Methodology to Evaluate the Effects of Access Control near Freeway Interchange Areas

Huaguo Zhou, P.E.¹; Kristine M. Williams²; and Waddah Farah³

Abstract: Access connections and signalized intersections within the functional area of an interchange can adversely impact safety and operations at the interchange crossroad and on the freeway, and can cause the interchange to fail prematurely. Standard practice is to acquire a minimum of 90 m (300 ft) of limited access right-of-way beyond the end of the acceleration/deceleration lanes for rural interchanges and 30 m (100 ft) in urban areas. Although the safety and operational benefits of managing access in freeway interchange influence areas are clear, the cost effectiveness of purchasing access rights at the time of interchange construction has not been established through national or state-level research. The primary objective of this study was to assess the relative costs and benefits of purchasing additional limited access right-of-way at the time of construction in lieu of retrofitting interchange areas after functional failure. The study methodology included the following basic steps: (1) traffic operations analysis of the study interchange with varying configurations of signalized access spacing using CORSIM; (2) safety analysis of a sample of Florida interchanges with varied access spacing; and (3) cost/benefit analysis of acquiring varying amounts of limited access right-of-way. This study indicates that the long-term safety, operation, and fiscal benefits of purchasing additional limited access right-of-way at interchange areas greatly exceed the initial costs. The findings suggest that state transportation agencies and the traveling public may benefit greatly by an increase in the amount of limited access right-of-way at interchange areas to a minimum of 180 m (600 ft) and a desirable 400 m (1,320 ft).

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CE Database subject headings: Interchanges; Benefit cost ratios; Traffic safety; Florida; Access roads.

Introduction

Past research shows that access connections and signalized intersections within the functional area of an interchange can adversely impact safety and operations at the interchange and on the freeway. A variety of transportation problems occur when driveways and intersections are too close to interchange ramps. Signalized intersections too close to ramp termini can cause heavy volumes of weaving traffic, complex traffic signal operations, crashes, congestion, and traffic backing up the ramps onto the main line (Feehey et al. 1998).

It follows, therefore, that avoiding access in the vicinity of freeway interchanges through effective planning and access control will preserve traffic safety and operations and may eliminate or postpone the need for interchange improvements. Alternatively, access in the vicinity of a freeway interchange may shorten the functional life of the interchange and lead to serious safety and operational problems on the mainline, as well.

Although the safety and operational benefits of managing interchange area access are clear, the benefits have not been quantified and compared with the cost of purchasing additional limited access right-of-way. For example, would acquiring more access control in the vicinity of interchanges preserve the safety and operations of an interchange and the freeway for a longer period, thereby reducing the need for interchange reconstruction? If so, will the up-front cost of acquiring more access control, be outweighed by the benefits of improved driver safety and the potential to extend the useful life of the interchange? And if inadequate access management contributes to early interchange failure, what about the potential costs of right-of-way acquisition for reconstructing the interchange after development has occurred?

The Center for Urban Transportation Research, under a grant from the Florida Department of Transportation (FDOT), examined these policy questions. The primary objective of the study was to determine if the potential operational and safety benefits of acquiring additional limited access right-of-way at interchange areas outweigh the potential costs. The study is particularly important given the dramatic increases in right-of-way costs that have been observed in Florida over the past few decades. To achieve the goals of the project, a methodology was developed to quantify the operational and safety benefits of different access spacing configurations near the interchange. This paper reviews issues and policy considerations regarding managing interchange area access, and provides a detailed discussion of the study methodology and findings.

¹Assistant Professor, Southern Illinois Univ., Edwardsville, IL 62025; and Senior Research Associate, Center for Urban Transportation Research, Univ. of South Florida, Tampa, FL 33620. E-mail: zhou@cutr.usf.edu
²Program Director, Planning and Corridor Management, Center for Urban Transportation Research, Univ. of South Florida, Tampa, FL 33620. E-mail: kwilliams@cutr.usf.edu
³Project Development & Technical Analysis Administrator, Florida Department of Transportation, Tampa, FL 33612. E-mail: waddah.farah@dot.state.fl.us

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Table 1. Suggested Minimum Access Spacing (Meter) Standards for Four-Lane Roads at Interchanges (Gluck et al. 1999, with Permission)

