

MEMORANDUM

To: Paul Mood, Town Engineer
Paradise Valley, Arizona

From: Kimberly Carroll, P.E., PTOE
Sr. Traffic Engineer
Kimley-Horn and Associates, Inc.



Date: November 9, 2018
Expires: 03/31/21

Subject: Lincoln Drive, Mockingbird Lane to Town of Paradise Valley (TOPV) Jurisdiction
Median Breaks and Access
Third Party Traffic Review Comments

Dear Paul:

As requested by Town Staff, Kimley-Horn has conducted a third-party traffic review of the Lincoln Drive Access Assessment Exhibits (Options 1 through 3) prepared by CivTech for Lincoln Drive, from Mockingbird Lane to the TOPV jurisdictional boundary. We understand that raised medians are proposed for installation as part of the TOPV capital improvements projects. We also understand that two developments (Smoke Tree Resort and Lincoln Medical Plaza) are also proposed within the corridor. The developments will generate additional traffic and would like to maintain full access to their parcels from Lincoln Drive. The purpose is to review each of the Access Assessment Options, traffic analysis, and data provided by CivTech. Kimley-Horn's (KH) evaluation and review consisted of the following:

- *Review of the traffic volume calculations prepared by CivTech, which is the basis for calculating the storage length requirements*
- *Left turn lane geometric requirements¹ including minimum storage length requirements and minimum median opening taper rates*
- *Observation of existing traffic operations and safety during a typical weekday morning and afternoon peak hour*
- *Review and comment on the Access Assessment Options exhibits prepared by CivTech*
- *Evaluate the need for exclusive right turn lanes based on the traffic volumes generated*

¹ Based on AASHTO, *Geometric Design of Highways and Streets and Design Standards*, 2011; and City of Scottsdale, *Design Standards & Policies Manual*, 2018

TRAFFIC VOLUMES AND OPERATIONS REVIEW AND COMMENTS

Lincoln Drive is classified as a major arterial in the TOPV 2012 General Plan, has a 40-mph posted speed limit between Mockingbird Lane and TOPV jurisdictional boundary, and 13,870 vpd, which was provided in the 2015 daily traffic volumes collected as part of the Ritz Carlton Resort Traffic Impact Analysis, prepared by CivTech, 2016. Using the projected year 2025 peak hour volumes provided by CivTech, the daily traffic volumes are estimated to exceed 20,000 vpd.

- Existing peak hour turning movement counts were collected at each of the intersections and existing driveways within the corridor on Thursday May 31, 2018.

KH Comment 1: While the day collected falls on a typical weekday, the data was collected at a time of the year when volumes drop around the Maricopa Region because school is no longer in session and winter residents have left the region. For this reason, we recommend that existing traffic volumes be seasonally adjusted and traffic analysis be revised based on these adjustments and comments that follow.

Response to Comment 1: CivTech updated the traffic volumes to reflect a seasonal adjustment (factored by 1.03).

- Trips were generated based on the Institute of Transportation Engineers (ITE) Trip Generation Manual, 10th Edition to determine the number of vehicles entering and exiting the driveways of the proposed developments. A summary of the trip generation analysis by CivTech is provided in **Appendix 1**.

KH Comment 2: Through coordination with TOPV staff we understand the Smoke Tree Resort is proposed to develop 150 rooms and 30 residential units. The trip generation analysis conducted was based on 132 rooms and 20 residential units and is provided in **Appendix 1**. We recommend the trip generation be updated to match the proposed development improvements.

Response to Comment 2: CivTech has updated the trip generation rates to reflect 150 rooms, 30 residential units, and 3500 square foot quality restaurant. The revised trip generation and calculations are provided in **Appendix 2**.

KH Comments 3: Smoke Tree Resort analysis was based on ITE Land Use Code (LUC) 330. The number of rooms proposed for development seem low and inconsistent for a resort hotel. The number of data points and size of the independent variable more closely align with the Hotel LUC 310, which has higher trip generation rate than resort hotel. Please provide additional support that would classify Smoke Tree as a resort (LUC 330) as opposed to a hotel (LUC 310).

Response to Comment 3: CivTech has updated the trip generation rates to reflect a blended rate between LUC 310 and 330. The trip generation calculation and approach were considered acceptable.

KH Comments 4: Smoke Tree Resort utilized equations as opposed to average rates. KHA went through the ITE Trip Generation Handbook process presented in Figure 4.2 assuming proposed number of units for resort hotel (LUC 330). The results of this process are presented below and KH redlines provided in **Appendix 1**.

Resort hotel (LUC 330) AM peak hour between 7-9am

- The number of rooms is way out of range of the data extremes; the lowest number of rooms in the manual is roughly 370 compared to the 132 that are proposed
- If you follow the equation, which happens to be a straight line and not a logarithmic function, then 132 rooms will generate a very low number of trips
- The number of data points is equal to 6
- The R2 value is close to the required 0.75, so you could argue it either way
- The standard deviation is less than 55% of the average rate

Because the rooms are not within the data extremes and the R2 value is less than 0.75, we recommend the weighted rates be used. Using the rates as opposed to the equation results in double the trips being generated in the AM peak hour.

Resort hotel PM peak hour between 4-6pm

- The number of rooms is just outside of the data extremes
- The number of data points is greater than 6
- The R2 value is well above the required 0.75
- The standard deviation is less than 55% of the average rate

Because the number of data points and the R2 value are high enough and the standard deviation requirement is met, the use of the equation during the PM peak is appropriate.

Response to Comment 4: CivTech has updated the trip generation rates to reflect a blended rate between LUC 310 and 330 as discussed in response to comment #3. The trip generation calculations were also revised to reflect 150 rooms, 30 residential units, and 3500 square foot quality restaurant. The revised trip generation calculations and approach were considered acceptable. The revised trip generation calculations, based on 150 rooms, 30 residential units, and 3500 square foot quality restaurant, are provided in **Appendix 2**.

KH Comments 5: A proposed growth of 1.125 was utilized through year 2025. Please provide background support on for the growth rate being utilized.

Response to Comment 5: CivTech developed future background volumes by comparing historic counts from 2012 to 2014 on Scottsdale Road between Indian Bend and Lincoln Drive.

LEFT TURN LANE GEOMETRIC REQUIREMENTS

The physical geometry of the left turn is generally made up of storage length and deceleration length. Each of the components as it relates to this project are described in more detail as follows:

- *Storage length is described as the queue length necessary to sufficiently store the estimated number of left turning vehicles during a critical period. In this case, the critical period is the during the peak hour. This storage length should be long enough to avoid vehicles from spilling back or stopping in the through lanes. If the storage length is not sufficient, there is a potential for rear end collisions due to the spill back or stopping of vehicles in the through lanes.*

Per American Association of State Highway and Transportation Officials (AASHTO), A Policy on Geometric Design for Highways and Streets, 6th Edition, the storage length at unsignalized intersections should be determined as follows:

“At unsignalized intersection, the storage lengths should be determined by an intersection traffic analysis based on the number of turning vehicles likely to arrive in an average two-minute period within the peak hour. Space for at least two passenger vehicles should be provided.”

AASHTO further recommends using the Transportation Research Board (TRB) Access Control Manual for additional support.

