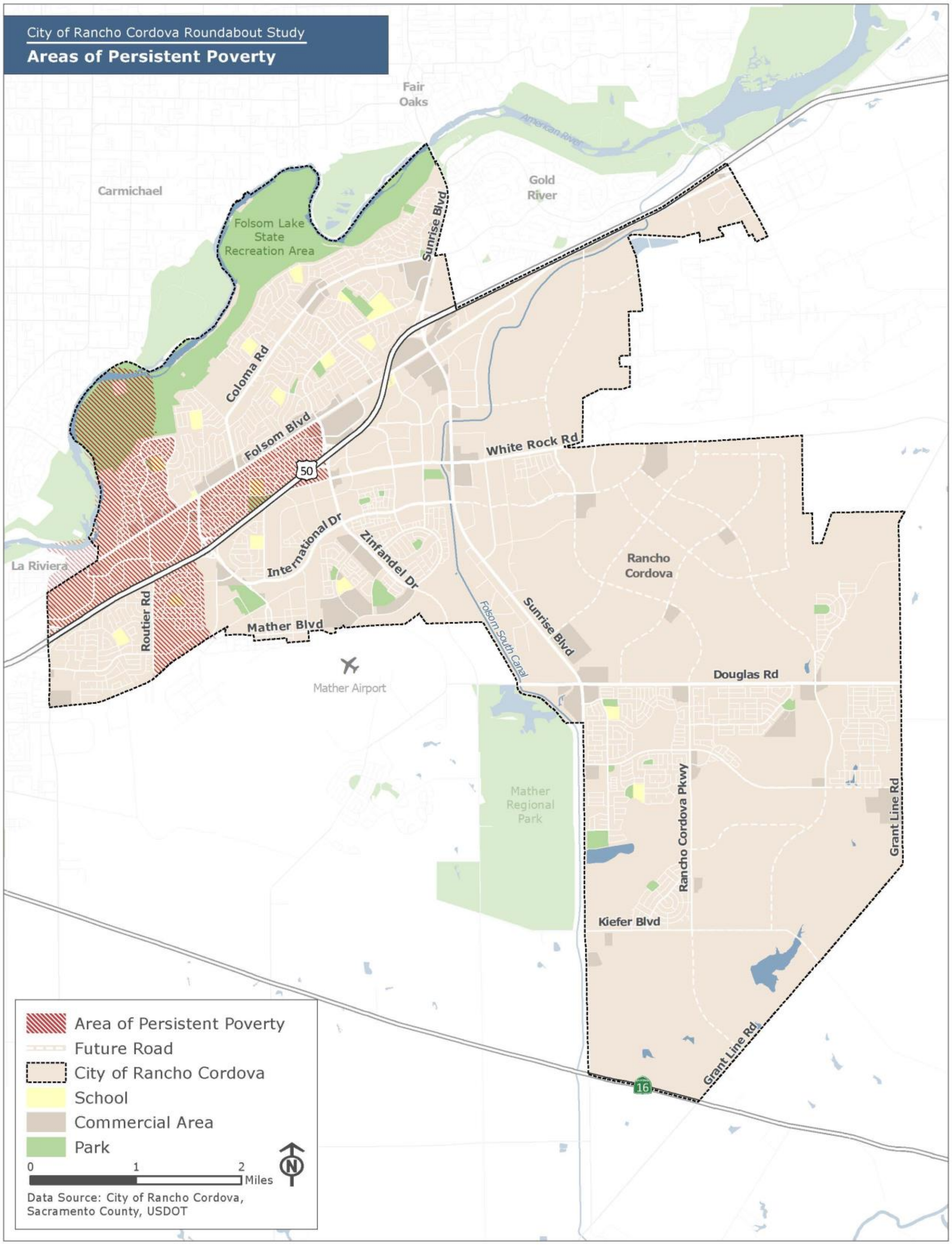


Figure 14. CalEnviroScreen 4.0