<table>
<thead>
<tr>
<th>Access type</th>
<th>Fully developed urban [55 km/h (35 mi/h)]</th>
<th>Suburban [72 km/h (45 mi/h)]</th>
<th>Rural [85 km/h (55 mi/h)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>First access from off-ramp</td>
<td>230 (750)</td>
<td>300 (990)</td>
<td>400 (1,320)</td>
</tr>
<tr>
<td>First median opening</td>
<td>300 (990)</td>
<td>400 (1,320)</td>
<td>400 (1,320)</td>
</tr>
<tr>
<td>First access before on-ramp</td>
<td>300 (990)</td>
<td>400 (1,320)</td>
<td>400 (1,320)</td>
</tr>
<tr>
<td>First major signalized intersection</td>
<td>805 (2,640)</td>
<td>805 (2,640)</td>
<td>805 (2,640)</td>
</tr>
</tbody>
</table>

Literature Review

The control of access around interchanges has been an issue in planning and engineering for decades, as reflected in the literature. As early as the 1960s, Ross Netherton addressed this issue in the landmark work *Control of Highway Access*, and concluded that interchange areas present special challenges concerning access management and land use control, due to changing traffic volumes and speeds where the interchange connects with surface road systems (Netherton 1963). Managing this interface is critical to preserving the capital investments made in interchange areas (TRB 1998).

Netherton emphasized that although a properly planned and managed interchange area can become an economic asset for a community, a poorly planned interchange can become a quagmire of reconstruction costs and property rights issues (Netherton 1963). The study goes on to conclude that efforts to restrict access through police power have not been particularly effective in areas with high value property, because political pressure to allow access can be overwhelming (Netherton 1963). For these reasons, Netherton advocated the purchase of access rights for control of interchange area access.

A study conducted for the Illinois Division of Highways, which provided the basis for changes to Illinois access control policies at interchange areas, recommended expanding the acquisition of property access rights “in critical cross-route problem areas” (Barton Aschman 1968). The study also encouraged the development of a comprehensive plan for interchanges that discourages shallow frontages in the vicinity of interchanges and redirects site frontage and access onto service drives or local streets.

Most state transportation agencies address the issue of limited access right-of-way in their roadway design manuals, which reflect policies of the American Association of State Highway and Transportation Officials (AASHTO). The AASHTO publication, *A Policy on Design Standards— Interstate System*, recommends that access control lines for interchanges “should extend beyond the ramp terminal at least 100 ft in urban areas and 300 ft in rural areas. However, in areas where the potential exists for traffic problems, it may be appropriate to consider longer lengths of access control (AASHTO 1991, 2005, p. 2).” Therefore, state interchange access control policies are still primarily limited to the immediate area of the interchange.

State practice is beginning to shift in response to contemporary guidance emerging from AASHTO and research conducted for the Transportation Research Board. The 2004 edition of the AASHTO *Policy on Geometric Design of Highways and Streets* (“Greenbook”) provides more extensive treatment of the subject of access separations and control on the crossroad at interchanges than previous editions. It addresses the importance of access control on interchange crossroads and mentions techniques to control access (AASHTO 2004). It also identifies operational and design elements to consider in determining appropriate access separations and access control distances in the vicinity of interchanges with free-flow ramps or diamond interchange designs. *NCHRP Synthesis 332* found that the minimum access spacing standards or guidelines vary from 30 to 230 m (100 to 750 ft), with the majority using 90 m (300 ft) or less (Butorac and Wen 2004).

Another recent update to the state of the practice in interchange area access management is found in the *Access Management Manual* (TRB 2003), which builds upon work done in *NCHRP Report 420: Impacts of Access Management Techniques*, and research conducted for the Oregon Department of Transportation (TRB 2003; Gluck et al. 1999; Layton 1998). The TRB *Access Management Manual* includes guidelines for interchange area access spacing ranging from 230 to 805 m (750 to 2,640 ft), depending upon the geometric characteristics of the interchange and crossroads, and whether the access is signalized (Gluck et al. 1999), as shown in Table 1.