Based on this review, the storage length calculation² is summarized as:

$$L \text{ or } Q = (V * s * k) / N = (2.0 * V * 25) / 30$$

L or Q = Storage Length (ft)

V = Estimated left turn volume (vph) during the peak hour

N = Number of cycles per hour, which (Per AASHTO) is based on a two-minute period at unsignalized intersections ($N = 3600 \text{ (sec/hr)} / 120 \text{ (sec/cycle)} = 30 \text{ cycles/hr}$)

s = Average vehicle length, including space between vehicles assumed to be 25 feet

k = Factor of 2.0 is commonly used for major arterials to account for the longest expected queue

KH Comment 6: *All storage lengths should be updated based on the revised traffic volumes previously commented above.*

Response to Comment 6: *CivTech updated exhibits and calculations. See KH Comments 9 through 13.*

KH Comment 7: *Calculation presented by CivTech uses an N value of 60 minutes per hour rather than 30 cycles per hour. One could argue the two-minute period. The two-minute period is a function of opposing volumes and the time necessary to make the left turn maneuver. Considering the high opposing volumes on Lincoln Drive, we recommend that no less than a two-minute period be utilized. For this reason, all storage lengths for each left turn lane should be updated. Furthermore, based on AASHTO, the minimum storage length shall be 50 feet (not 25 foot) to accommodate at least two passenger vehicles.*

² Per Transportation Research Board (TRB), Access Management Manual, Second Edition, Section 16-1.

Response to Comment 7: CivTech updated calculations. See KH Comments 9 through 13.

- Deceleration Length is described as the maneuver distance to decelerate from the through lane into the turn bay (opening taper) plus the distance necessary to complete a stop. Per AASHTO Table 9-22, 275 feet of deceleration is necessary for a 40-mph speed. Where constraints, such as closely spaced driveways or adjacent intersections exist, deceleration by drivers can be accomplished before entering the left turn bay as part of the opening taper length. In this case, the opening taper is being utilized for deceleration as well as the transition from through lane to the left turn lane.

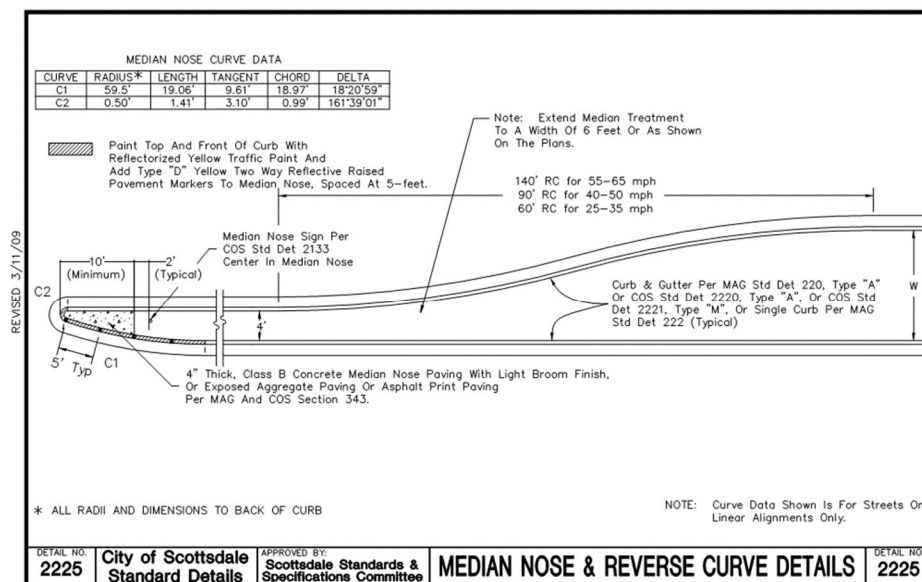
The opening taper length is also a function of speed as well as the rate at which vehicles traverse from the through lane to the left turn lane. Per AASHTO, an 8:1 rate for design speeds up to 30 MPH and 15:1 rate for design speeds up to 50 MPH or greater. In short, when a vehicle moves one (1) foot laterally, the same vehicle will need 8 feet (for 30 mph) or 15 feet (for 50 mph) to travel longitudinally. Example calculations include:

Traverse Distance from Through Lane to Left Turn Lane = 12 foot

Taper Length (30 mph) = 8 x 12 = 96 feet

Taper Length (50 mph) = 15 x 12 = 180 feet.

It should be noted that AASHTO also suggests that shorter tapers can be utilized in urban conditions when peak periods result in slower speeds. In this case and recognizing that the Town of Paradise Valley may follow the City of Scottsdale Standards, Kimley-Horn defaulted to the City of Scottsdale's, Design Standards & Policies Manual, 2018 and Standard Detail 2225 shown on the next page. Per the detail, a minimum taper of 90 feet should be provided for a 40 to 50 mph roadway.



KH Comment 8: *Posted speed limit of Lincoln Drive within the project limits is 40 MPH. We recommend that at a minimum an opening taper length of 90 feet be provided at all left turn bays to allow for the deceleration and safe transition of vehicles from the through lane into the left turn lane.*

OBSERVATION OF TRAFFIC OPERATIONS AND SAFETY

Kimley-Horn conducted a field observation on Tuesday, October 30th during the morning (from 7:30 to 8:30 am) and afternoon (from 4:30pm to 5:45 pm) peak hours. The following was observed:

- Eastbound traffic on Lincoln Drive at Scottsdale Road, queued (stacked) to just west of the existing Smoke Tree Resort eastern most driveway during both the AM and PM peak hours. Lincoln Medical Plaza as well as the eastern most driveway to Smoke Tree Resort was blocked during these queueing events. Three of these events were observed during the AM peak hour and five were observed during the PM peak hour.
- During the afternoon peak, the side friction associated with vehicles turning in/out of the existing driveways (AJ's Shopping Center, Lincoln Apartments, and Spectrum Office), between Scottsdale Road and Smoke Tree Resort eastern driveway, contributed to the stacking of the eastbound vehicle queueing length.
- The queueing occurred in the inner most eastbound lane leaving the outer lane free for vehicles to drive to the Lincoln Drive and Scottsdale Road intersection.
- Eastbound traffic provided gaps for left turning vehicles destined for the commercial parcels (AJ Shopping Center) on the south side of Lincoln Drive. However, near misses or potential collisions between eastbound vehicles on Lincoln Drive traveling in the outer eastbound lane and left turning vehicles were observed.

ACCESS ASSESSMENT OPTION EXHIBITS

Kimley-Horn reviewed the Access Assessment Options, prepared by CivTech, considering the comments listed above. The exhibits as well as Kimley-Horn comments are provided in **Appendix 3**. A summary of the comments are as follows:

KH Comment 9: *This comment applies to all CivTech exhibits prepared. Traffic volumes were not available for the driveways between Mockingbird Lane and Quail Run. In the absence of these volumes, AASHTO A Policy on Geometric Design of Highways and Street (2011), TRB Access Control Manual (2nd Edition), City of Scottsdale Design Standards & Policy Manual (2018), and engineering judgement was utilized to comment and make recommendations for full median break recommendations on Lincoln Drive between Mockingbird Lane and Quail Run.*

- *Lincoln Drive functional classification is Major Arterial, per TOPV 2012 General Plan*
- *Posted Speed Limit = 40 MPH*
- *Westbound 95% queue length at Mockingbird Lane (301 feet) per CivTech Synchro Results*
- *Eastbound 95% queue lengths at Quail Run (322 feet) per CivTech Synchro Results*
- *Per AASHTO (page 9-182), "Ideally driveways should be placed upstream and downstream outside the functional area of an intersection or the influence area of adjacent driveways." Per*

- AASHTO, the influence area includes the impact length or distance back from the driveway that cars begin to be affected, the perception-reaction distance, and the car length.
- Per TRB Access Control Manual (Exhibit 14-12), the Ideal Downstream Functional Distance Based on Decision Sight Distance to Stop is 690 feet for 40 MPH urban condition.
 - Per City of Scottsdale, Design Standards and Policy Manual, Section 5, on minor arterials, full median breaks should be no closer than 1/8-mile intervals with preferable 1/4 mile spacing.
 - Through discussion with Town staff, we understand the southwest quadrant of Quail Run and Lincoln Drive will be redeveloped in the future. Access to this future development is expected to be located on Lincoln Drive west of Quail Run. While a traffic study has not been completed, additional traffic is expected to be generated. The need to accommodate this storage should be factored into the location of median break and full access Lincoln Drive between Mockingbird Lane and Quail Run.
 - The existing spacing between Mockingbird Lane to Quail Run (centerline to centerline) is approximately 1325 feet (+/-).