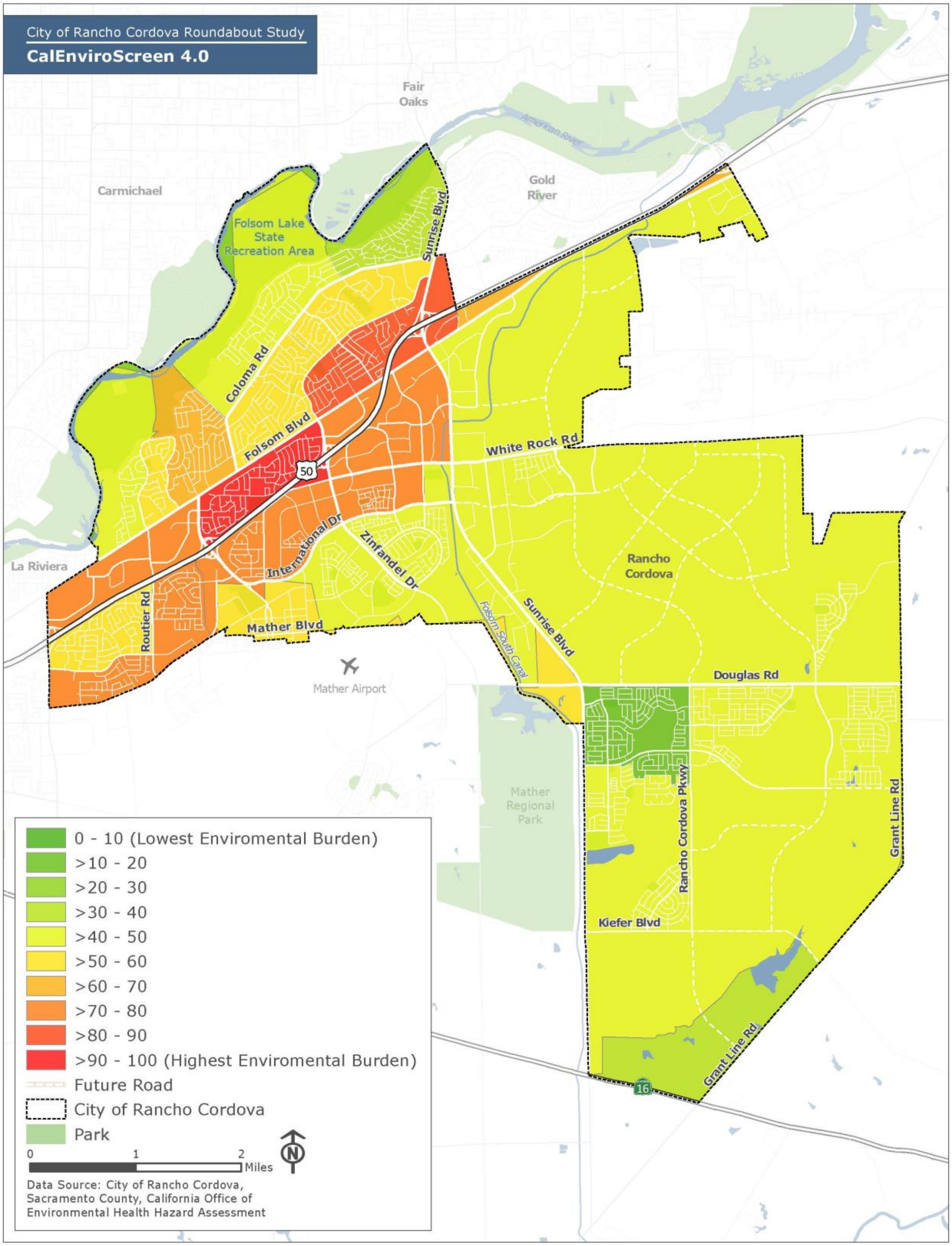


Figure 15. Healthy Places Index

