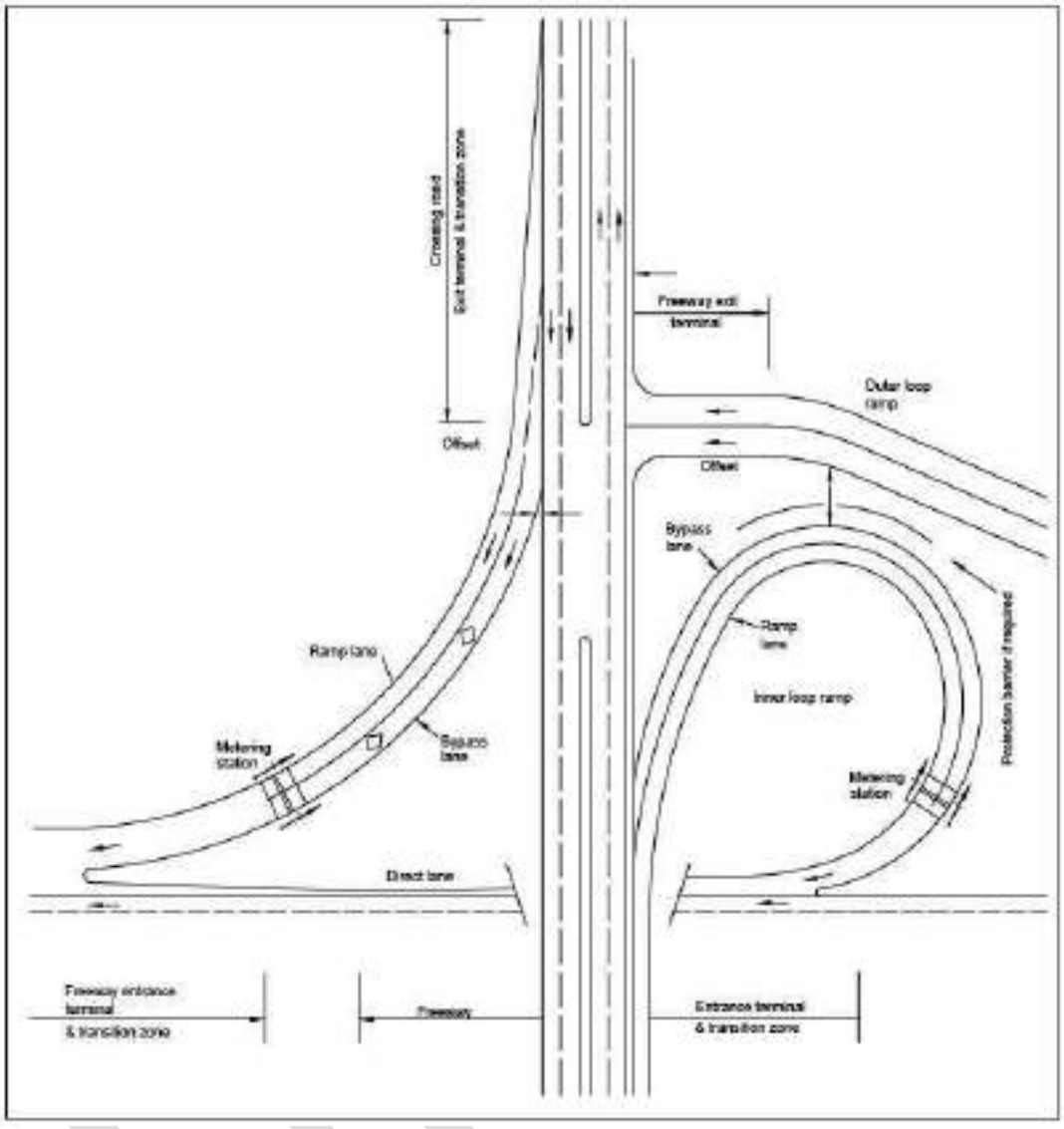
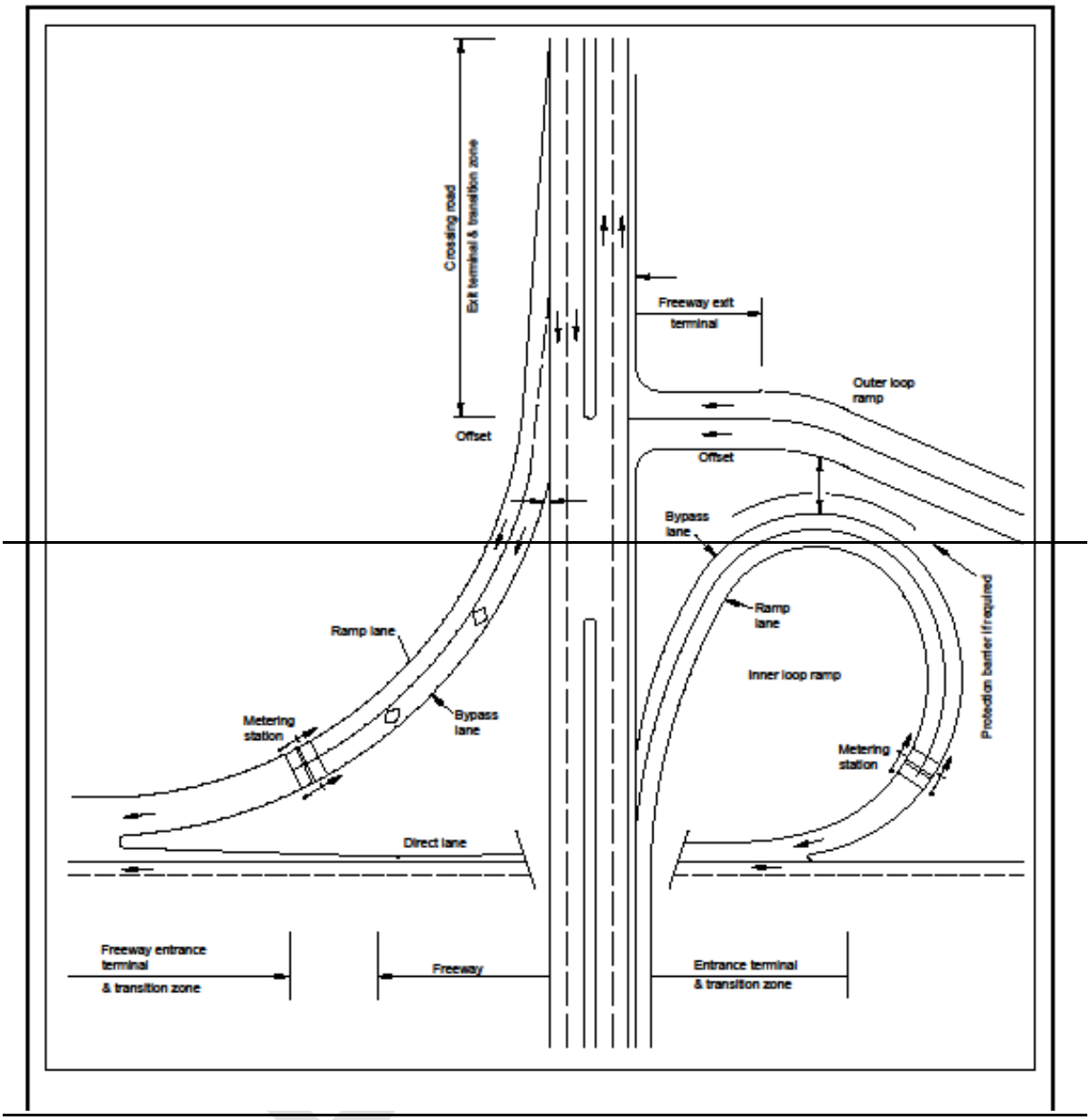

Crossing road
Exit terminal & transition zone
Offset
Freeway exit terminal
Outer loop ramp
Offset
Bypass lane
Ramp lane
Ramp lane
Inner loop ramp
Protection barrier if required
Metering station
Bypass lane
Metering station
Direct lane
Freeway entrance terminal & transition zone
Freeway
Entrance terminal & transition zone


Crossing road
Exit terminal & transition zone
Offset
Freeway exit terminal
Outer loop ramp
Offset
Bypass lane
Ramp lane
Metering station
Bypass lane
Ramp lane
Inner loop ramp
Protection barrier if required
Metering station
Direct lane
Freeway entrance terminal
& transition zone
Freeway
Entrance terminal
& transition zone