Based on the bullet points above, we recommend that the full access median break distance on Lincoln Drive between Mockingbird Lane and Quail Run be maximized at 660-foot spacing between the intersections. Currently, Applewood Pet Resort western most access is positioned approximately 714 feet east of Mockingbird Lane and approximately 612 feet west of Quail Run (centerline to centerline) and provides the most desirable location for a full access median break.

Access Assessment Option #1 (Individual Full Access) Exhibit

KH Comment 10: Storage length at Spectrum Office Driveway/AJ Driveway calculation ((29 vph x 25 feet x2)/30) is 48 feet. Per AASHTO, the minimum storage length is 50 feet. Exhibit illustrates a minimum of 50 foot being provided. This is considered acceptable.

KH Comment 11: As shown in Option #1 exhibit, access improvements include closure of the existing eastern access on Smoke Tree Resort, a new Smoke Tree Resort access approximately 183 feet west of Lincoln Medical Plaza access, and the existing Smoke Tree Resort western access to remain as right in/right out. The proposed improvements result in the following spacing (centerline to centerline) of driveways:

- Approximately 134 feet from Quail Run to Smoke Tree Resort western right in/right out driveway;
- Approximately 183-feet from Smoke Tree Resort western right in/right out to the proposed Smoke Tree Resort full access median break;
- Approximately 183-feet from the proposed Smoke Tree Resort full access median break to the proposed Lincoln Medical Plaza full access median break; and
- Approximately 132 feet from the proposed Lincoln Medical Plaza full access median break to the eastern Lincoln Medical Plaza right in/right out access.

Per City of Scottsdale Design Standards & Policy Manual (2018), the minimum driveway spacing is presented in the Figure on the following page. It should be noted that a major arterial in the City of Scottsdale is configured as a six-lane divided roadway. Lincoln Drive is a four-lane divided roadway, so a minor arterial classification was utilized to determine the minimum spacing required (250 feet) on Lincoln Drive.

STREET TYPE	STANDARD DRIVEWAY SPACING	MINIMUM DRIVEWAY SPACING
Local Residential / Local Collector	50 feet	50 feet
Local Industrial / Local Commercial	165 feet	125 feet
Minor Collector	165 feet	125 feet
Major Collector	250 feet	150 feet
Minor Arterial	330 feet	250 feet
Major Arterial	500 feet	300 feet

FIGURE 5-3.35 DRIVEWAY SPACING

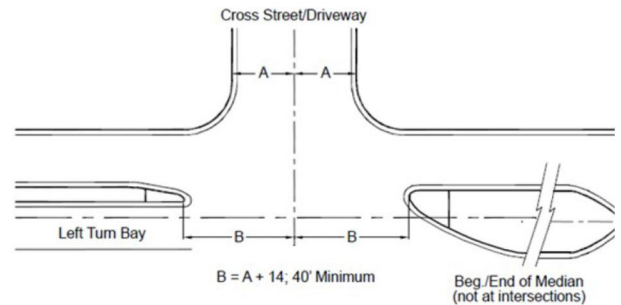
Based on the results, Kimley-Horn recommends the western Smoke Tree Resort driveway be closed to achieve the minimum spacing from Quail Run.

KH Comment 12: The storage length shown in Option #1 exhibit for Lincoln Medical Plaza is 70 feet. Per AASHTO calculations, storage length should be no less than 70 feet to adequately store the estimated number of vehicles generated by Lincoln Medical Plaza. This is considered acceptable. The storage length for the Smoke Tree Resort eastern driveway is 75 feet. Per AASHTO calculations, storage length should be no less than 55 feet to adequately store the estimated number of vehicles generated by the Smoke Tree Resort. This is considered acceptable.

KH Comment 13: As shown in Option 1 exhibit prepared by CivTech, opening bay tapers are 40 feet at Smoke Tree Resort and 43-3" feet at Lincoln Medical Plaza. KH recommends that no less than a 90-foot opening taper be utilized to safely traverse traffic from the through lane to the left turn lane on Lincoln Drive, per the criteria and discussion on Page 4, 5, and 6 of this document. Kimley-Horn recommends the median be extended and access points to Lincoln Medical Plaza be restricted to right in/right out only movements for two reasons:

- a) A minimum spacing of 290 feet (centerline to centerline), from Spectrum Office Driveway to Lincoln Medical Plaza driveway, is necessary to adequately store the estimated vehicles without spilling back into the Lincoln Drive through lanes as well as safely transition vehicles from the through lane to left turn lane. Currently the spacing (centerline to centerline) is approximately 220 feet (+/-) and is less than adequate. Calculations are summarized as follows:

- Peak Hour Left Turn Volume at Lincoln Medical Plaza = 42 vph
- Lincoln Medical Plaza Storage Length = $2 \times 25 \times 42 / 30 = 70$ feet
- Opening Taper Length = 90 feet (see KH Comment #8)
- Spectrum Office Storage Length = 50 feet (minimum per AASHTO)
- Distance (Spectrum centerline to median nose) = 40-foot (see COS Figure 5-3.28)
- Distance (Lincoln Medical Plaza centerline to median nose) = 40-foot (see COS Figure 5-3.28)
- Total length (centerline to centerline) = 290 feet



Notes:
1. This sketch is for a three leg intersection. If the intersection has four legs, the right side will also have an auxiliary lane for left turns, and the median on the right side will have the same configuration as the one on the left side rotated 180 degrees.
2. See COS Standard Details for median dimensions.

FIGURE 5-3.28 MEDIAN OPENINGS FOR INTERSECTIONS

- b) The observed queueing during the peak hours coupled with the near misses observed between the left turning vehicles (discussed on page 6 of this document) further support restricting Lincoln Medical Plaza access points to right in/right out to mitigate potential collisions between left turning vehicles into/out of Lincoln Medical Plaza and eastbound Lincoln Drive traffic.

Access Assessment Option #2 (Shared Full Access) Exhibit

KH Comment 14: As shown in Option #2 exhibit, access improvements include closure of the western Lincoln Medical Plaza access, a new shared access for the Smoke Tree Resort / Lincoln Medical Plaza approximately 55 feet from the shared Smoke Tree Resort / Lincoln Medical Plaza parcel line, and right in/right out to all other access points between Quail Run and TOPV jurisdictional boundary line. The proposed improvements in this option result in the following spacing (centerline to centerline) of driveways:

- Approximately 134 feet from Quail Run to Smoke Tree Resort western right in/right out driveway;
- Approximately 284-feet from Smoke Tree Resort western right in/right out to the proposed shared Smoke Tree Resort/Lincoln Medical Plaza full access median break;
- Approximately 221-feet from the proposed shared Smoke Tree Resort/Lincoln Medical Plaza full access median break to eastern Lincoln Medical Plaza right in/right out access.

Per City of Scottsdale Design Standards & Policy Manual (2018), the minimum driveway spacing is presented the minimum spacing required (250 feet) on Lincoln Drive. Kimley-Horn recommends the western Smoke Tree Resort driveway be closed to achieve the minimum spacing from Quail Run.

KH Comment 15: As shown in Option 2 exhibit prepared by CivTech, opening bay taper to the shared Smoke Tree Resort and Lincoln Medical Plaza is 90 feet. This is considered adequate.