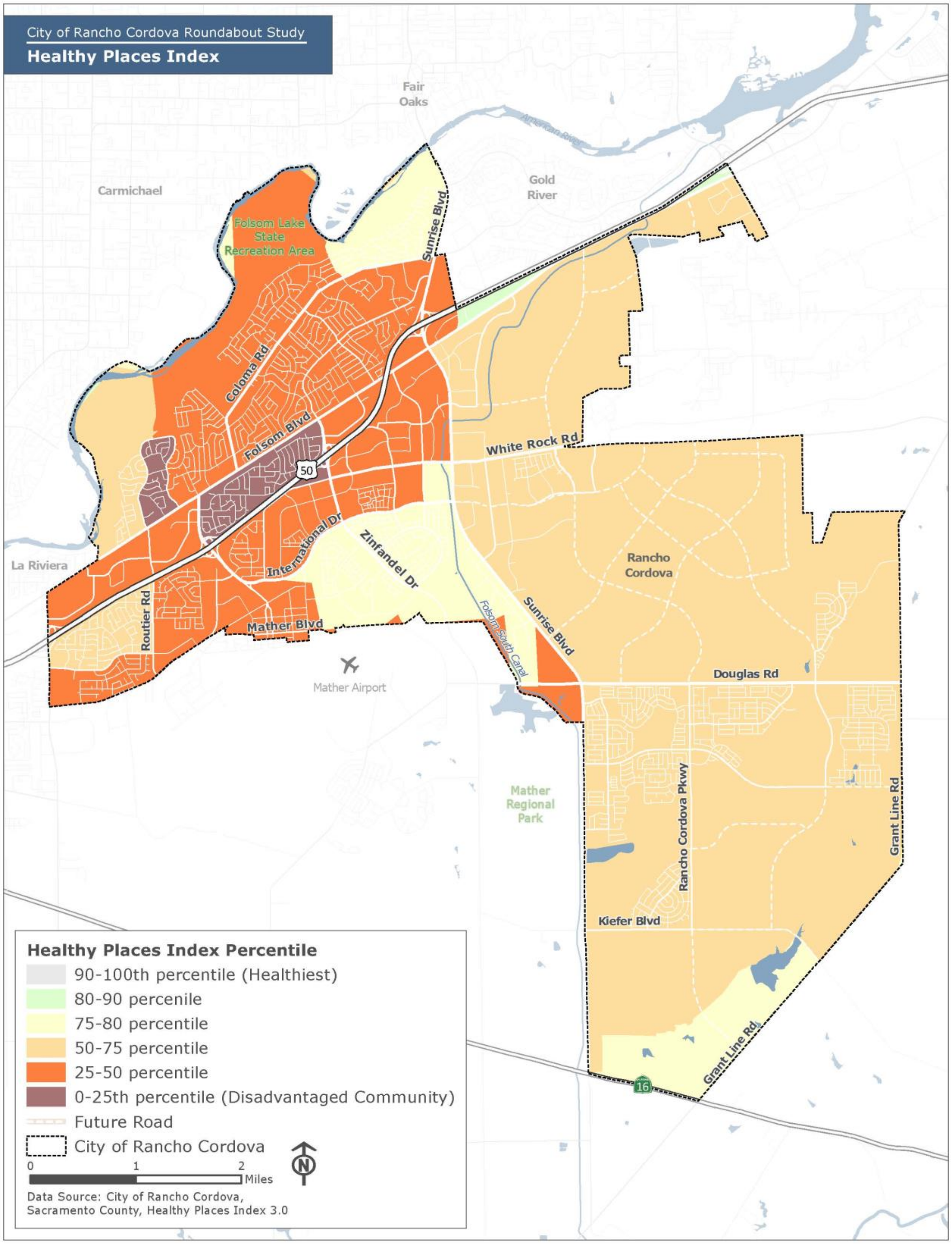


Figure 16. SACOG Disadvantaged Communities