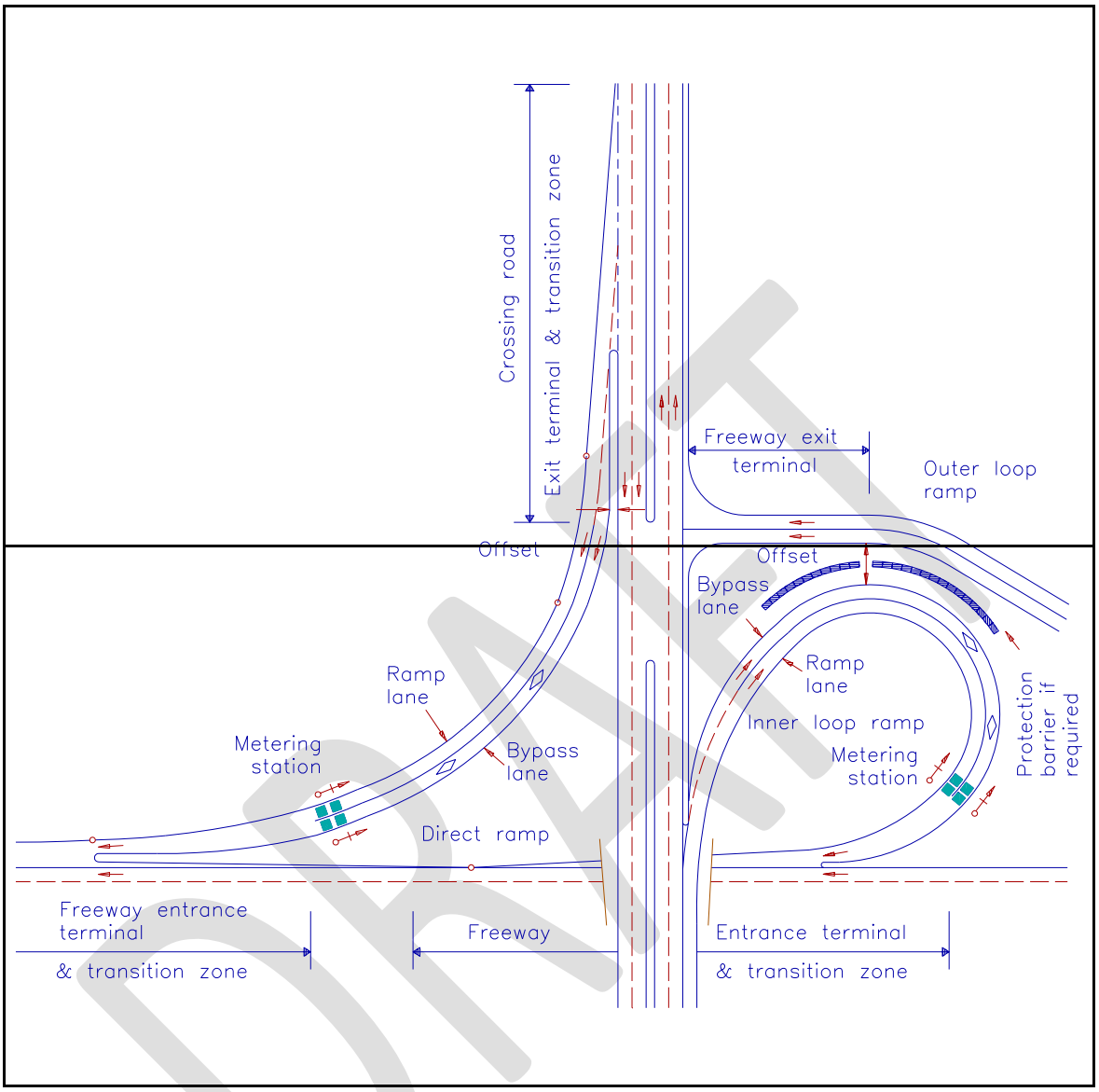
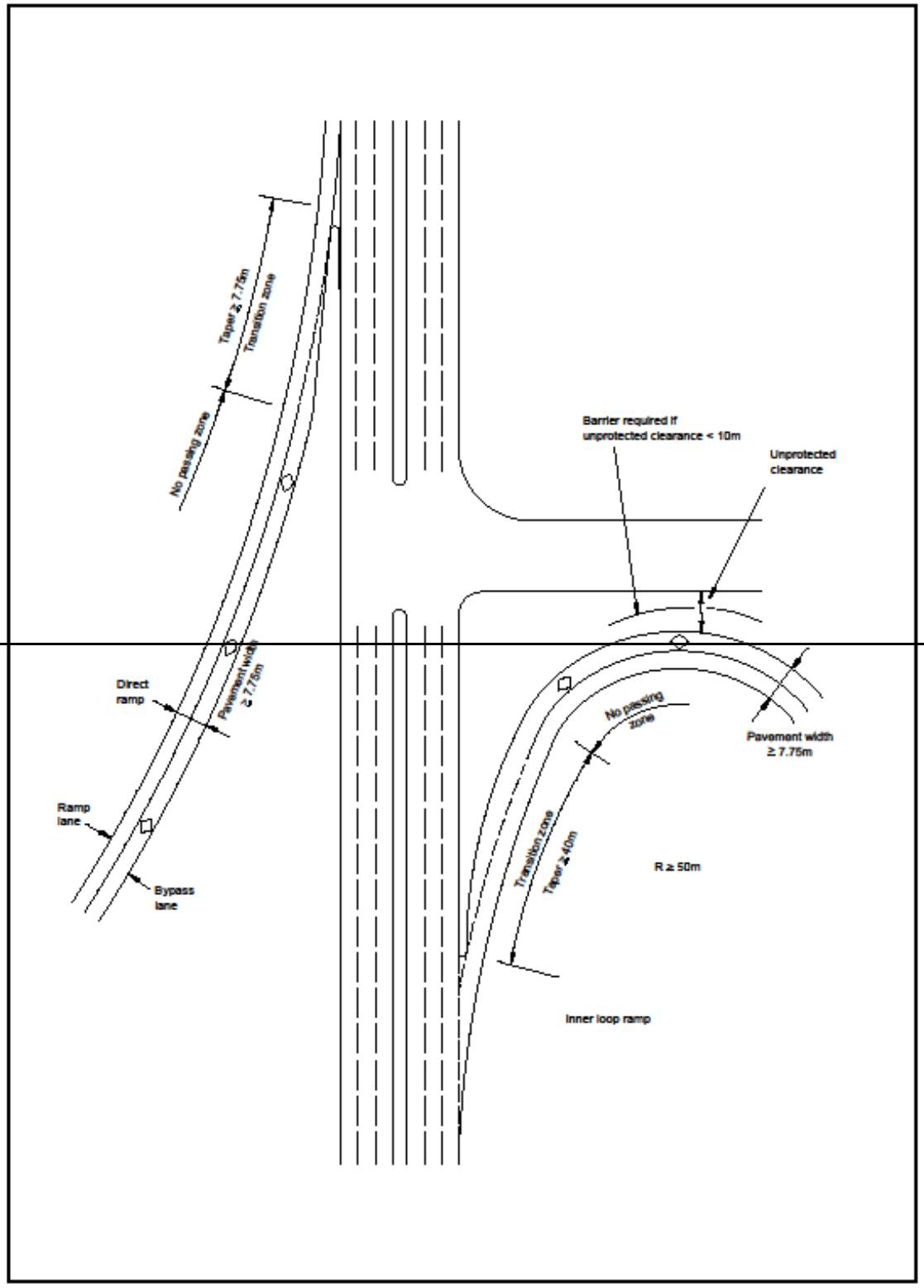
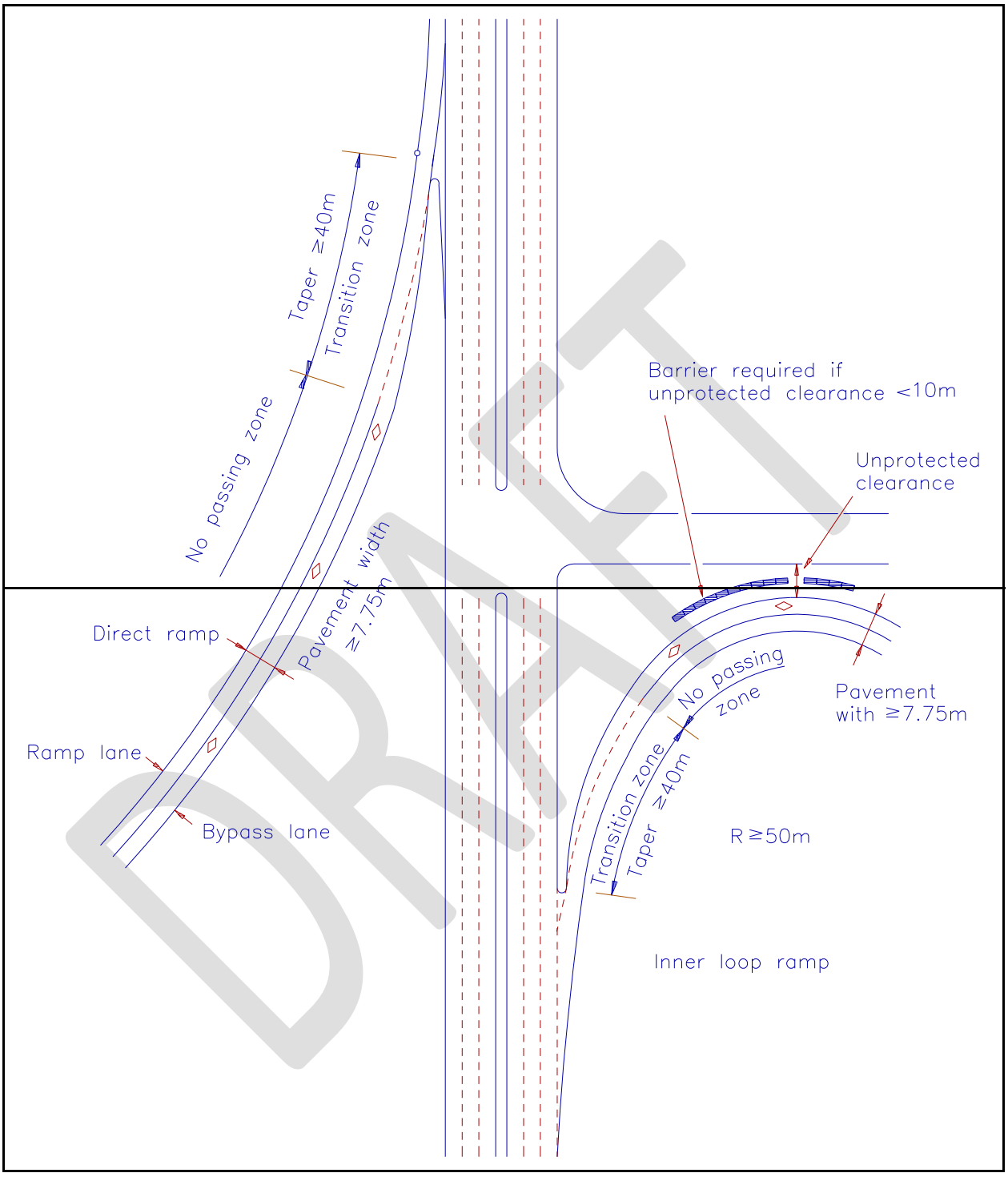