These sources recommend access spacing on the crossroads at freeway interchanges that is well beyond the minimum provisions of the 1991 and 2005 AASHTO interstate policy and corresponding 30–90 m (100–300 ft) of limited access right-of-way in use by most states. In response to these changing guidelines, several state transportation agencies have begun to revise their policies and practices to acquire more limited access right-of-way at interchanges. As noted in *NCHRP Report 420*: “Many states have established more stringent policies than AASHTO that reflect the importance of providing sufficient access control lengths and/or separation distances along crossroads (arterials) at interchanges (Gluck et al. 1999, p. 113).” Table 2 and Fig. 1 illustrate the recommended access separation guidelines presented in *NCHRP Report 420*.

Table 2. Recommended Separation Distances from Interchange Exit Ramps (Gluck et al. 1999, with Permission)

<table>
<thead>
<tr>
<th>Distance</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaving–moving across</td>
<td>245 m (800 ft) on two lane arterials</td>
</tr>
<tr>
<td>through lanes</td>
<td>365 m (1,200 ft) on four lane arterials</td>
</tr>
<tr>
<td></td>
<td>490 m (1,600 ft) on six lane arterials</td>
</tr>
<tr>
<td>Transition-moving into lane(s)</td>
<td>45–60 m (150–200 ft)</td>
</tr>
<tr>
<td>Perception-reaction distance</td>
<td>30–45 m (100–150 ft)</td>
</tr>
<tr>
<td>Storage</td>
<td>Adequate for volume without overflow into through lane [typically 60–90 m (200–300 ft) depending on demand]</td>
</tr>
<tr>
<td>Distance to centerline of intersection</td>
<td>12–15 m (40–50 ft)</td>
</tr>
</tbody>
</table>
Objective and Methodology

The objective of the study was to determine whether it is cost effective for FDOT to strategically acquire additional limited access right-of-way at the time an interchange is built, and specifically what benefits could accrue to the state and traveling public, in light of the potential costs. The methodology, which is discussed in more detail here, included the following basic steps:

1. Identify an interchange with the appropriate characteristics for use in the evaluation;
2. Conduct a traffic operations analysis of the interchange with varying access configurations, to determine the potential impact of access control on the operational life of the interchange;
3. Determine representative crash frequency for interchanges experiencing backups due to the proximity of signalized access to off-ramps;
4. Determine typical costs of limited access right-of-way in developed and undeveloped areas; and
5. Conduct a cost/benefit analysis of acquiring varying amounts of limited access right-of-way in light of the potential long term safety and operational benefits, and right-of-way costs.

Operational Analysis

Site Selection

With the assistance of FDOT, a list of potential sample interchanges was identified for possible use in this study. The team selected the I-75/CR581 interchange due to the availability of recent CORSIM data and the land development and access characteristics in the immediate area. CORSIM is a microscopic, stochastic traffic simulation model application. It represents the real world traffic environment by integrating freeways and arterial networks and produces a variety of tabular, graphic, and animation files for analysis. The interchange is located in a high growth area north of Tampa, known as New Tampa, and has experienced considerable development in the immediate area. Fig. 2 is a CORSIM simulation map of the interchange.

The existing I-75/CR581 interchange is a diamond configuration with signals at the intersection of I-75 ramp terminals with CR 581. Single lane ramps are currently provided for the southbound off-ramp, the southbound on-ramp, and the northbound on-ramp. The northbound I-75 off-ramp was recently widened to provide a two-lane off-ramp. A 550-m (1,800-ft) parallel deceleration lane was constructed on the I-75 mainline at the diverge area. Dual left-turn lanes are provided on this ramp for the northbound I-75 to southbound CR 581 movement. Two right-turn lanes are provided on this ramp for the northbound I-75 to northbound CR 581 movement. One of the two right-turn lanes joins the two northbound CR 581 through lanes as a lane addition (i.e., a free-flow lane) resulting in three northbound lanes that continue north of the Dona Michelle. The other right-turn lane is located immediately adjacent to the dual left-turn lanes and is subject to signal control.

A signalized intersection at CR 581 and Dona Michelle is approximately 525 m (1,720 ft) from the signalized intersection of northbound interchange off-ramp. The high traffic volumes on the northbound off-ramp resulted in a significant queue on CR 581 and periodic backups onto the mainline from the northbound
off-ramp. The existing right-of-way on I-75 is 100 m (324 ft) with the limited access right-of-way extending along the ramps approximately 30 m (94 ft) from the edge of the travel lane. The existing right-of-way on CR 581 is 60 m (200 ft). These factors, coupled with the explosive growth of New Tampa, make the CR 581/I-75 interchange an interesting site for further evaluation.