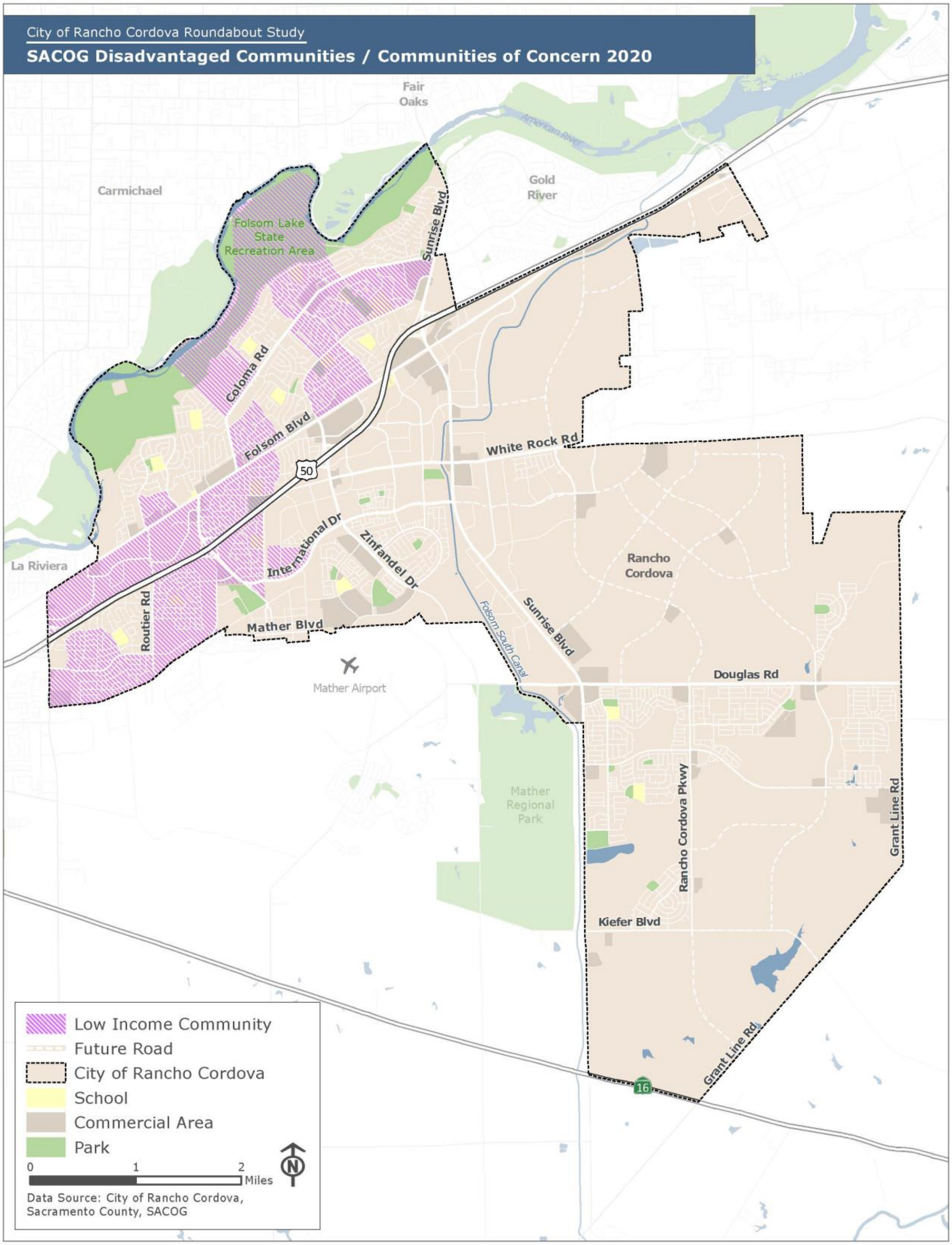
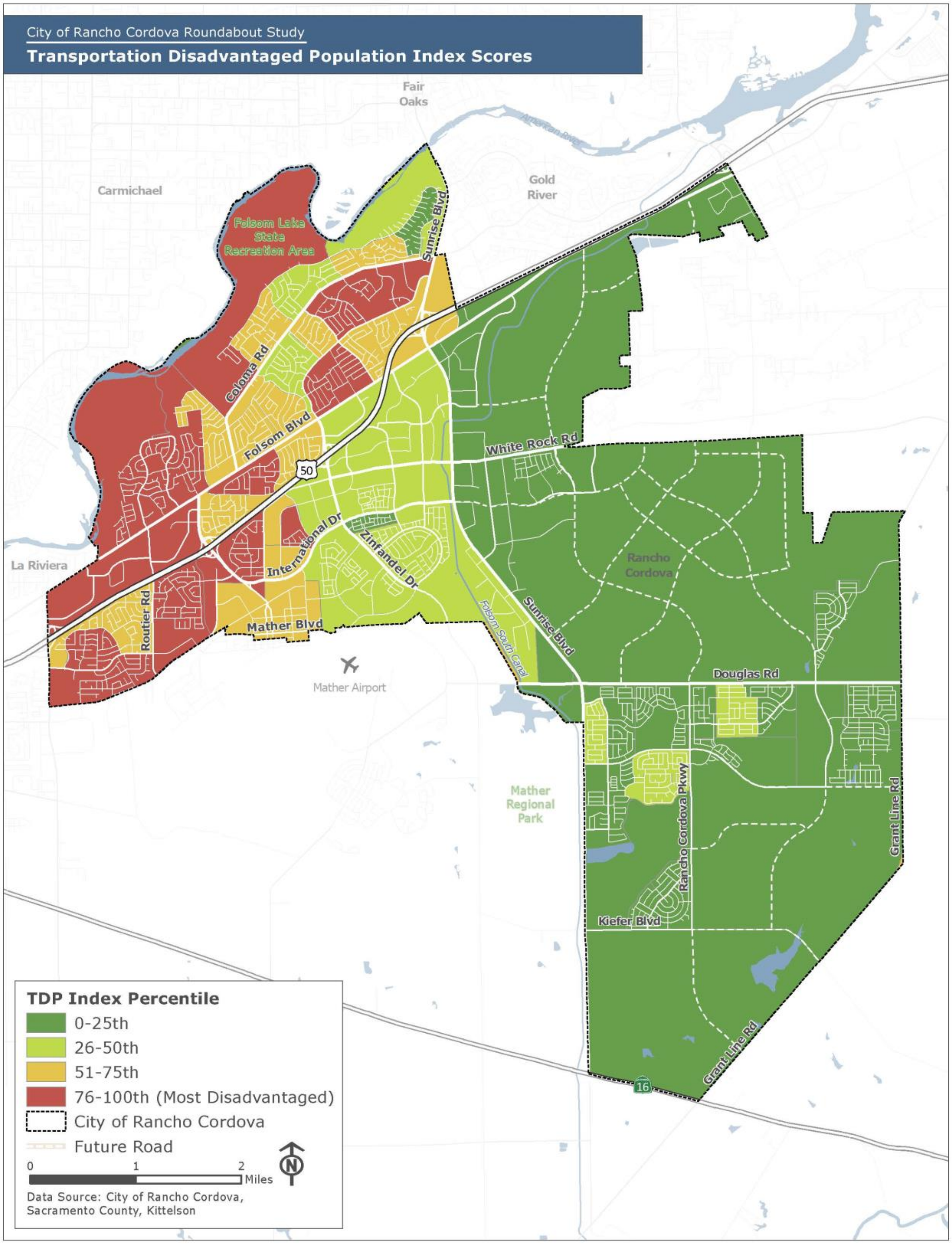