KH Comment 16: The storage length shown in Option #2 exhibit for the shared Smoke Tree Resort/Lincoln Medical Plaza access is proposed at 90 feet. Per AASHTO calculations, storage length should be no less than 115 feet to adequately store the estimated number of vehicles generated by

Smoke Tree Resort and Lincoln Medical Plaza. For this option, the shared access should move a minimum of 25 feet west of the location shown in the CivTech exhibit to accommodate the minimum storage length necessary to adequately store the estimated left turn volumes without spilling back into Lincoln Drive through lanes. This would result in placing the shared driveway a minimum of 80 feet from the Smoke Tree resort/Lincoln Medical Plaza parcel line.

It should also be noted that moving the driveway west will further improve the spacing between the shared Smoke Tree Resort/Lincoln Medical Plaza driveway and the Lincoln Medical Plaza eastern right in/right out driveway.

Access Assessment Option #3 (Full Median - Right In / Right Out Only) Exhibit

KH Comment 17: *As shown in Option #3 exhibit, all existing driveways between Quail Run and eastern Lincoln Medical Plaza access points, will remain and be restricted to right in/right out only. This results in the following spacing (centerline to centerline) between the existing driveways:*

- *Approximately 134 feet from Quail Run to Smoke Tree Resort western right in/right out driveway;*
- *Approximately 308-feet from Smoke Tree Resort western right in/right out to the existing eastern Smoke Tree Resort driveway;*
- *Approximately 67-feet from the eastern Smoke Tree Resort Driveway to the western Lincoln Medical Plaza driveway; and*
- *Approximately 132-feet from the western Lincoln Medical Plaza driveway to the eastern Lincoln Medical Plaza driveway.*

Per City of Scottsdale Design Standards & Policy Manual (2018), the minimum driveway spacing is presented the minimum spacing required (250 feet) on Lincoln Drive. Kimley-Horn recommends the western Smoke Tree Resort driveway be closed to achieve the minimum spacing from Quail Run. We further recommend that with the improvements to both Smoke Tree Resort and Lincoln Medical Plaza that the driveways be improved to achieve the minimum spacing.

KH Comment 18: *This option does provide the safest option by removing the conflict points that would occur with left in/left out maneuvers. It should be noted that Lincoln Drive does not provide enough pavement width necessary to safely make U-turn maneuvers. Providing an access point that is located to safely transition and adequately store the estimated left turn volumes will reduce the need for U-turn maneuvers. Allowing shared access between the Smoke Tree Resort and Lincoln Medical Plaza parcels would remove the need for any U-turn maneuvers. For this option, should it be determined that shared access will not be provided, Kimley-Horn recommends U-turns be restricted.*

EXCLUSIVE RIGHT TURN EVALUATION

Kimley-Horn evaluated the need for exclusive right turn lanes based on the City of Scottsdale, Design Standards & Policy Manual, 2018, per Section 5-3.206 Deceleration Lanes. Per Section 5-3.206 (p 325), the criteria to determine the need for exclusive right turn deceleration lanes is provided below:

- A. At least 5,000 vpd are expected to use the street;

Daily traffic volumes collected in 2015 indicate 13,870 vpd travel on Lincoln Drive within the project limits. This criterion is met is only expected to increase overtime as the developments in this area are built out.

- B. The 85th percentile traffic speed on the street is at least 35 mph;

Posted speed limit on Lincoln Drive within the project limits is 40 mph. This criterion is met.

- C. At least 30 vehicles will make right turns into the driveway during a 1-hour period.

- All the driveways, shown in Access Assessment Option 1 exhibit, are estimated to generate less than 30 vehicles. For Option 1 this criterion is not met.
- The proposed shared Smoke Tree Resort / Lincoln Medical Plaza access, shown in Access Assessment Option 2 exhibit, is estimated to generate less than 30 vehicles during the peak hour. For Option 2, this criterion is not met. However, with the recommended removal of the Smoke Tree Resort western driveway, the estimated right turn volumes would increase to 24 vehicles during the AM peak hour at the single access point to Smoke Tree Resort. In this case, we recommend a right turn deceleration lane (minimum 100-foot storage with 90-foot taper) be installed at the shared Smoke Tree Resort / Lincoln Medical Plaza access.
- Review of Access Assessment Option 3 exhibit is summarized as:
 - The western access to Lincoln Medical Plaza is estimated to generate more than 30 vehicles during the AM peak hour. The eastern access to Lincoln Medical Plaza falls short by 4 vehicles from meeting this criterion. This criterion is met at the Lincoln Medical Plaza western driveway. However, Kimley-Horn recommends a right turn deceleration lane (100-foot storage and 90-foot taper) be installed at both locations. It should be noted that the western Lincoln Medical Plaza driveway shown in the exhibit does not have enough frontage along their parcel and would impact the Smoke Tree Resort parcel to install the recommended right turn deceleration lane. Consolidation of the west and eastern Lincoln Medical Plaza driveways into one driveway would improve the driveway spacing.
 - The western driveway to Smoke Tree Resort is estimated to generate 30 vehicles during the PM peak hour. This criterion is met at the Smoke Tree Resort western driveway. However, as discussed in KH Comment #17, the spacing between Quail Run and Smoke Tree Resort western driveway is not available and should be considered for closure to improve spacing. It is recommended that the two Smoke Tree Resort driveways be consolidated to achieve the minimum driveway spacing between Quail Run on the west and Lincoln Medical Plaza on the east. With the consolidation of the two driveways, the estimated right turn volumes would increase to 42 vehicles during the AM peak hour and 50 vehicles during the PM peak hour. We recommend that right turn deceleration lane (100-foot storage and 90-taper) be installed. In this option, placing the consolidated access point a minimum of 250 east of Quail Run would also achieve approximately 270 feet separation from the Lincoln Medical Plaza western access point.

APPENDIX 1

CivTech Trip Generation Calculation

Kimley-Horn Trip Generation Review and Redlines

Smoke Tree Resort

Proposed

Trip Generation

October 2018

Appendix D

This form facilitates trip generation estimation using data within the Institute of Transportation Engineers' (ITE) *Trip Generation Manual*, 10th Edition and methodology described within ITE's *Trip Generation Handbook*, 3rd Edition. These references will be referred to as *Manual* and *Handbook*, respectively. The *Manual* contains data collected by various transportation professionals for a wide range of different land uses, with each land use category represented by a land use code (LUC). Average rates and equations have been established that correlate the relationship between an independent variable that describes the development size and generated trips for each categorized LUC in various settings and time periods. The *Handbook* indicates an established methodology for how to use data contained within the *Manual* when to use the fitted curve instead of the average rate and when to adjustments to the volume of trips are appropriate and how to do so. The methodology steps are represented visually in boxes in Figure 3.1. This worksheet applies calculations for each box if applicable.

Box 1 - Define Study Site Land Use Type & Site Characteristics, **Box 2 - Define Site Context** and **Box 3 - Define Analysis Objectives Types of Trips & Time Period**

The analyst is to pick an appropriate LUC(s) based on the subject's zoning/land use(s)/future land use(s). The size of the land use(s) is described in reference to an independent variable(s) specific to (each) the land use (example: 1,000 square feet of building area is relatively common).

Context assessment is to "simply determine whether the study sites is in a multimodal setting" and "could have persons accessing the site by walking, bicycling, or riding transit." This assessment is used in Box 4. The *Manual* separates data into 4 setting categories - Rural, General Urban/Suburban, Dense Multi-Urban Use and Center City Core. This worksheet uses the following abbreviations, respectively: R, G, D, and C. The *Manual* does not have data for all settings of all land use codes. The "General Urban/Suburban" setting is used by default.

This tool will focus on vehicular trips for a 24-hour period on a typical weekday as well as its AM peak hour and PM peak hour. Other time period(s) may be of interest.