**Operational Methodology**

The original CORSIM files for the interchange were obtained from FDOT for use in evaluating the operational effects of limiting access near the freeway interchange ramp. The models simulated operations at the interchange and its influence area, which includes several signalized intersections along the CR 581 crossroad and a nearby interchange at I-75 and Fletcher Avenue.

After delving into the analysis using the original models, it became clear that the number of variables would make it nearly impossible to isolate the impacts of access control on the operational life of the interchange. For example, a change in access spacing resulting in an average delay reduction for the right-turning vehicle of 15 s/vehicle, would likely be negligible if it were averaged into the total number of vehicles in the larger network. The presence of a sweeping free-flow right-turn lane also made the interchange configuration somewhat atypical for urban settings, where a wide radius is not typically needed because operating speeds are normally lower.

To more closely model an urbanized interchange, the free right-turn lane was removed from the network and the CORSIM data were changed to reflect a standard diamond interchange configuration. Other than this, the number of lanes on the freeway, off-ramp, arterial, and intersection were the same as the actual interchange. Next, the links not affected by the length of limited access right-of-way were removed, as was the off-ramp interaction with an adjacent downstream traffic signal.

The final network includes one direction of the freeway, a small segment of the arterial cross street, the off-ramp of interest, the corresponding on-ramp, and the downstream traffic signal—just enough links and nodes to properly simulate the interactions of interest. As the analysis proceeded, the spacing was changed between the ramp and the downstream signal, but the total lane-miles in the network remained unchanged. This allowed easy, direct comparisons of the results from the various simulation runs.

Two measures of effectiveness were used to evaluate the effects of the various degrees of access control on interchange operations. These were:

1. Queue length on the interchange off-ramp; and
2. Vehicle hours of delay for the entire network.

A variety of other variables could also impact interchange operations. To focus the analysis on the impacts of access control, these other variables were considered to be constants and included the following:

1. Distribution of traffic volumes on the freeway mainline and off-ramp;
2. Percentage of turning movement counts at the intersections;
3. Proportion of “up” weaving vehicles (vehicles weaving from the freeway off-ramp into or across the arterial traffic);
4. Proportion of “down” weaving vehicles (arterial traffic that weaves across the entering off-ramp traffic);
5. Heavy vehicle percentage; and
6. Signal progression effects.

In sum, the final methodology for the operational analysis included the following three steps:

1. Modify the existing interchange configuration to an average urban diamond design, including the elimination of a free flow right-turn opportunity, and then increase the traffic flowing through the interchange area until the interchange fails operationally. To reduce the number of combinations of different traffic volumes on the off-ramp and arterial, the volume on the off-ramp was set the same as the directional volume on the arterial. (Note: A 3% annual growth rate in all traffic was assumed. “Fails operationally” indicates that the off-ramp traffic queue from the interchange traffic signal was observed backing up onto the interstate mainline based on CORSIM simulation.)
2. Model the modified interchange with 60 m (200 ft) of separation between the freeway ramp intersection and the first signalized intersection on the crossroad (permitting no additional access between the ramp terminus and the intersection) and increase traffic flow until the interchange fails operationally.
3. Continue to model the interchange with the varied access spacing between the freeway ramp intersection and the first signalized intersection on the arterial at 60 m (200-ft) increments (continuing to permit no additional access between the ramp terminus and the intersection) until the intersection is approximately 400 m (1/4 mi) downstream, and increasing traffic flow at each increment until the interchange fails operationally.

Based on initial simulation studies, a highly significant correlation was observed between the queue length on the interchange off-ramp and length of limited access frontage. The relationship between these two variables reveals how insufficient access spacing causes off-ramp traffic to back into the freeway mainline and create major delays on the interstate. The delay of the entire network could be used to quantify the operational benefits from reduced delay for the varied access spacing.

**Findings**

The operational analysis included two parts: (1) effects of the length of access controlled frontage on the traffic backups on the interstate and (2) estimated delay savings between varied lengths of access controlled frontage.

To test the effect of varied length of access controlled frontage on traffic backups on the interstate, the length was set from 60–365 m (200–1,200 ft) at 60 m (200-ft) increments and a final 35 m (120 ft) increment from 365–400 m (1,200–1,320 ft). For each signalized access spacing, traffic volumes were gradually increased until the traffic on the off-ramp was observed to back into the freeway mainline. Fig. 3 illustrates traffic volumes on the off-ramp and arterial that make the interchange fail operationally.