Figure 17. Transportation Disadvantaged Populations



Hazard Risk

Roundabouts are a more resilient infrastructure option than traffic signals because they do not require power supply to operate. Therefore, in the event of a power outage, they can continue to operate without the presence of traffic control officers. Hence, the proposed screening includes prioritization of locations sensitive to hazard risks.

The Federal Emergency Management Agency (FEMA) developed the National Risk Index (NRI) to create a framework for assessing the likelihood and consequences of natural hazards combined with social factors and resilience capabilities. The NRI includes eighteen hazard types. The three most relevant hazard types to the City of Rancho Cordova geographic context and its roadway operations are:

- Wildfire
- Flooding
- Earthquake

Figure 18 through Figure 20 show a map of the NRI scores in the City by Census tract for each of the three isolated hazard types. The hazard type risk score is relative to all other Census tracts nationally. Scores are not absolute measurements and should be expected to change over time either by their own changing measurements or changes in other communities.

Figure 18. Earthquake Hazard Risk

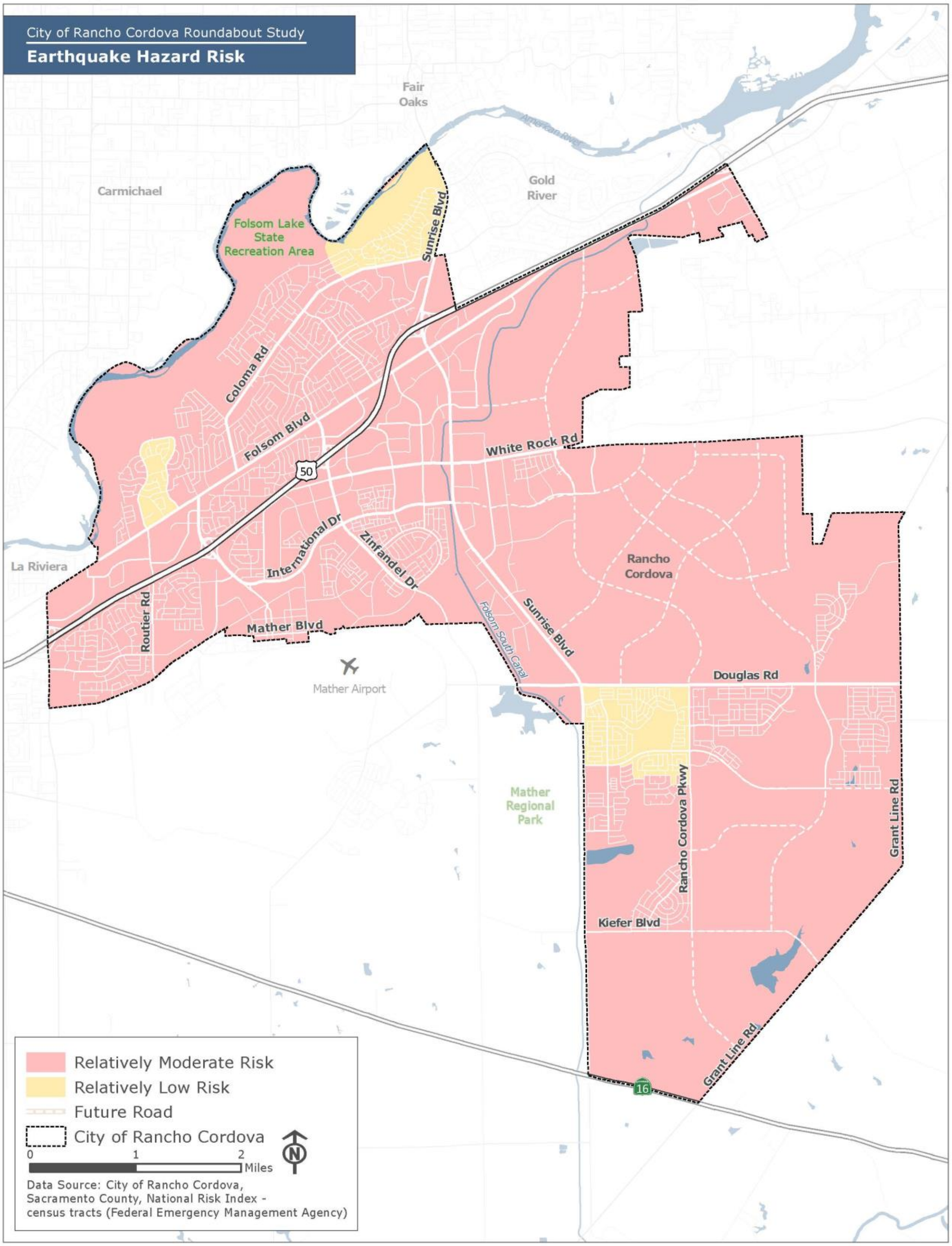


Figure 19. Flooding Hazard Risk

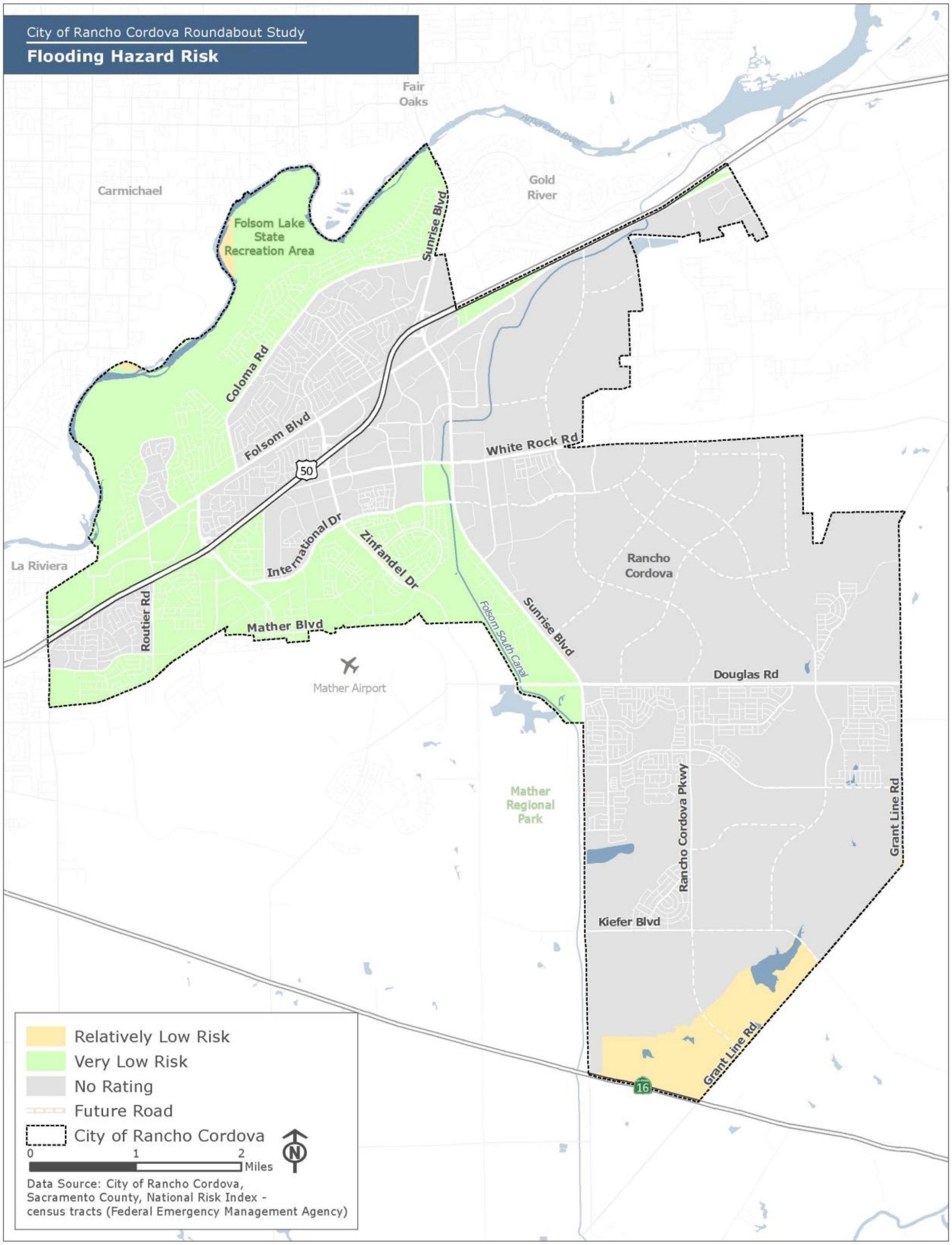
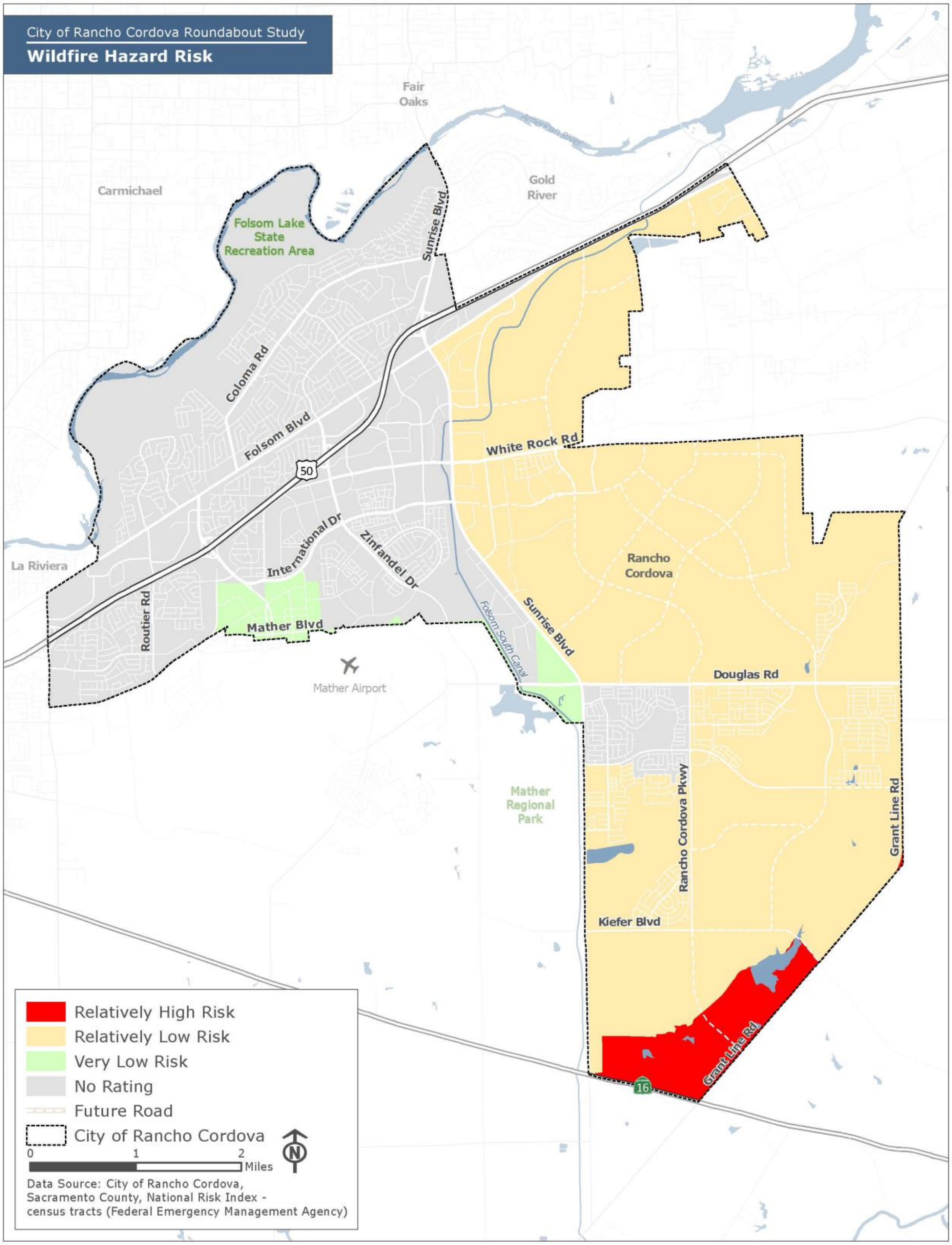


Figure 20. Wildfire Hazard Risk



PROPOSED SCREENING METHODOLOGY

This section identifies a proposed screening method to identify priority locations for the City to pursue roundabout projects. The screening as proposed will not by itself determine project feasibility but will rank locations based on City priorities and will include relevant data to help assess feasibility at a planning level.

