

8 Bike and Walk Networks

8.1 Coding Bike Facilities into the Highway Network

8.1.1 Off-Street Bicycle-Pedestrian Facilities

Exclusive bike or walk links are coded into the highway network to reflect more detailed skims across features like parks, etc., where biking or walking is allowed, but where no motorized access is allowed.

Off-street bike paths are separate links in the model network, coded with a CAPCLASS value of 7 and BIKE value of 1. Normally, the free-flow SPEED value for these off-street bike-walk links is 3mph. Use these links to represent any off-street bike and pedestrian paths, bridges, etc.

8.1.2 On-Street Bicycle Facilities

On-street bicycle facilities (i.e., on a street where motor vehicles can operate) are represented by the BIKE value in the highway network. The values for each on-street bicycle facility type are listed below. A link's bicycle facility type influences the perceived cost of bicycling on that link, as described below in the [section on Building Bike and Walk Skims](#).

BIKE values in the highway network correspond to the following facility types:

- 0 = bikes are allowed, but no signage or other special infrastructure exists for cyclists.
- 1 = off-street bike-ped path. Motorized vehicles are not allowed on these links. Only [off-street bike facilities](#) should have a BIKE value of 1.
- 2 = Class 2 on-street painted bike lane.
- 3 = Class 3 on-street bike route, usually indicated by “bike route” signs and/or shared-lane markings, known as “sharrows”.
- 8 = Class 2 painted bike lane, but on the arterial overpass or underpass of a freeway interchange. These are coded separately from BIKE values of 2 to capture the higher levels of stress associated with cycling through freeway interchanges.
- 9 = The arterial overpass or underpass of a freeway interchange. These are coded separately from BIKE values of 0 to capture the higher levels of stress associated with cycling through freeway interchanges.

8.2 Building Bike and Walk Skims

8.2.1 Building Bike and Walk Paths for Skims

Separate TAZ-to-TAZ distance skims are prepared for walk modes, which include the following features:

- Bike and walk links are included in path building
- All surfaces streets are included in path building
- Reverse direction on one-way streets are allowed
- Ramps and freeways are excluded.

8.2.2 Effect of Bike Facility Type

Research has shown that bicyclists have unique route preferences and aversions, based route characteristics such as presence or absence of a bike lane and traffic volumes^{10,11}. SACSIM attempts to model these preferences, based on the [type of bicycle facility coded](#) and the traffic volume (if any) on the link. The adjustment to distance is scaled to reflect the level of preference (indicated by an adjustment factor < 1.0—effectively “shortening” the perceived distance on the link) or aversion (indicated by an adjustment factor >1.0—effectively “lengthening” the perceived distance on the link). Table 8-1 Distance Adjustment Factors for Skimming Bicycle Facilities summarizes how these preferences are represented in SACSIM. In general, the assumptions for preferences are:

- Bicyclists prefer exclusive, Class 1 bicycle facilities where available and will travel extra distance to use them.
 - The distance adjustment factor sets this preference at 16 percent—i.e. a cyclist might travel 16 percent further in order to use Class 1 bicycle facility, compared to a shared roadway.
- If exclusive, Class 1 facilities are not available, bicyclists prefer roadways with lower vehicle volumes.
 - The aversive effect of higher volumes increases with increasing volumes. For example, roadways with about 12,000 daily vehicles are perceived as being 13 percent longer than a low volume roadway, but a roadway with 60,000 or more vehicle is perceived as being 150 percent longer.
 - Looked at the other way, a bicyclist might travel 150 percent extra distance in order to avoid a high volume roadway with no bike lane.
- If a Class 2 bike lane is provided, the aversive effect of higher vehicle volumes on a roadway is somewhat reduced.
 - For example, while a bicyclist might travel 150 percent extra distance to avoid a roadway with 60,000 vehicles and NO bicycle lane, they might travel 100 percent extra distance to avoid the same roadway WITH a Class 2 bike lane.
- Bicyclists avoid routes which take them on surface streets crossing freeways, with ramp intersections on the surface street, and will travel significant extra distance to avoid these facilities.
 - This factor was NOT explicitly researched in any study used by SACOG for establishing this process for path-building—it was generated by SACOG staff based on anecdotal evidence, and application of well researched factors like slope.