Land Use Types and Size

Proposed Use	Amount Units	ITE LUC	ITE Land Use Name
Resort Hotel	132 Rooms	330	Resort Hotel
Apartments	20 Dwelling Units	220	Multifamily Housing (Low-Rise)

Box 4 - Is Study Site Multimodal?

Per the Handbook, "if the objective is to establish a local trip generation rate for a particular land use or study site, the simplified approach (Box 9) may be acceptable but the Box 5 through 8 approach is required if the study site is located in an infill setting, contains a mix of uses on-site, or is near significant transit service."

Box 5/Box 9 - Estimate Baseline Trips/Estimate Vehicular Trips (Determine Equation)

Vehicular trips are estimated using rates/equations applicable to each LUC. When the appropriate graph has a fitted curve, the *Handbook* has a process (Figure 4.2) to determine when to use it versus using the weighted average rate or collecting local data. The methodology requires for engineering judgement in some circumstances and permits engineering judgement to override or make adjustments when appropriate to best project (example 1: study site is expected to operate differently than data in the applicable land use code - such as restaurant that is closed in the morning or in the evening, example 2: LUC data in a localized area fails to be represented by the typically selected fitted curve/weighted average rate - a small shop/LUC 820, AM peak hour is skewed by the high y-intercept).

Equation Type: Equation Used [Equated Rate] (Type Abbreviations: Weighted Average Rate ("WA"), Fitted Curve Type: Equation Used [Equated Rate]

Proposed Use	ADT	AM Peak Hour	PM Peak Hour	(not used)
Resort Hotel	WA: []	FC: $T=0.38 \times X-28.58$ [0.16]	FC: $T=0.52 \times X-55.42$ [0.10]	
Apartments	FC: $T=7.56 \times X-40.86$ [5.52]	FC: $LN(T)=0.95 \times LN(X)-0.51$ [0.52]	FC: $LN(T)=0.89 \times LN(X)-0.02$ [0.71]	

Box 5/Box 9 - Estimate Baseline Trips/Estimate Vehicular Trips (Apply Equations and in/out Distributions)

Baseline Vehicular Trips

Proposed Use	ADT				AM Peak Hour				PM Peak Hour				(not used)
	% In	In	Out	Total	% In	In	Out	Total	% In	In	Out	Total	
Resort Hotel	50%	100	100	200	72%	16	6	22	43%	6	7	13	
Apartments	50%	55	55	110	23%	2	8	10	63%	9	5	14	
Totals		155	155	310		18	14	32		15	12	27	



Lincoln Medical Center Proposed

Trip Generation October 2018

Appendix D

This form facilitates trip generation estimation using data within the Institute of Transportation Engineer's (ITE) *Trip Generation Manual*, 10th Edition and methodology described within ITE's *Trip Generation Handbook*, 3rd Edition. These references will be referred to as *Manual* and *Handbook*, respectively. The *Manual* contains data collected by various transportation professionals for a wide range of different land uses, with each land use category represented by a land use code (LUC). Average rates and equations have been established that correlate the relationship between an independent variable that describes the development size and generated trips for each categorized LUC in various settings and time periods. The *Handbook* indicates an established methodology for how to use data contained within the *Manual* when to use the fitted curve instead of the average rate and when to adjustments to the volume of trips are appropriate and how to do so. The methodology steps are represented visually in boxes in Figure 3.1. This worksheet applies calculations for each box if applicable.

Box 1 - Define Study Site Land Use Type & Site Characteristics, Box 2 - Define Site Context and Box 3 - Define Analysis Objectives Types of Trips & Time Period

The analyst is to pick an appropriate LUC(s) based on the subject's zoning/land use(s)/future land use(s). The size of the land use(s) is described in reference to an independent variable(s) specific to (each) the land use (example: 1,000 square feet of building area is relatively common).

Context assessment is to "simply determine whether the study sites is in a multimodal setting" and "could have persons accessing the site by walking, bicycling, or riding transit." This assessment is used in Box 4. The *Manual* separates data into 4 setting categories - Rural, General Urban/Suburban, Dense Multi-Urban Use and Center City Core. This worksheet uses the following abbreviations, respectively: R, G, D, and C. The *Manual* does not have data for all settings of all land use codes. The "General Urban/Suburban" setting is used by default.

This tool will focus on vehicular trips for a 24-hour period on a typical weekday as well as its AM peak hour and PM peak hour. Other time period(s) may be of interest.

Land Use Types and Size

Proposed Use	Amount Units	ITE LUC	ITE Land Use Name
Medical, dental or health office buildings and clinics	31,000 1,000 square feet	720	Medical-Dental Office Building

Box 4 - Is Study Site Multimodal?

Per the *Handbook*, "if the objective is to establish a local trip generation rate for a particular land use or study site, the simplified approach (Box 9) may be acceptable but the Box 5 through 8 approach is required if the study site is located in an infill setting, contains a mix of uses on-site, or is near significant transit service."

Box 5/Box 9 - Estimate Baseline Trips/Estimate Vehicular Trips (Determine Equation)

Vehicular trips are estimated using rates/equations applicable to each LUC. When the appropriate graph has a fitted curve, the *Handbook* has a process (Figure 4.2) to determine when to use it versus using the weighted average rate or collecting local data. The methodology requires for engineering judgement in some circumstances and permits engineering judgement to override or make adjustments when appropriate to best project (example 1: study site is expected to operate differently than data in the applicable land use code - such as restaurant that is closed in the morning or in the evening; example 2: LUC data in a localized area fails to be represented by the typically selected fitted curve/weighted average rate - a small shop/LUC 820, AM peak hour is skewed by the high y-intercept).

Equation Type: Equation Used [Equated Rate] (Type Abbreviations: Weighted Average Rate ("WA"), Fitted Curve ("Type: Equation Used [Equated Rate])