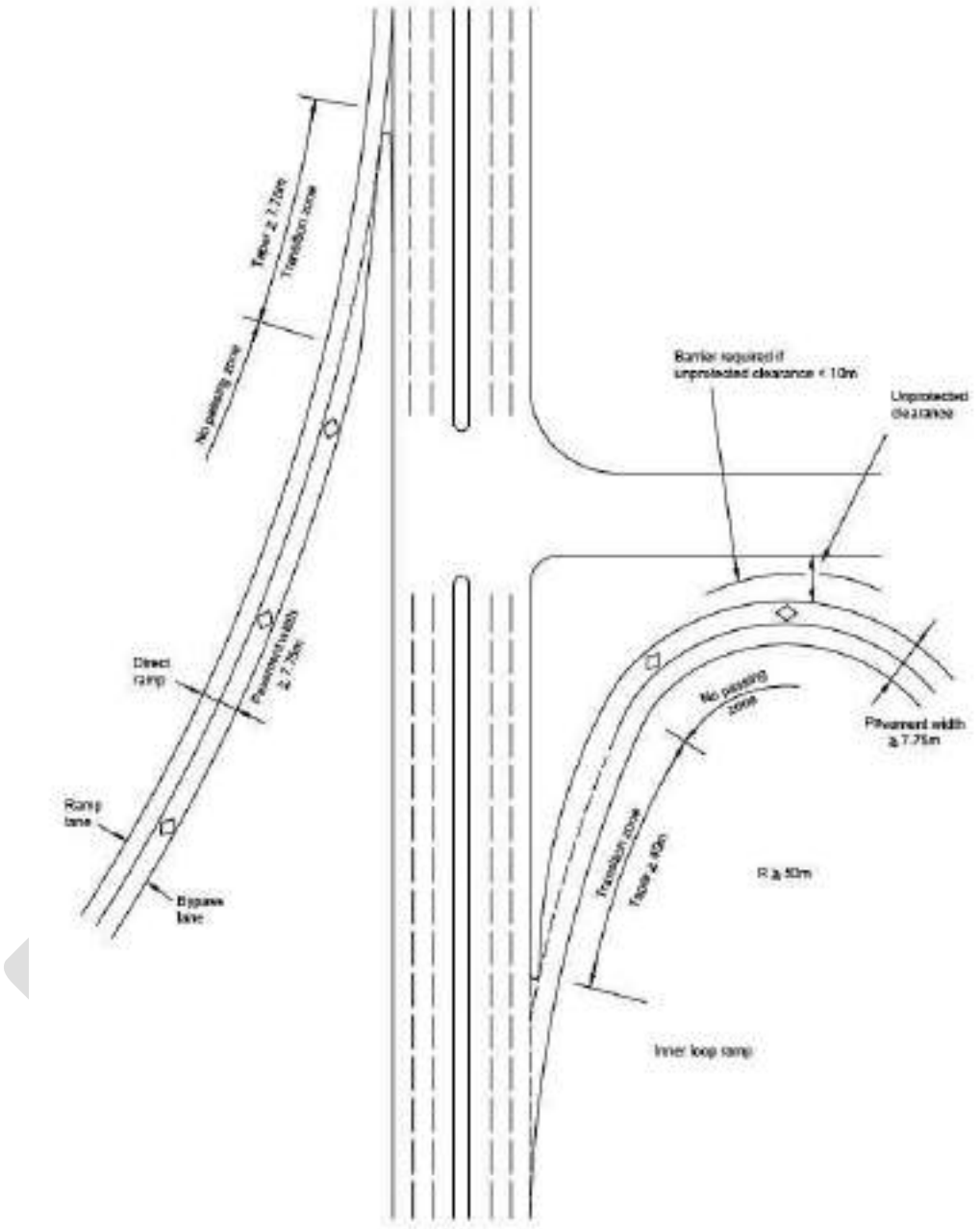
Exhibit 12AL

Crossing Road Exit Terminals at "Parclo A" Interchanges

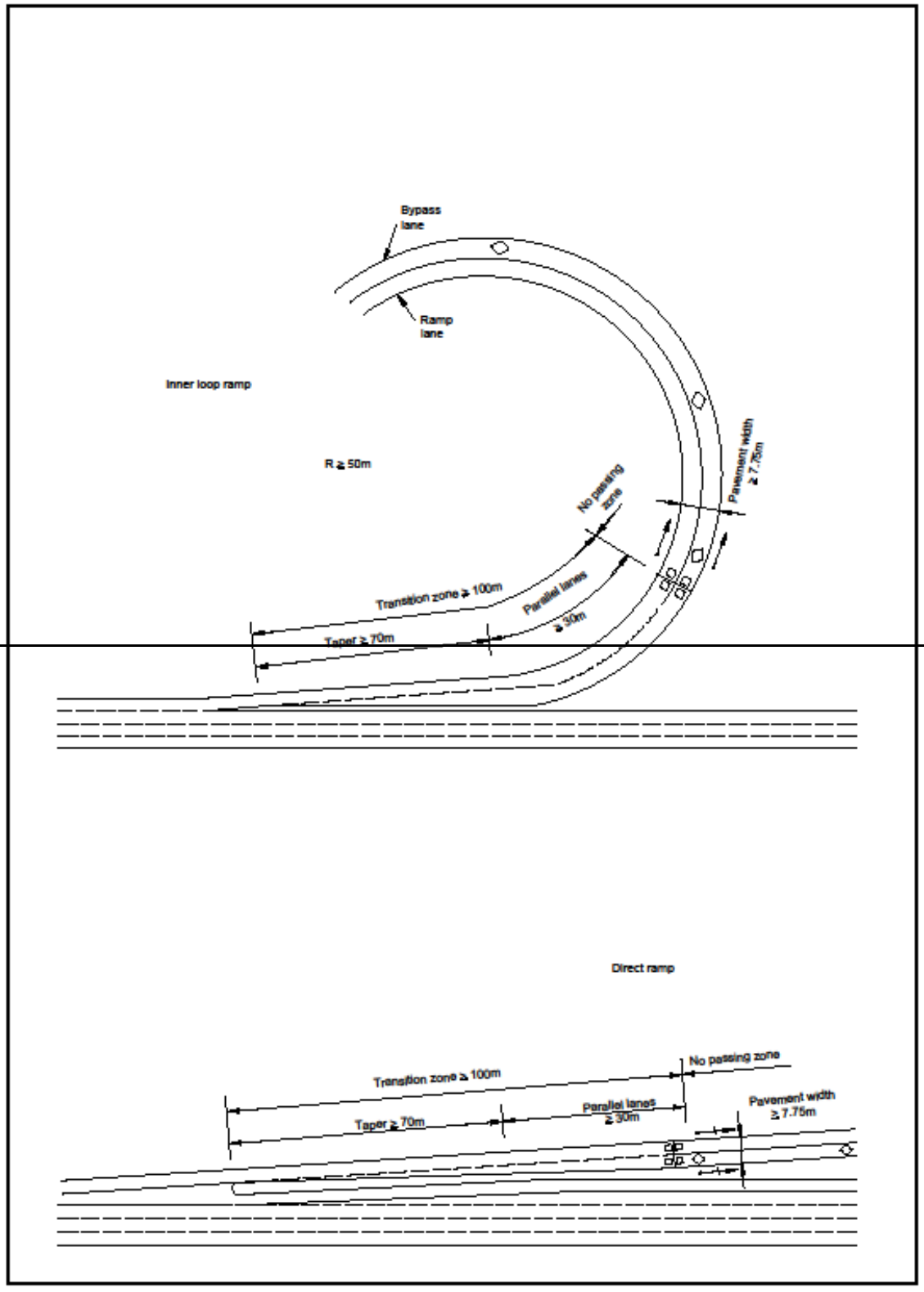
~~**Figure 12.5.19 "Parclo A" Interchange with Bypass Lanes**~~