To reduce the number of combinations of traffic volumes on

![Fig. 3. Effect of access controlled frontage on volume](image-url)
the off-ramp and arterial, the volume on the off-ramp was set the same as the directional volume on the arterial. Fig. 3 illustrates the impact of increasing signalized access spacing on traffic volumes that the off-ramp can accommodate before interchange failure. For example, when the signalized access spacing was equal to 60 m (200 ft), the interchange failed operationally when the off-ramp volume or the directional arterial volume reached 1,500 vehicles/h.

As seen in Fig. 3, increasing access spacing from 60–180 m (200–600 ft) resulted in the most significant capacity gains, and these capacity gains began to level off between 180 and 400 m (600 and 1,320 ft). The volume of the off-ramp and arterial was increased by approximately 400 vehicles/h when the access spacing was increased from 60–180 m (200–600 ft). Between 180 and 400 m (600 and 1,320 ft), the volume of the off-ramp increased by about 100 vehicles/h.

Given the study assumptions, including a 3% growth rate in traffic volume, the increase of access spacing from 60–180 m (200–600 ft) would postpone interchange failure for approximately 8 years. Acquiring 400 m (1,320 ft) of limited access right-of-way could potentially extend the operational life of the interchange for approximately 10 years.

Based on the previous analysis, three alternatives for signalized access spacing—60, 180, and 400 m (200, 600, and 1,320 ft)—were recommended for evaluation in the cost benefit analysis. The difference of total network delay was used to quantify operational benefits of one alternative over the other. In this study, the traffic volume was assumed to increase at a 3% growth rate. Usually, a new interchange was designed for a normal 20 year life. The geometry of the simulation network was assumed to remain the same over the life of the interchange. A total of 20 CORSIM simulation runs were conducted for each alternative.

Safety Analysis

One benefit of acquiring additional limited access right-of-way around interchanges is the potential reduction of crashes on the freeway due to traffic backups causing lane blockage. No past studies were found that examined the safety effects on the freeway of the length of limited access frontage. To quantify this potential safety benefit, a safety analysis was conducted to relate crash frequency to the length of access controlled frontage, and provide an approximate measure of potential crash reduction for the benefit and cost analysis.

The safety analysis examined crash rates in the vicinity of exit ramps at several interchanges. The study sites, selected in coordination with FDOT, were interchanges characterized by traffic back-ups onto the freeway mainline due to insufficient separation of signalized access on the crossroad. Crash data for the study sites were obtained from FDOT for a five year period from 1999 to 2003. For each site, crash data were obtained for a 1 mile freeway section before the off-ramp. This freeway segment was believed to most likely have safety problems due to insufficient access controlled right-of-way.

To provide an approximate measure of potential crash reduction for the benefit and cost analysis, regression models were developed to establish the relationship between the number of crashes at each of the 11 study sites and the length of limited-access frontage. The total number of crashes on one mile of freeway segment before the off-ramp in the five-year period was used as the dependent variable. The length of limited-access frontage was used as the independent variable.

The results of the regression analysis are provided in Fig. 4, which illustrates the relationship between the actual number of crashes in 5 years and the length of limited-access frontage. Fig. 4 shows the potential number of crashes that could be reduced when the length of limited-access frontage is increased. In addition, regression models were developed for estimating the number of fatalities, number of injuries, and number of property-damage-only (PDO) crashes for different lengths of limited access frontage. Figs. 5–7 illustrate the trend line for each type of crash.

The crash data showed a consistent descending tendency for three types of crashes (fatality, injury, and PDO) with the increase of length of limited-access frontage. The $R^2$-squared values for the regression models are relatively low. Theoretically, the length of limited access frontage only has an impact on the crashes caused by traffic backups onto the freeway mainline. Practically, it is unlikely to separate this type of crash from the others.