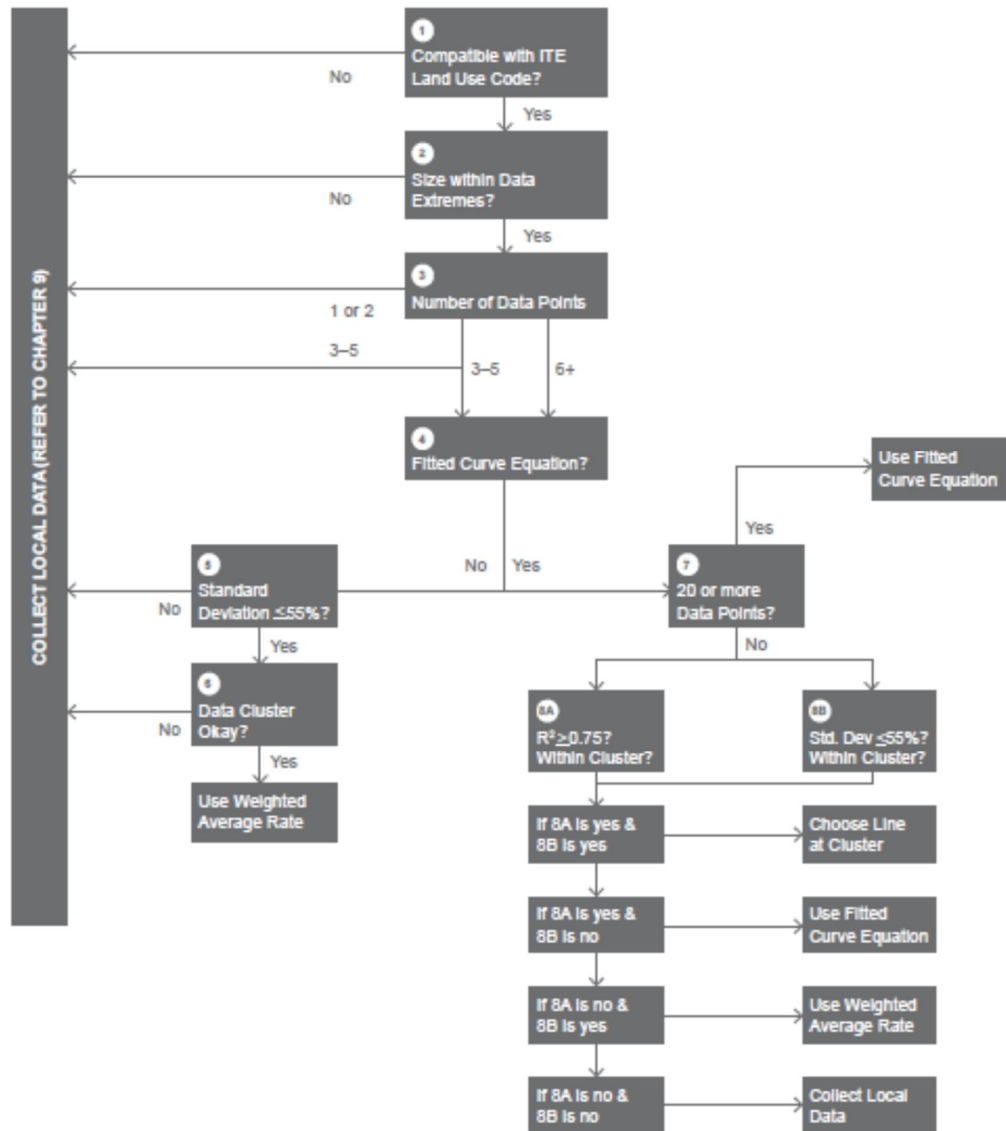
Proposed Use	ADT	AM Peak Hour	PM Peak Hour	(not used)
Medical, dental or health office buildings and clinics	FC: $T=38.42 \times X-87.62$ [35.59]	FC: $LN(T)=0.89 \times LN(X)+1.31$ [2.54]	FC: $T=3.39 \times X+2.02$ [3.46]	

Box 5/Box 9 - Estimate Baseline Trips/Estimate Vehicular Trips (Apply Equations and In/out Distributions)

Baseline Vehicular Trips

Proposed Use	ADT				AM Peak Hour				PM Peak Hour				(not used)
	% In	In	Out	Total	% In	In	Out	Total	% In	In	Out	Total	
Medical, dental or health office buildings and clinics	50%	552	552	1,104	78%	62	17	79	28%	30	77	107	
Totals		552	552	1,104		62	17	79		30	77	107	

Figure 4.2 Process for Selecting Average Rate or Equation
in Trip Generation Manual Data



1 ✓
2 X → COLLECT LOCAL DATA
3 ✓
4 ✓
7 X
8a X } NO \$ YES
8b ✓ } USE AVG

Resort Hotel (330)

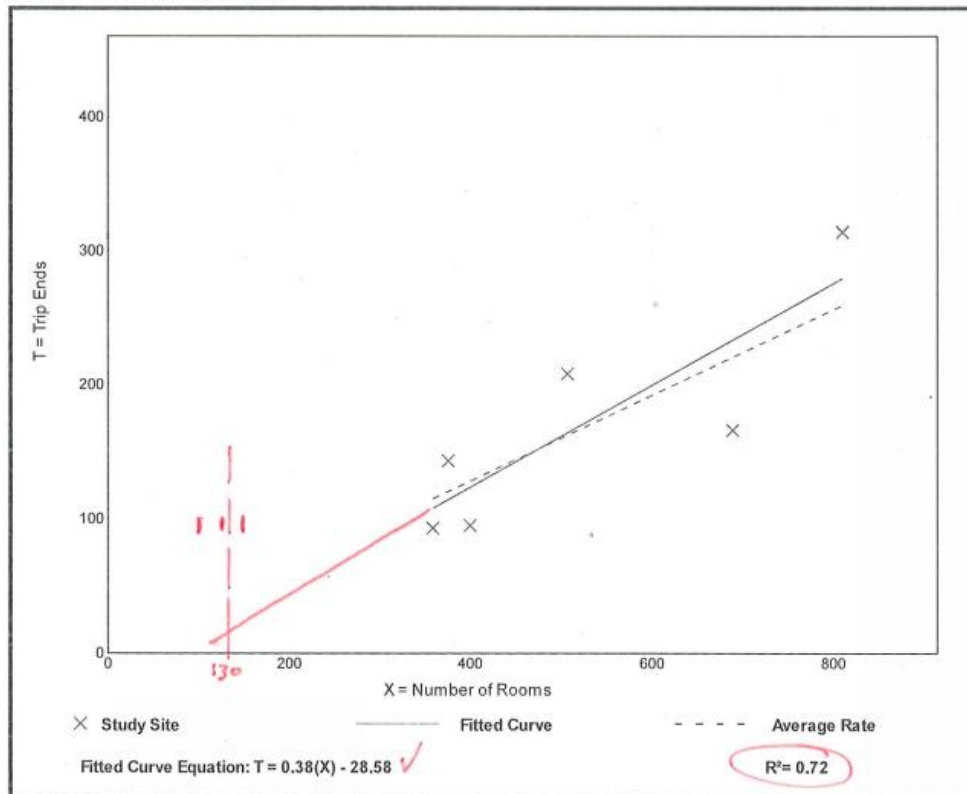
Vehicle Trip Ends vs: Rooms
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
Number of Studies: 6 ≥ 6 & < 20
Avg. Num. of Rooms: 524
Directional Distribution: 72% entering, 28% exiting

Vehicle Trip Generation per Room

Average Rate	Range of Rates	Standard Deviation
0.32	0.24 - 0.41	0.08

$$\frac{0.08}{0.32} = 0.25$$

Data Plot and Equation



1 ✓
2 ✓
3 ✓
4 ✓
7 X

8a ✓ } YES & YES
8b ✓ } USE WEST CLUSTER

Resort Hotel (330)

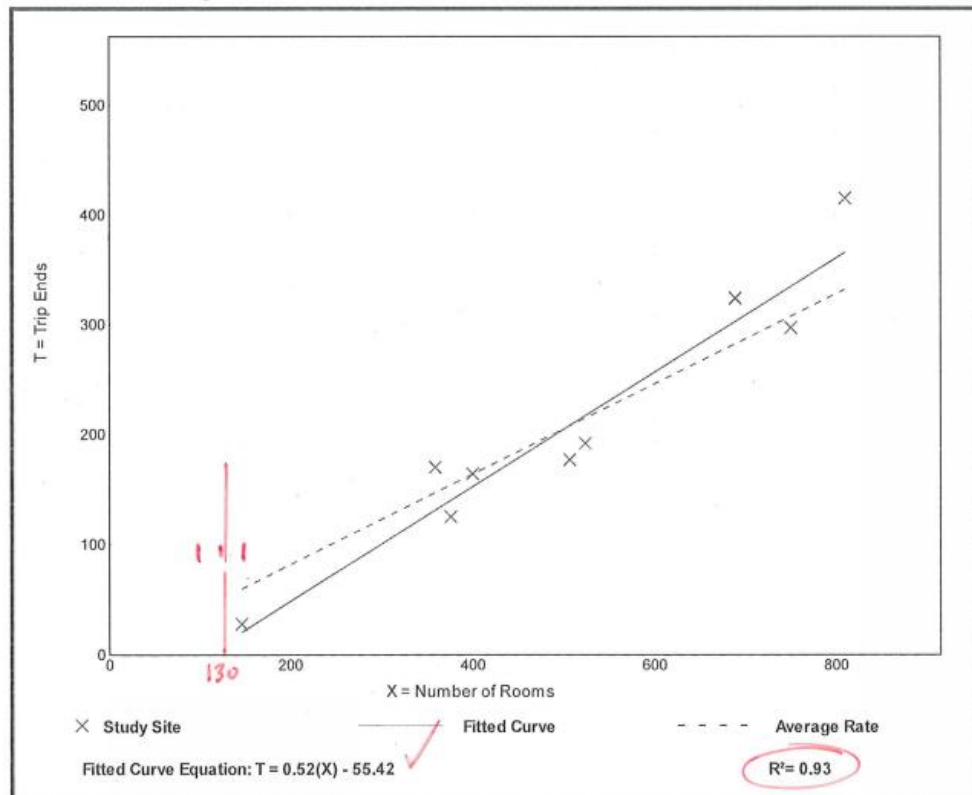
Vehicle Trip Ends vs: Rooms
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 9 ≥ 6 & < 20
Avg. Num. of Rooms: 507
Directional Distribution: 43% entering, 57% exiting