Taper ≥ 7.75m
Transition zone
No passing zone
Barrier required if unprotected clearance < 10m
Unprotected clearance
Direct ramp
Pavement width ≥ 7.75m
Ramp lane
Bypass lane
No passing zone
Pavement width ≥ 7.75m
Transition zone
Taper ≥ 40m
R ≥ 50m
Inner loop ramp


Taper ≥40m
Transition zone
No passing zone
Barrier required if unprotected clearance <10m
Unprotected clearance
Pavement width ≥7.75m
Direct ramp
Ramp lane
Bypass lane
Pavement with ≥7.75m
No passing zone
Transition zone
Taper ≥40m
R≥50m
Inner loop ramp



~~Figure 12.5.20 Crossing Road Exit Terminals at "Parclo A" Interchanges~~


Bypass lane
Ramp lane
Inner loop ramp
R ≥ 50m
No passing zone
Pavement width ≥ 7.75m
Transition zone ≥ 100m
Parallel lanes ≥ 30m
Taper ≥ 70m
Direct ramp
Transition zone ≥ 100m
No passing zone
Taper ≥ 70m
Parallel lanes ≥ 30m
Pavement width ≥ 7.75m

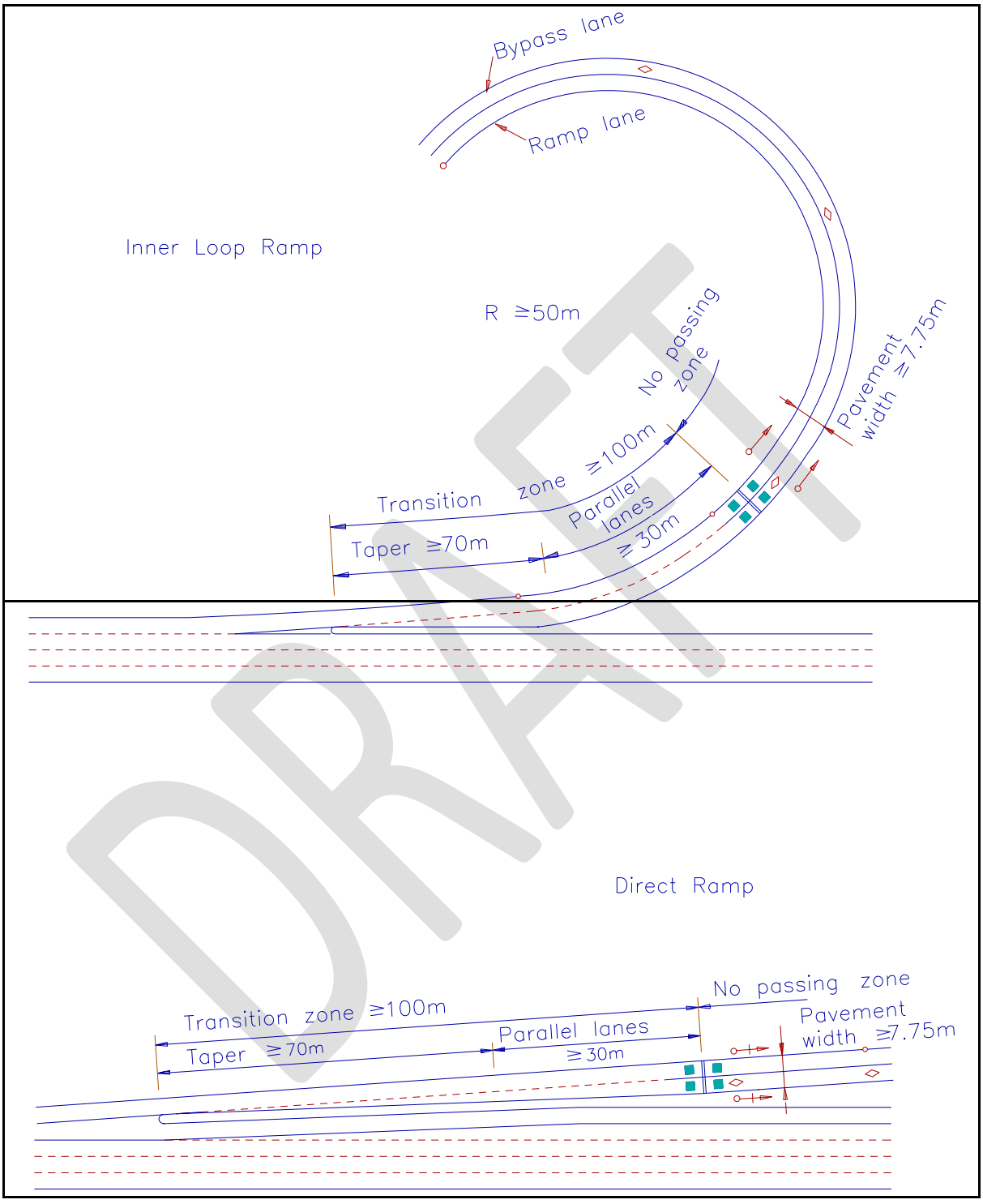
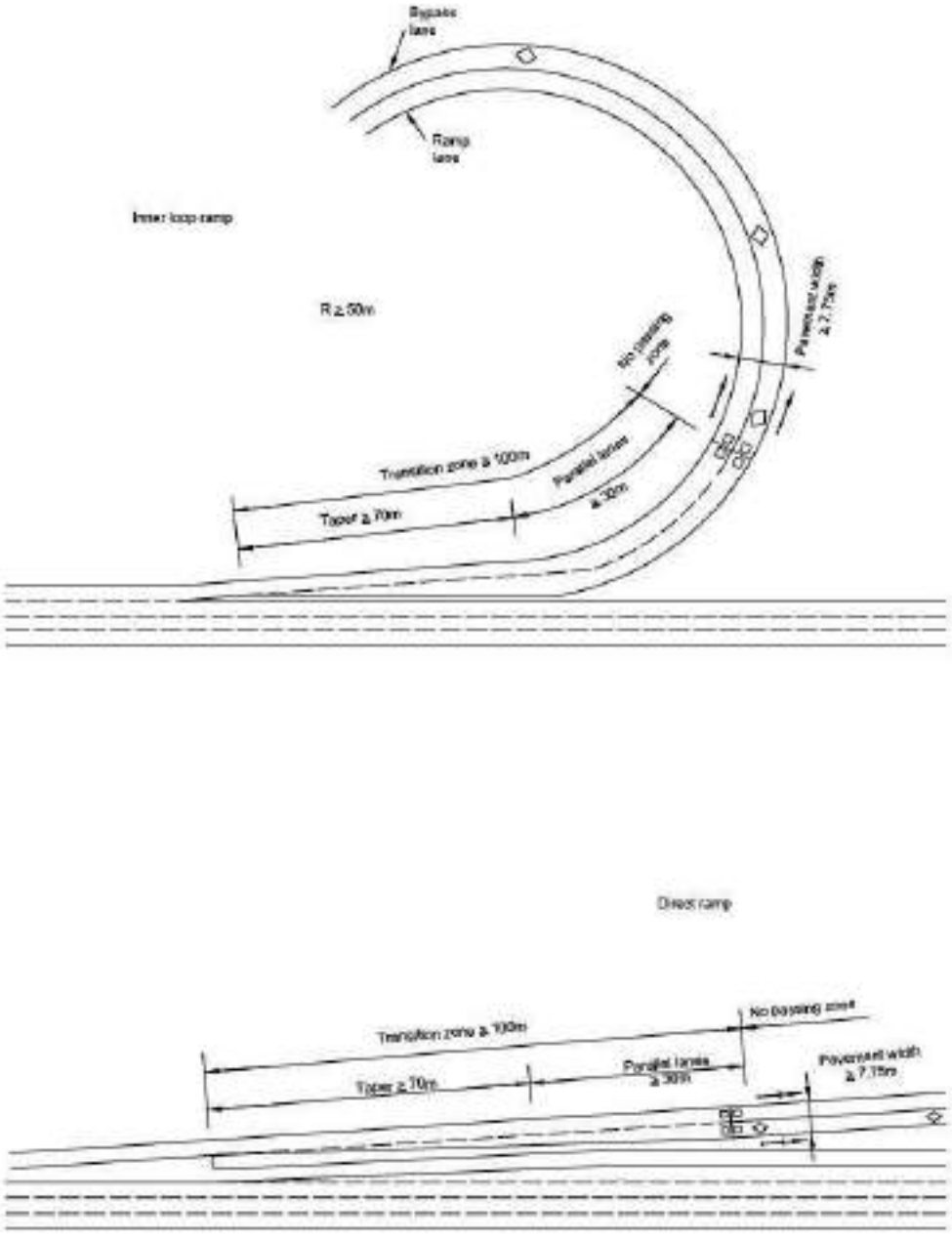

Bypass lane
Ramp lane
Inner Loop Ramp
R ≥50m
No passing zone
Pavement width ≥7.75m
Transition zone ≥100m
Taper ≥70m
Parallel lanes ≥30m
Direct Ramp
Transition zone ≥100m
Taper ≥70m
Parallel lanes ≥30m
No passing zone
Pavement width ≥7.75m

Exhibit 12AM

Freeway Entrance Terminals with Bypass Lanes



~~Figure 12.5.21 Freeway Entrance Terminals with Bypass Lanes~~

12.5.2.6 Separate HOV Roadway

A separate roadway dedicated to HOV use can be applied where there is a very high volume of HOVs, where a freeway facility is physically incapable of accommodating necessary HOV provisions, where desired operational characteristics require off-line facilities, or where a barrier-separated exclusive access facility can be provided within a freeway right-of-way.