Benefit/Cost Analysis

The next step in the study was to determine the different costs and benefits associated with purchasing different lengths of limited access right-of-way (LA ROW) at interchanges. The change (usu-
ally, an increase) in benefits and costs is used to calculate the benefit-cost ratio (all the changes in benefits and costs were converted into present worth) as shown in

$$B/C = \frac{\Delta \text{ user benefits}}{\Delta \text{ investment cost}}$$  \hspace{1cm} (1)

The cost/benefit analysis compared the following alternatives:

- Alternative A: purchasing 60 m (200 ft) of LA ROW (current practice);
- Alternative B: purchasing 180 m (600 ft) of LA ROW; and
- Alternative C: purchasing 400 m (1,320 ft) of LA ROW.

The following is an overview of benefits and costs factored into the analysis.

**Benefits**

The benefits of purchasing LA ROW that were examined for the benefit/cost analysis include: (1) Purchasing additional ROW near the interchange area in advance of development, when costs are lower; (2) Delay savings from increased separation of signals from interchange off-ramps; and (3) Crash reduction and corresponding reductions in costs, based on the average cost of crashes as provided by the National Safety Council. These benefits are explained further.

Based on FDOT experience, a minimum of 120 m (400 ft) of ROW needs to be acquired to reconstruct a freeway off-ramp. If FDOT owns only 30–90 m (100–300 ft) of ROW, then reconstructing an off-ramp would generally require at least another 30 m (100 ft) of ROW. At this point the land needed for ROW would also typically be developed.

Vehicle delays could also increase dramatically if the minimum 30–90 m (100–300 ft) of ROW is acquired near the newly built interchange areas, thereby allowing the potential for signals serving too close to off-ramps. This benefit can be calculated by examining the impacts of separating signals from off-ramps at varying distances. The study assumed that a signal was installed at 60 m (200 ft) from the off-ramp terminal for Alternative A, 180 m (600 ft) for Alternative B, and 400 m (1/4 mi) for Alternative C.

The difference of delay between Alternative A and Alternatives B or C over a normal interchange 20 year life period was computed to determine the relative operational benefits of these alternatives. For this analysis, the delay savings was assumed to include delay only in the two afternoon peak hours per day and for 250 work days per year. The average cost of time was assumed to be $13.25 per person hour based on the Urban Mobility Report developed by the Texas Transportation Institute (TTI) (Schrank and Lomax 2007).

The potential safety benefit of the crash reductions associated with acquiring additional ROW was determined using the equations in Figs. 5–7. This analysis reflected the relative safety performance of a small sample of actual interchanges with varying spacing of signals from the off-ramp and was applied to determine the relative differences in crash experience that might be expected between Alternative A and Alternatives B or C. The average cost of each type of crash was obtained from the National Safety Council, which publishes statistical information annually on the costs of various types of crashes.

The equations for computing the above-mentioned three benefits are as follows:

1. Dollar savings for not purchasing LA ROW on developed land ($B_1$)

$$B_1 = \text{Average cost of ROW per front foot \times 120 m}$$  \hspace{1cm} (2)

where $B_1$ = present cost of ROW for 120 m (400 front ft) of developed land; 400 front ft was provided by FDOT as the minimum length that would need to be purchased to reconstruct the freeway off-ramp area.

In Eq. (2), the front foot is defined as a front foot of ROW, which means frontage footage, adjacent to the road, adjacent to the travel lanes, fronting the road. It costs more than a square foot that is away from the road. Based on past experience, most of the interchanges, probably over 90% will need to purchase 120 m (400 front ft) of developed land for modification around the off-ramp area during the normal 20 years interchange lifetime.

2. Decreased delay and travel time ($B_3$)

$$B_3 = (\Delta \text{ delay}) \times 1.25 \times 2 \times 250 \text{ Average cost of time}$$  \hspace{1cm} (3)

where $\Delta \text{ delay}$ = difference of delays between Alternative A and Alternative B or C in 20 years; working days = 250 days per year; average cost of time (year 2002) = $13.25 per person hour; number of PM peak hours per day = 2; and vehicle occupancy = 1.25 persons per vehicle. (Note: The congestion cost per person hour was obtained from the TTI Urban Mobility Report. It is $13.25 per person hour, assuming 1.25 persons per vehicle and 250 days per year.)