Vehicle Trip Generation per Room

Average Rate	Range of Rates	Standard Deviation
0.41	0.19 - 0.51	0.08

$$\frac{0.08}{0.41} = 0.195$$

Data Plot and Equation



APPENDIX 2

CivTech Revised Trip Generation Calculations

Smoke Tree Resort Proposed

Trip Generation November 2018 Appendix D

Methodology Overview

This form facilitates trip generation estimation using data within the Institute of Transportation Engineer's (ITE) *Trip Generation Manual*, 10th Edition and methodology described within ITE's *Trip Generation Handbook*, 3rd Edition. These references will be referred to as *Manual and Handbook*, respectively. The *Manual* contains data collected by various transportation professionals for a wide range of different land uses, with each land use category represented by a land use code (LUC). Average rates and equations have been established that correlate the relationship between an independent variable that describes the development size and generated trips for each categorized LUC in various settings and time periods. The *Handbook* indicates an established methodology for how to use data contained within the *Manual* when to use the fitted curve instead of the average rate and when to adjustments to the volume of trips are appropriate and how to do so. The methodology steps are represented visually in boxes in Figure 3.1. This worksheet applies calculations for each box if applicable.

Box 1 - Define Study Site Land Use Type & Site Characteristics

The analyst is to pick an appropriate LUC(s) based on the subject's zoning/land use(s)/future land use(s). The size of the land use(s) is described in reference to an independent variable(s) specific to (each) the land use (example: 1,000 square feet of building area is relatively common).

Land Use Types and Size

Proposed Use	Amount Units	ITE LUC	ITE Land Use Name
Resort Hotel	150 Rooms	330	Resort Hotel
Condos	30 Dwelling Units	220	Multifamily Housing (Low-Rise)
Quality Restaurant	3,500 1,000 square feet	931	Quality Restaurant

Box 2 - Define Site Context

Context assessment is to "simply determine whether the study sites is in a multimodal setting" and "could have persons accessing the site by walking, bicycling, or riding transit." This assessment is used in Box 4. The *Manual* separates data into 4 setting categories - Rural, General Urban/Suburban, Dense Multi-Urban Use and Center City Core. This worksheet uses the following abbreviations, respectively: R, G, D, and C. The *Manual* does not have data for all settings of all land use codes. See the table on the next page titled "Site Context and Time Periods" - if this table is not provided, the "General Urban/Suburban" setting is used by default.

Box 3 - Define Analysis Objectives Types of Trips & Time Period

This tool will focus on vehicular trips for a 24-hour period on a typical weekday as well as its AM peak hour and PM peak hour. Other time period(s) may be of interest.

Box 4 - Is Study Site Multimodal?

Per the Handbook, "if the objective is to establish a local trip generation rate for a particular land use or study site, the simplified approach (Box 9) may be acceptable but the Box 5 through 8 approach is required if the study site is located in an infill setting, contains a mix of uses on-site, or is near significant transit service."

Box 5/Box 9 - Estimate Baseline Trips/Estimate Vehicular Trips (Determine Equation)



Smoke Tree Resort

Proposed

Trip Generation

November 2018

Appendix D

Vehicle trips are estimated using rates/equations applicable to each LUC. When the appropriate graph has a fitted curve, the *Handbook* has a process (Figure 4.2) to determine when to use it versus using the weighted average rate or collecting local data. The methodology requires for engineering judgement in some circumstances and permits engineering judgement to override or make adjustments when appropriate to best project (example 1: study site is expected to operate differently than data in the applicable land use code - such as restaurant that is closed in the morning or in the evening; example 2: LUC data in a localized area fails to be represented by the typically selected fitted curve/weighted average rate - a small shop/LUC 820, AM peak hour is skewed by the high y-intercept).

Equation Type: Equation Used [Equated Rate] (Type Abbreviations: Weighted Average Rate ("WA"), Fitted Curve ("FC"), or Custom ("C"))

Proposed Use	ADT	AM Peak Hour	PM Peak Hour	(not used)
Resort Hotel	WA: []	FC: $T=0.38 \times X-28.58$ [0.19]	FC: $T=0.52 \times X-55.42$ [0.15]	
Condos	FC: $T=7.56 \times X-40.86$ [6.20]	FC: $\ln(T)=0.95 \times \ln(X)-0.51$ [0.51]	FC: $\ln(T)=0.89 \times \ln(X)-0.02$ [0.67]	
Quality Restaurant	WA: $T=X \times 83.84$ [83.84]	WA: $T=X \times 0.73$ [0.73]	WA: $T=X \times 7.8$ [7.80]	

Box 5/Box 9 - Estimate Baseline Trips/Estimate Vehicular Trips (Apply Equations and in/out Distributions)

Baseline Vehicular Trips

Proposed Use	ADT				AM Peak Hour				PM Peak Hour				(not used)
	% In	In	Out	Total	% In	In	Out	Total	% In	In	Out	Total	
Resort Hotel	50%	389	389	778	72%	42	17	59	43%	32	43	75	
Condos	50%	93	93	186	23%	3	12	15	63%	13	7	20	
Quality Restaurant	50%	147	147	294	0%	0	3	3	67%	18	9	27	
Totals		629	629	1,258		45	32	77		63	59	122	

Box 6 - Convert Baseline Vehicle Trips to Person Trips

If no vehicle trip reductions are to be applied, this portion may be ignored. The *Handbook* states "There are not enough samples to derive precise percentages by mode...however, for all but one, ...the motor vehicle percentage of total person trips is at least 90 percent." and "[vehicle occupancy for] many of the most commonly analyzed land use codes are not [available]." This form assumes that the total baseline vehicle trips for all land use codes accounts for 90% of total person trips. Unless otherwise specified, this form later reverses the conversion in Box 8.

Box 7 - Estimate Internal Person Trips, External Walk/Bike Trips, Transit Person Trips, External Person Trips (Internal Capture)

Internal capture occurs for mixed-use developments when a portion of the trips generated by the site are expected to have the both the origin and destination within the site. Internal capture is



Smoke Tree Resort

Proposed

Trip Generation

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Appendix D

not dependent on mode choice. The table below presents the internal capture percentages and trips in units of vehicle trips. CivTech can provide trips in units of persons if requested.