The Transitways planned to date in Ontario have not considered the potential use of the facility by other HOVs, notably carpools, vanpools and/or taxis. -The planning principles for an HOV roadway open to carpools and vanpools would be like those used for the Ottawa or Mississauga Transitways but several design details would require modification in order to make the facility safe and suitable for all HOVs. Key design issues have been outlined in **Exhibit 12AN**~~Table 12.5.7~~.

~~Table 12.5.7~~Exhibit 12AN
Key Design Issues for Separate HOV Roadways

Design Element	Busway Standard (Typical)	HOV Standard (Desirable)
Design Speed for Vertical and Horizontal Main Line Alignment	80 km/h	120 km/h
Median Treatment	Solid Painted Line	Physical Barrier
Entrance Ramps	Direct Entry / Intersections	Acceleration Lane / Free Flow

Since the higher design speed for an HOV facility could act as a significant constraint in this development and design (e.g. a minimum horizontal radius of 650 m is required for 120 km/h operation, while only 250 m radius is required for 80 km/h operation), it must be considered in the local context. Since the intent of the facility is to provide a faster overall trip time for HOVs compared to the mixed flow alterative, use of a higher design speed would be appropriate in an area where the HOV route parallels, or is an alternative to, a freeway. -The reduction of design

speed in an area of physically constrained right-of-way may also be acceptable if it would be safe and would not eliminate the benefits of HOV.

12.5.2.7 HOV / HOT Lane Access / Egress

Access to a HOV/HOT lane facility and the extent to which it is controlled, are fundamental issues in the design and operation. ~~-~~Cost, operational, safety, and enforcement trade-offs associated with the different levels of access control must be considered. There are multiple approaches to providing access to HOV/Hot lanes: continuous, restricted at-grade access, and grade-separated access.

The need for various access types depends on the traffic patterns and physical opportunities present in a corridor. ~~-~~They further depend on the HOV lane type being considered and its operational characteristics, **Exhibit 12AO**~~**Table 12.5.8**~~ provides a brief overview of the situations in which various access provisions may be considered.

There has been interest in continuous access where motorists can enter or exit priced managed lanes (HOT) at any point.~~-~~ The use of continuous access for priced lanes has implications on the number of tolling points, ETC installations and enforcement practices.~~-~~ While tolls are often collected downstream of access points, additional access points in intermediate locations are now also common on newer priced managed lane facilities.

~~Table 12.5.8~~Exhibit 12AO

Application of HOV Lane Access Provisions

Access/Egress Type		HOV Lane Type				
		Concurrent Flow				Reversible Flow
		Median			Right Side	
		Barrier	Buffer	Non-Separated		
At-Grade	Continuous (unrestricted)	No	No	Yes	No	No
	Designated Weaving Zone	No	Yes	Yes	Yes	No
	Dedicated Weaving Lane	No	Yes	No	No	No
	Designated Access Point(s)	Yes	No	No	Yes	Yes
Grade-Separated	Direct Ramp From Crossing Road	Yes	Yes	No	No	Yes
	"Tee" Ramp at Off-Line Node	Yes	Yes	No	No	Yes

12.5.2.7.1 At-Grade Access – Median HOV Lane

For at-grade (weaving) provisions, the following elements may be present:

- N~~n~~o buffer, buffer, or barrier between the HOV and mixed flow lanes
- C~~c~~ontinuous access, designated weaving zone, or dedicated weaving lane
- O~~o~~ne-way weave or two-way (access and egress) weave

Additional factors which affect the type and location of weaving manoeuvre include:

- V~~v~~olume of traffic in HOV lane, in mixed-flow lanes, and performing weaving manoeuvre
- L~~l~~ocation of weaving zone relative to right side freeway ramp entrances and exits
- W~~w~~idth of buffer or barrier
- N~~n~~umber of freeway lanes and Level of Service on mixed-flow lanes
- A~~a~~vailable cross-section width/configuration
- S~~s~~ight distance
- S~~s~~eparate mixed-flow weaving/merging conditions

12.5.2.7.1.1 Continuous Access

The simplest means of providing access to/from the HOV lane is across a standard or double dashed lane marking from the adjacent mixed flow lane.~~-~~ This is the recommended approach when the HOV lane is used only during peak periods and is open to all users at other times; in such a case, the lane should appear similar to a mixed flow lane and designation relies on signage.

If an HOV lane is a permanent installation, it is preferable to restrict access to designated locations or zones; lack of acceleration/deceleration areas, relatively high-speed differential between HOV lane and adjacent traffic, and improved safety and enforcement characteristics which follow from segregation of traffic flows militate against the use of continuous access in such a situation.

12.5.2.7.1.2 Designated Weaving Zone

The experience to date with design and operation of weaving zones has been that they should be a minimum of 300 m and a maximum of 450 m in length.~~-~~ The guidelines strike a balance between providing adequate merge/diverge length and minimizing the risk/incentive for congested mixed flow traffic to use the HOV lane as a passing lane.

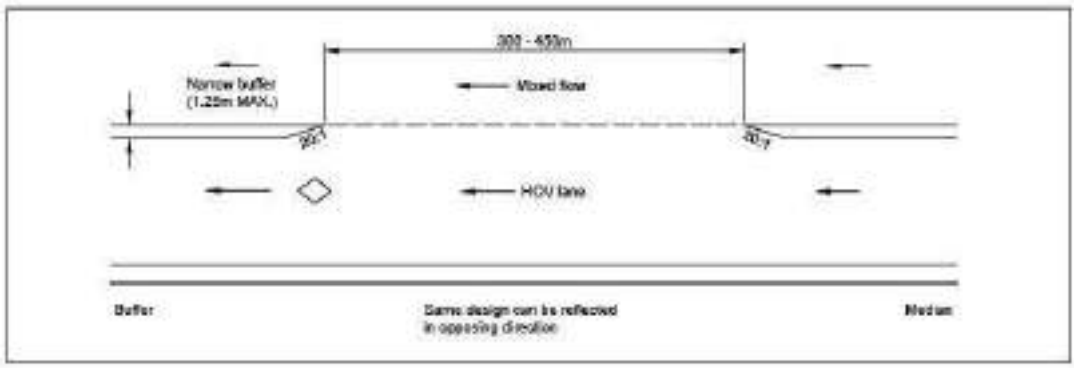
Where a solid painted line demarcates HOV lane and where a buffer zone separates the lane from adjacent mixed flow lanes, the recommended strategy is to designate defined zones for access to/from the HOV lane by introducing a dashed pavement marking in an appropriate location.- **Exhibit 12AP~~Figure 12.5.22~~** illustrates one application and provides guidelines regarding weaving zone design and location.