¹⁰ Broach, Joseph, et al, “Bicycle Route Choice Model Developed Using Revealed Preference GPS Data”, Portland State University, November 2010.

¹¹ Charlton, et al, “Bicycle Route Choice Data Collection using GPS-Enabled Smartphones”, San Francisco Transportation Authority, 2010.

Bicycle TAZ-to-TAZ skims are then built from the adjusted distance. In all cases, the true distance is skimmed, but the paths are built using the adjusted distance. Five different skim values are skimmed. The first value is the end-to-end distance—each of the four subsequent values are portions of the total end-to-end distance:

- The total TAZ-to-TAZ true distance;
- The distance on Class 1 bicycle lanes;
- The distance on Class 2 bicycle lanes;
- The distance on BIKE="8" links; and
- The distance on BIKE="9" links.

Table 8-1 Distance Adjustment Factors for Skimming Bicycle Facilities

Daily Vehicle Volume [†]	"BIKE" Link Coding [‡]					
	0	1	2	3	8	9
< 2,000	1.00	0.84	0.90	1.00	1.10	1.00
6,000	1.00	n/a	0.90	1.00	1.10	1.00
12,000	1.13	n/a	0.95	1.07	1.35	1.18
30,000	1.87	n/a	1.28	1.51	2.74	2.14
60,000+	2.50	n/a	1.50	2.00	4.00	3.00

Source: SACOG 2020.

Note: Distance adjustment factors used to scale actual link distance in SACSIM19 networks—e.g. "0.84" translates to a 16 percent reduction (shortening) of link distance; "1.50" translates to a 50 percent increase of link distance.

Daily vehicle volume is total (i.e. both directions for 2-way roads) and is drawn from the highway assignment results for each iteration of SACSIM19. Distance adjustment factors are computed from volumes—shown on this table are a few key points.

"BIKE" codes are described in detail in Chapter 3. "0" = no bike facility; "1" = Class 1 (exclusive bicycle lane); "2" = Class 2; "3" = Class 3; "8" = surface street at freeway interchange with NO bicycle lane; "9" = same as "8" but with Class 2 lane.

8.3 Estimating Bike and Walk Trip Distances

DAYSIM starts from parcel level land use inputs, and all location and destination choice models predict choices at parcel level, too. However, highway and transit networks are TAZ-based. Because of this inconsistency in spatial detail between the land use inputs and DAYSIM locations/destinations, and the highway and transit networks, an algorithm was developed to merge parcel-to-parcel distance estimates, and TAZ-to-TAZ estimates of the same. For more detail on this process, see Chapter 5 (Bike and Walk Networks). The algorithm used is:

- $TRAVDIST = NWFRAC * SKIMDtaz + (1-NWFRAC)*ORTHDparcel$
- Where:
 - $TRAVDIST$ = the travel distance between parcels, adjusted
 - $SKIMDtaz$ = TAZ-to-TAZ distance skim
 - $NWFRAC$ = a proportion ranging from 0 to 1, computed as:
 - $\text{Min}(1, SKIMDtaz / 6)$
 - $ORTHDparcel$ = the orthogonal (x+y component) distance between the parcels

Starting with parcel/points in SACSIM provides an opportunity to replace the centroid/skim representation of proximity with something more detailed and more directly based on the actual land use pattern. In theory, the best approach would be to use a street-centerline GIS file (rather than a stick-and-ball TAZ-based highway network) to find “true” proximity of one parcel to another (rather than one TAZ to another). However, this is impractical for a working travel demand model for two reasons. First, finding actual parcel-to-parcel paths using a GIS file would be prohibitive in terms of computation time. Second, in many cases specific street patterns for future land uses are not known in the present, and some treatment of street access to future developments would need to be created.

SACSIM computes two measures of proximity at parcel level. One is a parcel-to-parcel orthogonal distance (the sum of the “X” and “Y” coordinate distance separating two parcels). The second is a conventional TAZ-to-TAZ distance skim, comparable to skims for four-step, TAZ-based models. Based on orthogonal distance estimate, the two measures of proximity are formulaically combined. For parcels which are closer, the parcel-to-parcel distance is weighted heavily; for parcels which are very distant, the TAZ-to-TAZ distance skim is weighted heavily. By using this combined approach, unique measures of parcel-to-parcel distance are computed, which reflect the “true” proximity to a greater degree than do TAZ-to-TAZ skims alone.