Adjustments for Internal Trips

Proposed Use	ADT				AM Peak Hour				PM Peak Hour				(not used)
	Percent	In	Out	Total	Percent	In	Out	Total	Percent	In	Out	Total	
Resort Hotel	0%	0	0	0	0%	0	0	0	0%	0	0	0	
Condos	0%	0	0	0	0%	0	0	0	0%	0	0	0	
Quality Restaurant	50%	74	74	148	50%	0	2	2	50%	9	5	14	
Totals		74	74	148		0	2	2		9	5	14	

Box 8 - Convert Person Trips to Final Vehicle Trips

The vehicle occupancy and baseline alternate mode are now factored out from the external trips in vehicles, after any adjustments for internal capture and additional alternate mode from Box 7. In Box 6, vehicle trips were considered to account for 90% of total person trips. Alternate mode trips in addition to the baseline, if any, are accounted for in Box 7. It is estimated that vehicle trips should be reduced by an additional 0% due to carpooling. The final external trips in vehicles is multiplied by $90\% - 0\% = 90\%$ to produce the external vehicle trips.

External Vehicular Trips

Proposed Use	ADT			AM Peak Hour			PM Peak Hour			(not used)
	In	Out	Total	In	Out	Total	In	Out	Total	
Totals	555	555	1,110	45	30	75	54	54	108	

Box 10 - Estimate Vehicle Trip Subsets Pass-by/Diverted Trips, Truck Trips (Pass-By Trips)

Some trips may be classified as "pass-by" trips, where some vehicle trips generated by the study site are already traveling on an adjacent road and make a stop while passing by. These trips do not add traffic volume to the roadway. The Handbook does not specify that a "pair" of pass-by trips must enter and exit the same driveway. The current edition of the Handbook indicates that pass-by trips should have directional distribution applied (%in/%out), though reviewers often comment when pass-by trip "pairs" do not occur within a the specified time period. This is likely due to ease of calculation and traditional methodology found in the first edition of the Handbook. As such, the analyst may ignore the direction distribution divide the total pass-by trip volume by 2 to apply pass-by "pairs". In addition, the analyst may consider pass-by rates at a reduced rate. Data is not available for all land use codes and all periods, assumptions are highlighted. The percentage is applied to total external vehicle trips.

Lincoln Medical Proposed

Trip Generation November 2018 Appendix D

This form facilitates trip generation estimation using data within the Institute of Transportation Engineer's (ITE) *Trip Generation Manual*, 10th Edition and methodology described within ITE's *Trip Generation Handbook*, 3rd Edition. These references will be referred to as *Manual* and *Handbook*, respectively. The *Manual* contains data collected by various transportation professionals for a wide range of different land uses, with each land use category represented by a land use code (LUC). Average rates and equations have been established that correlate the relationship between an independent variable that describes the development size and generated trips for each categorized LUC in various settings and time periods. The *Handbook* indicates an established methodology for how to use data contained within the *Manual* when to use the fitted curve instead of the average rate and when to adjustments to the volume of trips are appropriate and how to do so. The methodology steps are represented visually in boxes in Figure 3.1. This worksheet applies calculations for each box if applicable.

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Land Use Types and Size

Proposed Use	Amount Units	ITE LUC	ITE Land Use Name
Medical, dental or health office buildings and clinics	32,630 1,000 square feet	720	Medical-Dental Office Building

Box 4 - Is Study Site Multimodal?

Per the *Handbook*, "if the objective is to establish a local trip generation rate for a particular land use or study site, the simplified approach (Box 9) may be acceptable but the *Box 5 through 8* approach is required if the study site is located in an infill setting, contains a mix of uses on-site, or is near significant transit service."

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Equation Type: Equation Used [Equated Rate] (Type Abbreviations: Weighted Average Rate ("WA"), Fitted Curve ("Type: Equation Used [Equated Rate])

Proposed Use	ADT	AM Peak Hour	PM Peak Hour	(not used)
Medical, dental or health office buildings and clinics	FC: $T=38.42 \times X^{-0.72}$ [35.74]	FC: $\ln(T)=0.89 \times \ln(X)+1.31$ [2.53]	FC: $T=3.39 \times X+2.02$ [3.45]	

Box 5/Box 9 - Estimate Baseline Trips/Estimate Vehicular Trips (Apply Equations and In/out Distributions)

Baseline Vehicular Trips

Proposed Use	ADT				AM Peak Hour				PM Peak Hour				(not used)
	% In	In	Out	Total	% In	In	Out	Total	% In	In	Out	Total	
Medical, dental or health office buildings and clinics	50%	583	583	1,166	78%	64	18	82	28%	32	81	113	
Totals		583	583	1,166		64	18	82		32	81	113	

APPENDIX 3

Kimley-Horn Comments on
CivTech Access Assessment Option 1 through 3



$$AASHTO\ Q\ length = 2 * \frac{\left(\frac{vehicles}{hour}\right)}{30\ cycles\ hour} * average\ vehicle\ length$$



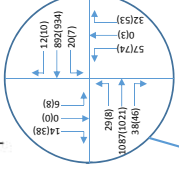
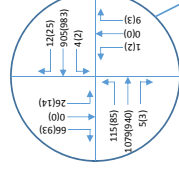
MATCH LINE STA 135+00
SEE BELOW LEFT

APPLEWOOD PET RESORT

LINCOLN DRIVE

MOCKINGBIRD LANE

Ideal and recommended location for full access median break between Mockingbird Lane and Quail Run. This location will allow for westbound queuing at Mockingbird Lane and eastbound queuing at Quail Run without blocking the driveway. Will also accommodate the spacing necessary for future left turn storage and taper.



MATCH LINE STA 135+00
SEE ABOVE RIGHT

LINCOLN DRIVE

SMOKETREE RESORT

QUAIL RUN ROAD

Quail Run access to Smoke Tree

Recommend removal of this driveway.

Per AASHTO calculations, the minimum storage length required is 115 feet. The storage length presented will not adequately store the estimated number of vehicles. Move this driveway a min. 25 feet west to achieve the minimum storage length.

Legend

xx(xx) – AM(PM) Peak Hour Volumes



Lincoln Drive
ACCESS ASSESSMENT

Option 2
Shared Access

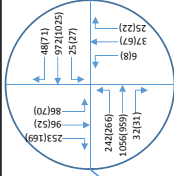
PRELIMINARY
NOT FOR
CONSTRUCTION



DATE NO.	10/20/2016	DESIGNED	DC
1ST SUBMITTAL	10/20/2016	CHECKED	DC
2ND SUBMITTAL	10/20/2016	APPROVED	DC
DATE	10/20/2016	BY	DC

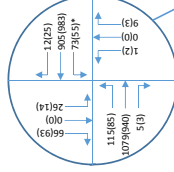
SHEET
Opt-02
02 OF 03

$$AASHTO\ Q\ length = 2 * \frac{\left(\frac{vehicles}{hour}\right)}{30\ cycles\ hour} * average\ vehicle\ length$$



MOCKINGBIRD LANE

*Note: 69(53) are trips from LMC turning to head east



SEE ABOVE RIGHT
MATCH LINE STA 135+00

LINCOLN DRIVE

Ideal and recommended location for full access median break between Mockingbird Lane and Quail Run. This location will allow for westbound queuing at Mockingbird Lane and eastbound queuing at Quail Run without blocking the driveway. Will also accommodate the spacing necessary for future left turn storage and taper.

AASHTO = 50'

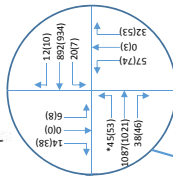
QUAIL RUN ROAD

Quail Run access to Smoke Tree



Recommend driveway be moved west to increase the spacing from Lincoln Medical Plaza western driveway. We further recommend that the western driveway be removed to increase the spacing from Quail Run.

AASHTO = 50'



*Note: 16(45) are trips from LMC turning to head west

LINCOLN DRIVE

SCOTTSDALE CITY LIMIT

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

90'

Legend

xx(xx) – AM(PM) Peak Hour Volumes



Lincoln Drive ACCESS ASSESSMENT

Option 3 Restricted Access

PRELIMINARY NOT FOR CONSTRUCTION



SHEET
Opt-03
03 OF 03