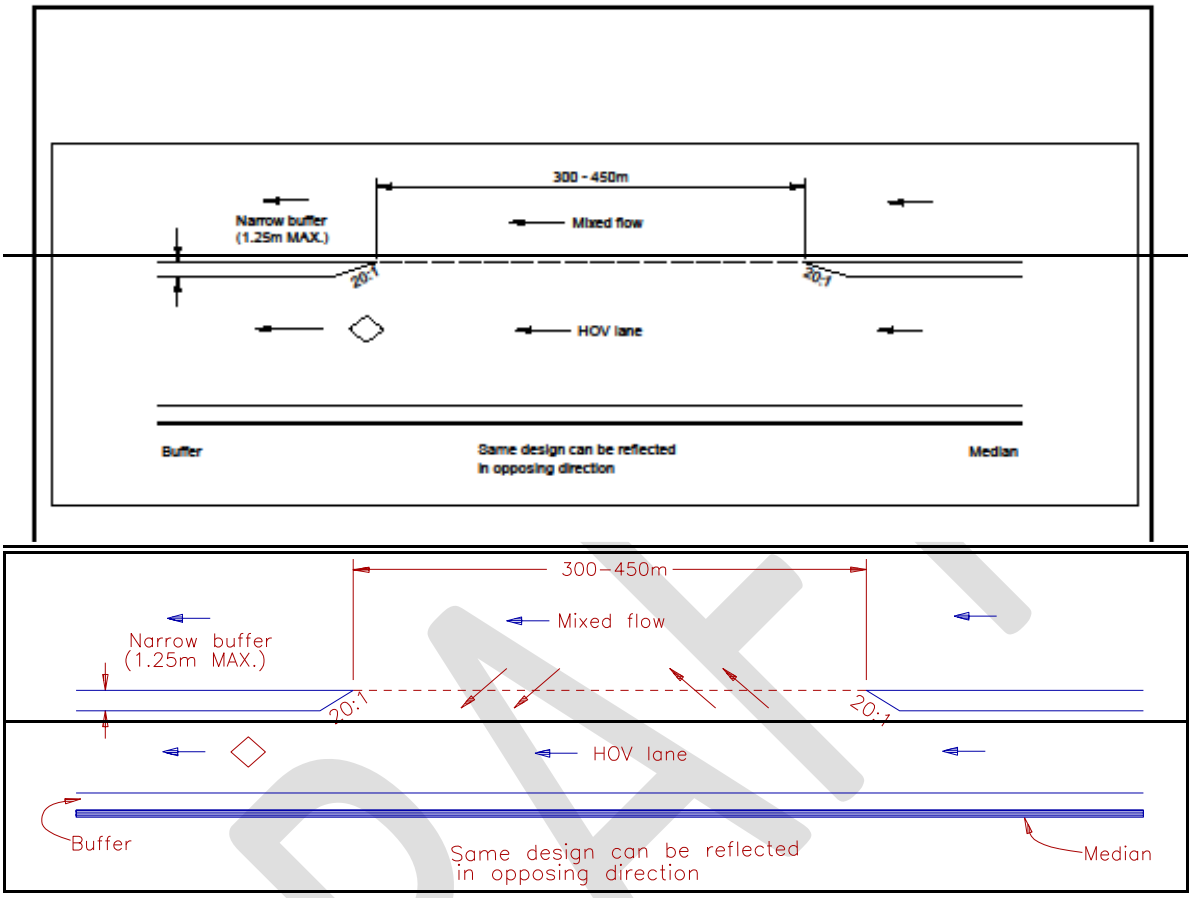
In most circumstances, two-way (access and egress) moves can be accommodated within a weaving area. -HOV lane volumes are limited, the number of HOVs entering or exiting the lane at any one point would generally be 500 per hour or less, and in most locations the weaving manoeuvre would emphasize either access or egress; therefore, the risk of HOV weaving manoeuvre itself operating at a poor level of service is low.- If these conditions were not met in a particular case, one-way (access only or egress only) operation could be assessed, but enforcement would be an issue not easily resolved.

The location of ingress/egress zones should be subject to careful corridor-specific study, considering HOV traffic origin and destination patterns as well as physical fit and feasibility.- It is neither necessary nor appropriate to attempt to serve every freeway entry and exit ramp with an at-grade HOV lane access zone; prime consideration should be reserved for: freeway-to-freeway connections, transit needs, ramps with a high volume of car/vanpools, ramps serving major park and ride/park and pool facilities and isolated interchanges.

Exhibit 12AP

Designated Weaving Zone for Buffer Separated HOV Lanes





~~Figure 12.5.22 Designated Weaving Zone for Buffer Separated HOV Lanes~~

The placement of an HOV lane weaving zone must consider weaving condition introduced to freeway as HOV users entering at a right-side ramp weave across congested mixed flow lanes to access HOV lane via the weaving zone. ~~-~~A site-specific weaving analysis for a variety of operational situations is required; the "worst case" situation is not necessarily the peak hour, as weaving may in fact be more difficult in the "shoulder" periods where high volumes are combined with high speeds.

As noted above, the weaving zone location is flexible, and can be adjusted by simple restriping in response to field observation of traffic operations. ~~-~~As a planning guideline, however, the following guidelines have emerged from experience elsewhere as shown in **Exhibit 12AO**~~**Table 12.5.8**~~.

The distances are intended to maintain a Level of Service "D" for the weaving manoeuvre. ~~-~~The greatest distance for an "exiting" weave reflects provisions for buses which find it more difficult

(due to visibility) to shift lanes to the right.

In Ontario, two sequential entry ramps from Parclo "A" type interchanges are common; for HOVs from both ramps to have the ability to access the HOV lane, the weaving zone location should be based on the downstream entry ramp's bullnose.

For a corridor where several interchanges are located, interchange spacing may determine location of weaving zones.- If interchanges are too close together to accommodate entry weave, weaving zone, and exit weave (i.e. 1000 m - 1800 m between interchange ramp bullnoses), there should not be a weaving zone provided. -This will prevent one or the other weaving manoeuvre being "forced" into too short a distance.

For interchange spacing greater than the minimum and up to approximately 2500 - 3000 m, a single weaving zone should be used (if both interchanges serve key HOV routes).- Consideration should be given to skewing weaving zone location within the envelope ~~so as to~~to give greater weaving distance to higher volume move, or to tying the weaving more closely to the more significant crossing road. -Beyond that spacing, two weaving zones should be provided if both interchanges are to be served.

12.5.2.7.1.3 Dedicated Weaving Lane

Consideration should be given to the provision of dedicated weaving lanes where there are high volumes (>500 vph) of HOVs entering or exiting a median HOV lane or where a new or reconstructed freeway project offers adequate right-_-of-_-way or where operational concerns with designated weaving zones are present.~~,~~

~~Table 12.5.9~~Exhibit 12AQ
Guidelines for HOV Lane Weaving Zones

HOV Volumes	No. of Mixed Flow Lanes	Distance from Right Side Entry Ramp Bullnose to Start of Weaving Zone	Distance from Start of Weaving Zone to Right Side Exit Ramp Bullnose	
			"Must Exit" at Bullnose	"Choice" at Bullnose
< 250 vph	2	300 m	600 m	400 m
	3	400 m	600 m	400 m
250 - 500 vph	2	400 m	800 m	600 m
	3	500 m	800 m	600 m

The basic parameters regarding length and location relative to interchanges are like those for a designated weaving zone, as outlined in **Section 12.5.2.7.1.2**.- Illustrations of dedicated weaving lanes are included in **Exhibit 12AR~~Figure 12.5.23~~** and **Exhibit 12AS~~Figure 12.5.24~~**.

A dedicated weaving lane provides optimum conditions for at-grade access to a buffer-separated median HOV lane, providing a clearly defined area where acceleration or deceleration matching the speed of merging traffic to occur safely and without interference.

Within a single corridor, access types could include both zones and lanes, applied as appropriate relative to the HOV and mixed flow traffic conditions and demands. -The addition of a weaving lane can force realignment of mixed flow lanes if in a retrofit narrow median situation; the associated costs and impacts may be significant.

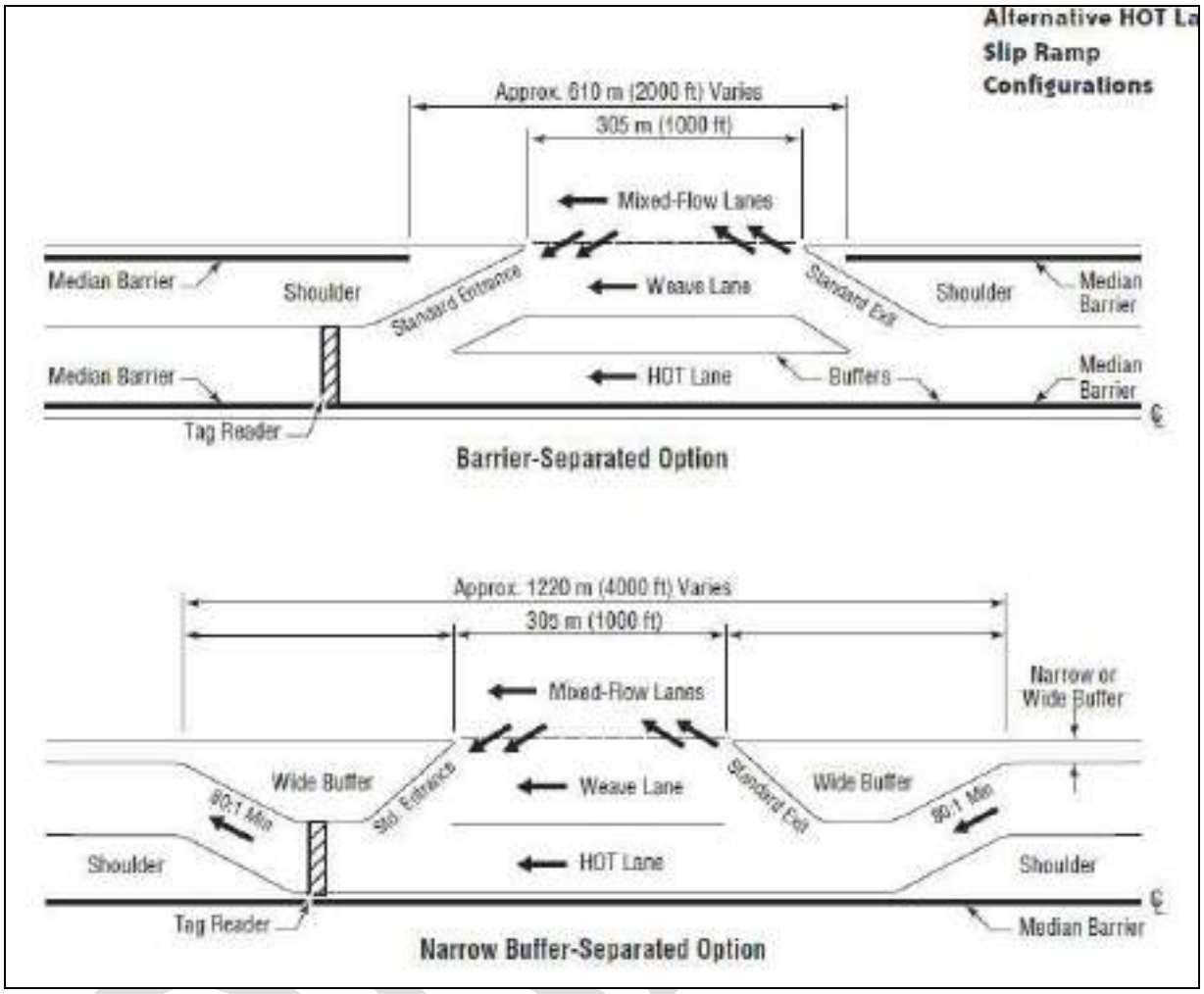
Dedicated weaving lanes are less flexible than other at-grade options and should be considered carefully where uncertainty regarding demand is present.- It may be more appropriate to begin

with a weaving zone and upgrade to a dedicated lane if and as needed, based on operational experience. ~~-~~Similarly, such lanes could be protected for in new highway construction.