The proposed screening will use factors to describe the City's priorities and criteria to evaluate them. The following definitions apply to the screening:

- **Factors**: Categories used to express community or agency values, or general categories that define technical feasibility. An example factor is *safety*.
- **Criteria:** Characteristics used to measure or evaluate each factor. An example criterion for the *safety* factor would be *intersection crash severity score*, where each intersection is given a score to evaluate the relative crash frequency and severity.
- **Scaling:** The process of making two variables comparable. An example scaling would be normalizing the *intersection crash severity score* (dividing all scores by the maximum score) to create values that range from 0 to 1.
- **Weights:** Number used to indicate the relative importance of different factors. Weighting allows a screening to emphasize certain factors.

Kittelson proposes to conduct the screening in three steps:

- **Step 1 – Roadway Class, Lane, and Volume Selection.** This step acts as a filter and reduces the analysis to include only portions of the roadway network where the City would consider a project. Therefore, this step would exclude:
  - Local/local intersections (volumes would not likely justify a roundabout)
  - Roadways with more than four approaching through lanes,
  - State-owned facilities (outside of City jurisdiction)
  - Intersections for which all approaches are private roadways (as indicated by City provided GIS layer).
- **Step 2 – Prioritization.** This step applies a score for each proposed factor and weights the factor scores to calculate a single score for each intersection. The single score would be used to sort the top locations.
- **Step 3 – Planning and Design Values.** This step will add relevant information that can be carried forward to inform roundabout design needs and assess feasibility of the top scoring sites. This step does not modify scores or further filter intersections but provides relevant context information for the City to refine its list of priority locations from the scores created in Step 2.

The steps and relevant data are listed in Table 2.

Table 2. Proposed Screening Methodology

Factor	Criterion/Criteria
Step 1: Roadway Class, Lane, and Volume Selection	
Roadway functional classification	Identify intersections that serve collector or arterial roadways. Exclude all others.
Lane Number	Identify intersections that serve roadways with fewer than 6 total through lanes. Exclude all others.
Volume	Exclude intersections where a multilane would be over capacity with existing traffic volumes (see discussion below table).
Step 2: Prioritization	
Safety	Calculate a crash severity score based on five-year intersection crash frequency and severity. All intersections at the 97.5 percentile score and above receive a maximum score, and intersections below that level are assigned a proportionally scaled score.
Social equity	Calculate a composite social equity score for the intersection's location based on HPI and CES4.0 scores (weighing each of the two equally).
Natural hazard risk	Calculate a composite score for the intersection based on natural hazard risk (weighing all three inputs equally).
Modal priorities	An aggregate modal priority score is calculated with one point each for the following: ▪ Existing or proposed Class I or Class IV bikeway ▪ NOT along a truck route (0 points for an intersection along a truck route) ▪ Along a transit line
Land Use Opportunities and Constraints	Identify existing and expected access need(s), traffic characteristics, and growth potential at potential site locations. Identifies potential "fatal flaw" right-of-way impacts. Scores range from -0.5 to +1 for a combination of the following factors: ▪ Point deductions for an intersection located directly adjacent to a rail line or other constraint land use types ▪ Point additions for an intersection located directly adjacent to an opportunity land use type