3. Fewer crashes ($B_4$)

$$B_4 = \text{\Delta crash rate} \times \text{Average cost per crash} + \frac{\Delta \text{PDO}}{\text{Average cost per PDO}}$$  \hspace{1cm} (4)

where $\Delta \text{ crash rate}$ = difference of number of fatalities between Alternative A and Alternative B or C in 20 years; $\Delta \text{ injury}$ = difference of number of injuries between Alternative A and Alternative B or C in 20 years; and $\Delta \text{ PDO}$ = difference of number of property damage only crashes between Alternative A and Alternative B or C in 20 years. Average cost for each type of crash: death = $1,120,000; nonfatal injury = $45,500; and PDO = $3,200 (P) (source: National Safety Council 2003).

**Costs**

The additional cost between Alternative A and Alternative B or C contains only the initial cost for purchasing additional LA ROW of undeveloped land ($C_i$). For Alternative B, the additional cost will be equivalent to the value of 120 m (400 front ft) of addi-
tional ROW of undeveloped land. For alternative C, the additional cost will be equivalent to the value of 340 m (1,120 ft) of additional ROW of undeveloped land.

The average costs of ROW per front foot were obtained from FDOT as follows:
1. Average rural unimproved: $500 per front ft;
2. Average rural improved: $1,000 per front ft;
3. Average urban unimproved: $1,625 per front ft; and
4. Average urban improved: $15,000 per front ft.

### B/C Ratio

The benefit–cost (B/C) ratio was calculated for two comparisons: Alternative A 60 m ((200 ft)) versus Alternative B 180 ((600 ft)) and Alternative A 60 m ((200 ft)) versus Alternative C 400 m ((1,320 ft)) using the following equation:

\[
B/C = (B_1 + B_2 + B_3)/C_1
\]

The results of B/C analysis are listed in Tables 3 and 4. The B/C ratios are estimated for four different scenarios: Alternative A versus B for both urban and rural conditions, and Alternative A versus C for both urban and rural conditions. Delays savings is the largest portion of the total benefits (approximately 80–95% of total benefits). The second is the safety benefit. The B/C ratio is very high as the initial costs are very small compared to the benefits. It is apparent from these findings that the combined benefits of acquiring additional limited access right-of-way near an interchange in advance of development far exceed the costs of repair after the fact. For urban conditions, the savings for not purchasing additional ROW have exceeded the initial cost of purchasing additional ROW before considering the benefits of delay savings and crash reductions. For rural conditions, the delay savings were estimated based on the same traffic conditions as the urban conditions. This may overestimate the delay saving and safety benefits, which is the reason why the B/C ratios are much higher for rural conditions.

### Conclusions and Recommendations

Rapid population growth and escalating right-of-way costs can have potentially dire implications for the ability of state transportation agencies in high growth states such as Florida to keep pace with transportation improvement needs. For interchange areas the problem is particularly acute, given the rapid development that occurs when an interchange is built. If this development is not carefully planned, the resulting access problems can lead to premature interchange failure and safety hazards on the freeway. At that point, reconstructing the interchange may prove cost prohibitive, given the cost of acquiring limited access right-of-way on improved commercial property.

Although FDOT regulates access spacing in interchange areas, managing interchange area access through police power alone has certain limitations. Political pressures tend to be high for interchange area access development is rapid but incremental making coordinated planning difficult, and land ownership patterns and subdivision practices can limit the effectiveness of state policies. Access permits cannot be denied to individual properties when the result would be to deny all access, unless the property is acquired by the government agency or alternative access is provided.

Given these limitations, it is advisable for state transportation agencies to acquire additional LA ROW [beyond the standard 30 or 90 m (100 or 300 ft)] when the interchange is being planned and before the adjacent land is subdivided and developed. This would help redirect access to more appropriate locations for safety and traffic operations. It would also help force the issue of adequate internal street and circulation networks for interchange area development. Those who own businesses or have homes in the interchange area would benefit from improved access design and the lower likelihood that their land would be damaged or needed for interchange expansion. Policy measures would help accomplish the desired outcomes.

These findings indicate that the long term safety, operational, and fiscal benefits of purchasing additional LA ROW at interchange areas, greatly exceed the initial up front costs of acquiring additional limited access right-of-way. Clearly, the findings are preliminary, given the limited data set, the generalized nature of the study interchange, and the limitations of CORSIM. Additional research is suggested to further refine and expand upon these results. Nonetheless, the results suggest that state transportation agencies and the traveling public may benefit greatly by an increase in the amount of LA ROW at interchange areas to a minimum 180 m (600 ft) and a desirable 400 m (1,320 ft).

### References