Exhibit 12AR

Alternative Hot Lane Slip Ramp Configurations

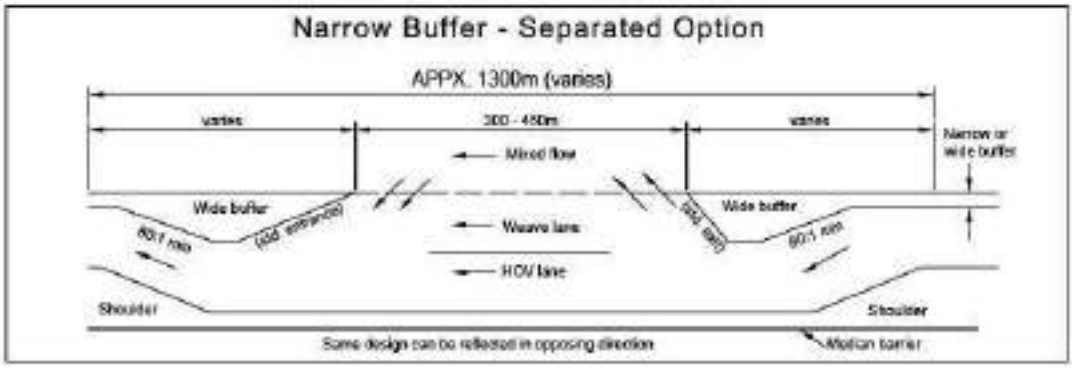
Source: FHWA "A Guide for Hot Lane Development"

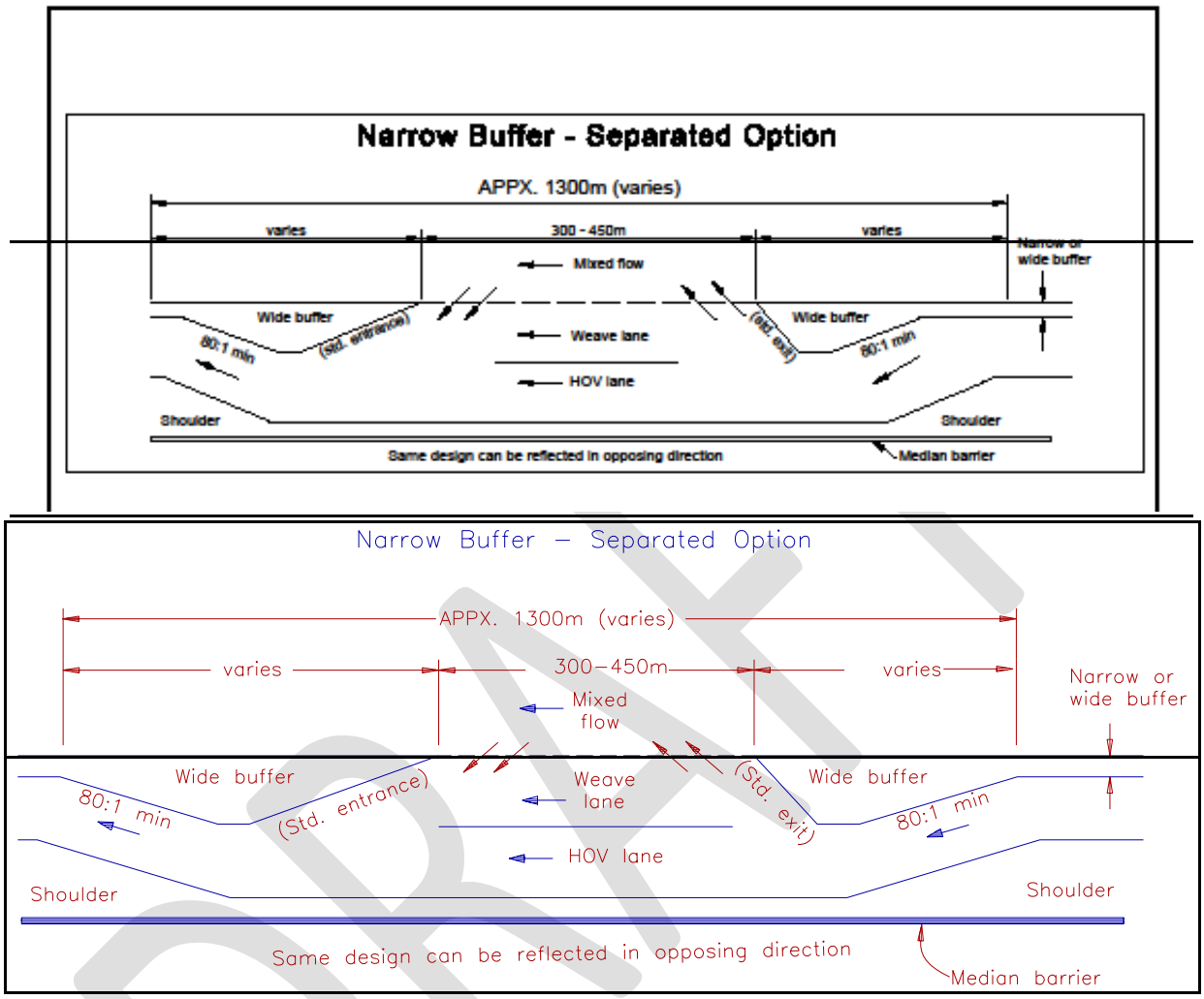


~~Figure 12.5.23 Alternative Hot Lane Slip Ramp Configurations~~

Exhibit 12AS

Dedicated Weaving Lane for Narrow Buffer-Separated HOV Lane Access ~~*Source: FHWA "A Guide for Hot Lane Development"*~~



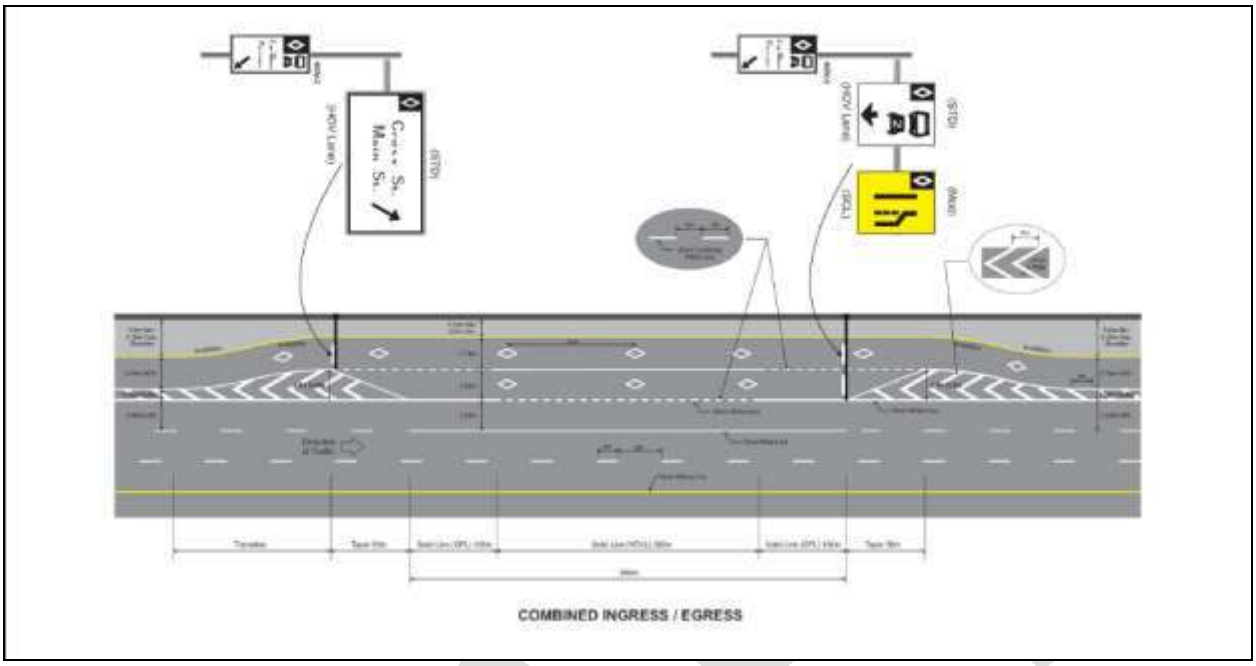


~~Figure 12.5.24 Dedicated Weaving Lane for Narrow Buffer-Separated HOV Lane Access~~