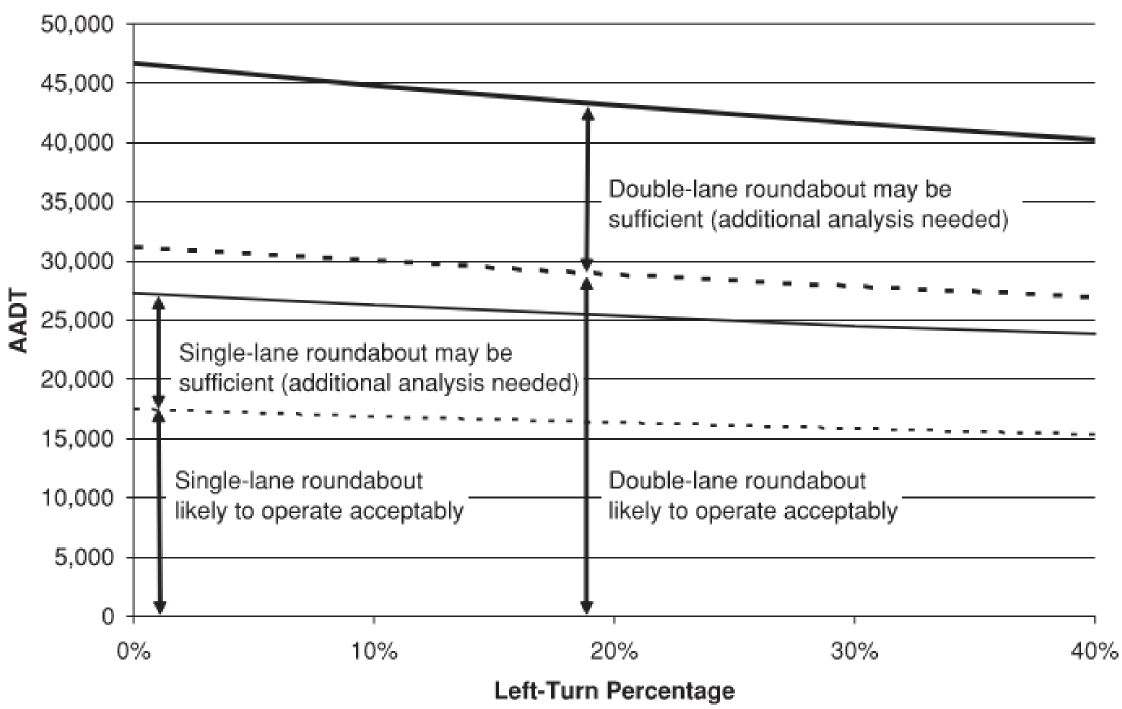
Capacity Feasibility

Exhibit 3-12 from NCHRP Report 672 (recreated as Exhibit 2 below) provides a planning-level assessment of roundabout intersection capacity based on daily volumes. To apply the chart to this feasibility screening, the following daily capacities may be applied:

- Single Lane Volumes: Less than or equal to 25,000 daily entering vehicles
- Multilane Volumes: Greater than 25,000 and less than or equal to 45,000
- Infeasible: Greater than 45,000

For intersections where model volumes can readily be postprocessed, the modeled daily entering existing conditions volumes can be applied against these values. Kittelson was able to estimate daily entering volumes for 84 intersections and apply this feasibility screening as a proposed element of Step 1.

Exhibit 2 Planning-Level Daily Intersection Volumes



Source: NCHRP Report 672, Exhibit 3-12

Factor/Criteria Notes

The approach presented in Table 2 represents a screening agreed upon between Kittelson and the City. More details about some of the factors and criteria are listed below.

- **Social equity factor.** create a composite score from the CES4.0 and HPI datasets. These two indicators offer most of the input information that each of the other datasets independently offer, so combining these two avoids unnecessary redundancy. A composite score avoids double counting with other indicators but would incorporate pollution burden, environmental quality, socioeconomic characteristics, public health conditions, economic conditions, education levels, transportation access, and healthcare access.
- **Modal priority.** Deprioritize locations along truck routes because they require larger roundabouts (costlier and harder to fit within site constraints). Prioritize locations along transit lines to capture

potential benefit provided to transit riders. All else equal, intersections that serve buses would require a larger roundabout, but roundabouts can improve safety and operations for buses. Prioritize locations along bike routes/trails because roundabout's safety and traffic calming benefits would help improve conditions for people biking.

Table 3 provides the data Kittelson proposes to associate with intersections as part of step 3. As previously indicated, these data would not affect prioritization scores but would help inform an initial assessment of project feasibility for locations identified in Steps 1 and 2. The table explains the influence of each input on roundabout feasibility.

Table 3: Proposed Screening Step 3: Planning and Design Values

Data	Purpose
Intersection Control Type	Contextual information.
Transit stop at intersection	Identifies if relocating a bus stop may present a design challenge.
Traffic volumes	Determine single- versus multilane feasibility and test the resilience of roundabout sizing decisions against future growth.
Lane numbers	Provides an indication of relative volumes served (if traffic volumes are not available) and the existing curb-to-curb size.
Speed limits	Indicate whether roundabouts would slow traffic, integrate well with existing traffic speeds, or (if high-speed approaches) require approach speed management techniques.

Roundabout Corridors

Research documented in NCHRP Report 772: *Evaluating the Performance of Corridors with Roundabouts* indicates that roundabouts may provide increased benefits if present as a consistent intersection control throughout a corridor in certain scenarios.[5] However, the document emphasizes a corridor-specific approach which acknowledges the unique operating, political, and community context of an area. The screening processes proposed in this memo will help identify areas with a high viability for roundabout implementation based on desired operational and community characteristics. The City may choose to evaluate the final list of prioritized and feasible roundabout locations by elevating sites that begin to create a roundabout "series".

[5] NCHRP 722 defined a "series of roundabouts" as a minimum of three roundabouts that function independently on an arterial roadway.

Factor Weighting

Factor weighting provides the City the opportunity to express priorities by assigning larger weights to some factors than to others. Table 4 provides example weighting scenarios for step 2 of the screening which reflect various potential goals such as equally weighing inputs or emphasizing safety over modal priorities and social equity. The outcome of this is a score that can be used to prioritize locations. Kittelson will set up the screening process so that the City can iterate and conducted sensitivity testing of various scenarios. The City and Kittelson will collaboratively determine the desired weighting scenario to use for the plan.

Table 4: Example Initial Spatial Prioritization for Screening Step 2

Factor	Factor Weights		
	Option 1: Equal Weights	Option 2: Safety First	Option 3: Social Equity and Opportunities
Safety	20%	50%	30%
Equity Indicators	20%	12.5%	30%
Hazard Risk	20%	12.5%	7.5%
Modal Priorities	20%	12.5%	7.5%
Land Use Opportunities and Constraints	20%	12.5%	25%

NEXT STEPS

Kittelson and the City have discussed appropriate inputs for the screening, and decisions are reflected in the preceding discussion. Kittelson and the City have compared the results of the scenarios presented in Table 4 and have decided to proceed with "Option 2: Safety First."

The screening process will be used to identify an initial top 50 locations to assess design feasibility as part of Task 2.2. Kittelson will test roundabout footprint sizes on the top 50 locations as a first-pass feasibility check. Following that test, Kittelson and the City will meet to determine locations for further project development and determine the right time for a community meeting to gather input.