Exhibit 12AT

HOV Transfer Lane Application in Ontario Accommodating Access and Egress Movement Simultaneously

Source: Access / Egress Lanes for HOV Facilities, MTO Study "Dedicated at Grade Transfer Lanes for Freeway HOV Facilities", June 2009



~~**Figure 12.5.25 HOV Transfer Lane Application in Ontario Accommodating Access and Egress Movement Simultaneously**~~

~~*Source: Access / Egress Lanes for HOV Facilities, MTO Study "Dedicated at Grade Transfer Lanes for Freeway HOV Facilities", June 2009*~~

12.5.2.7.1.4 Designated Access Point

Exhibit 12AU~~**Figure 12.5.26**~~ illustrates that access to a barrier separated HOV lane is best provided by designated access points rather than by weaving zones along its length (since the latter inherently involve elimination of the barrier for several hundred metres).~~-~~ A designated access point therefore tends to be at the end of an HOV lane or at a key point such as a freeway-to-freeway interchange. ~~-~~Such a design is ~~usually~~ typically site-specific; typical layouts are shown on **Exhibit 12AU**~~**Figure 12.5.26**~~.

Key issues are signage, safety (the introduction of a barrier between two concurrent flow lanes is a concern), and enforcement (a pull-over shoulder, with the ability to return ineligible vehicles to mixed flow traffic and it should be located downstream of the entry point).

12.5.2.7.2 At-~~-~~Grade Right Side HOV Lane

The provision of access and egress for right side HOV lanes is relatively simple, yet complex operational issues arise and potentially unacceptable in their impact.~~-~~ The issues are mainly a result of the need for mixed flow vehicles entering or exiting the freeway at interchanges to cross the HOV lane to/from right side ramps.
While there are several ways of resolving the resultant weaving conflict, the costs and impacts involved may negate whatever gains the HOV lane is intended to provide.

Examples of such measures include:

- ~~·~~ Ggrade separation with entry ramps:~~-~~ high cost and conflict with short term / temporary right-side opportunities~~;~~
- ~~·~~ cConsolidation of entry ramps (e.g. merging loop and direct on ramps to a single freeway entry point): focuses traffic to create an even more severe weaving condition~~;~~
- ~~·~~ Rramp metering: must occur corridor-wide and has minimal impact on hourly volume~~;~~
- ~~·~~ Rrestriction of HOV lane usage (by raising minimum occupancy rates, bus-only designation, etc.): ~~-~~conflicts with goal of moving more people more conveniently and with minimum acceptable lane usage criteria~~; or~~
- ~~·~~ Pprovision of adequate specialized merge / weave area:~~-~~ potential physical impact on interchange, structure, and area~~.~~

Due to these concerns, right lane application to date has been restricted to areas where there are no such conflicts, to low-volume Reserved Bus Lanes, or to locations where both HOV lane and interchange ramp volumes are relatively low.

A design which provides for the weaving of entering or exiting traffic across HOV lane is shown in **Exhibit 12AV**~~Figure 12.5.27~~, based on the layout of a typical urban Parclo "A" type interchange in Ontario. ~~-~~Basic signage, lane lengths, and lane marking concepts are shown; development of more detailed design standards is required.

In some cases, a right side HOV lane can still be effective if it does not pass through an interchange.~~-~~ A bus-only lane used by buses exiting and re-entering freeway at each

interchange via a transit interface or by buses traveling only between interchanges, can provide a queue-jump time saving.~~-~~ Such a lane would physically appear little different from an auxiliary lane or paved shoulder, with exception of a solid paint lane line, a buffer zone and special signage. Access / egress would occur on the interchange ramps, as shown in **Exhibit 12AW**~~Figure 12.5.28~~.

12.5.2.7.3 Spacing Between Access / Egress Zones

For facilities that do not provide continuous access, defined access points are provided at regular intervals or logical locations; restricted-access points are not intended to serve every general-purpose entrance and exit ramp. ~~-~~The spacing between access openings on existing facilities, has a design domain between **1.6 km to 4.8 km** (1 and 3 mi). ~~-~~The reasons for providing access of a particular type or in a specific location vary, ranging from policy decisions to safety or operational considerations. ~~-~~Each agency determined which factors were most important to a given facility, and the factors chosen varied from one facility to another. ~~-~~Similar considerations of applicable policies and safety or performance goals must be made when planning for new or revised access points.

12.5.2.7.4 Grade Separated Access

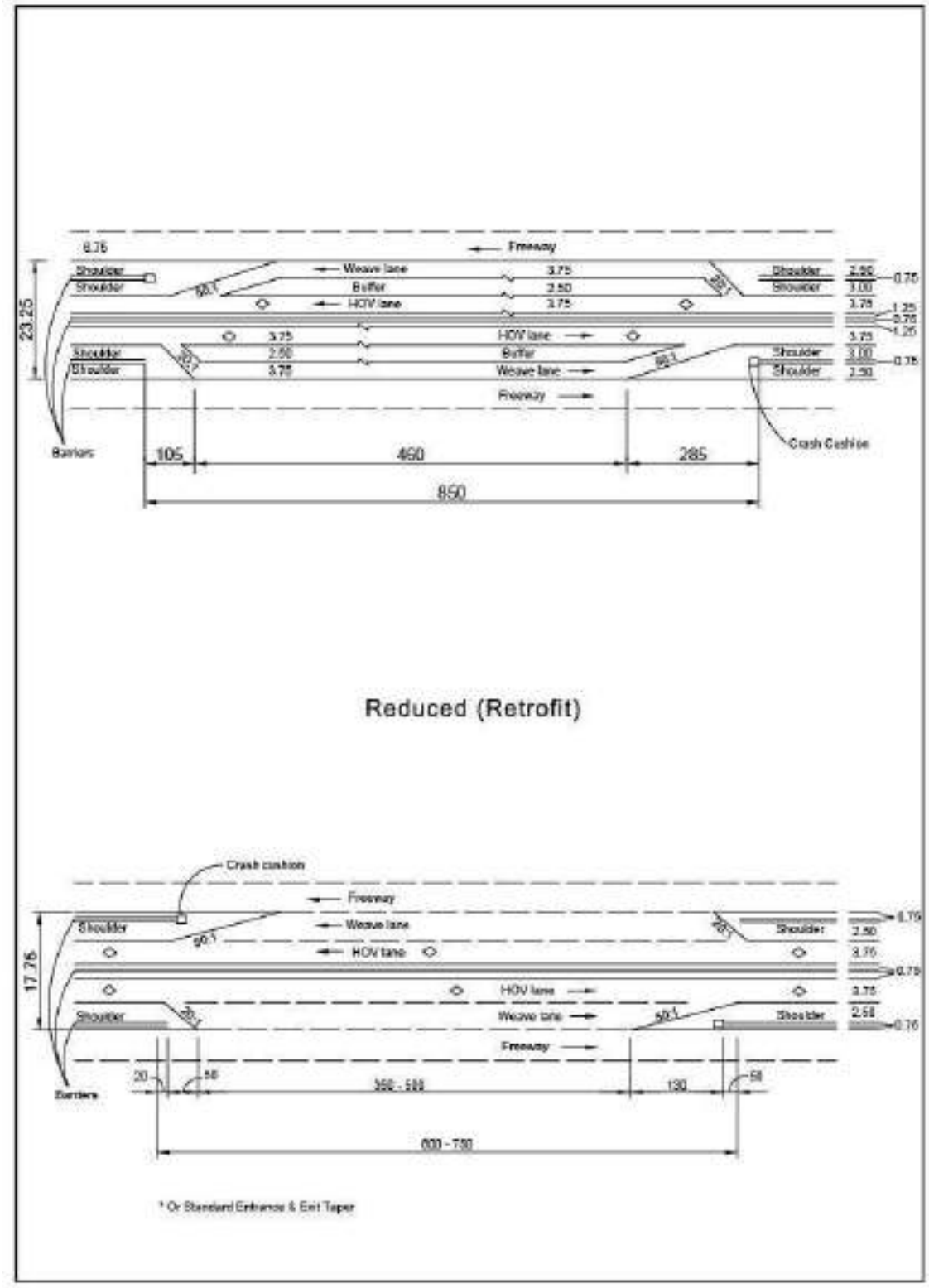
As described in **Section 12.5.2.7.1,** reliance on at-grade access for median HOV lanes yields several operational issues and may place constraints on effectiveness and attractiveness of HOV lanes.~~-~~ Furthermore, in some locations of high demand, the freeway / interchange configuration, or physical constraints may virtually preclude use of at-grade measures.

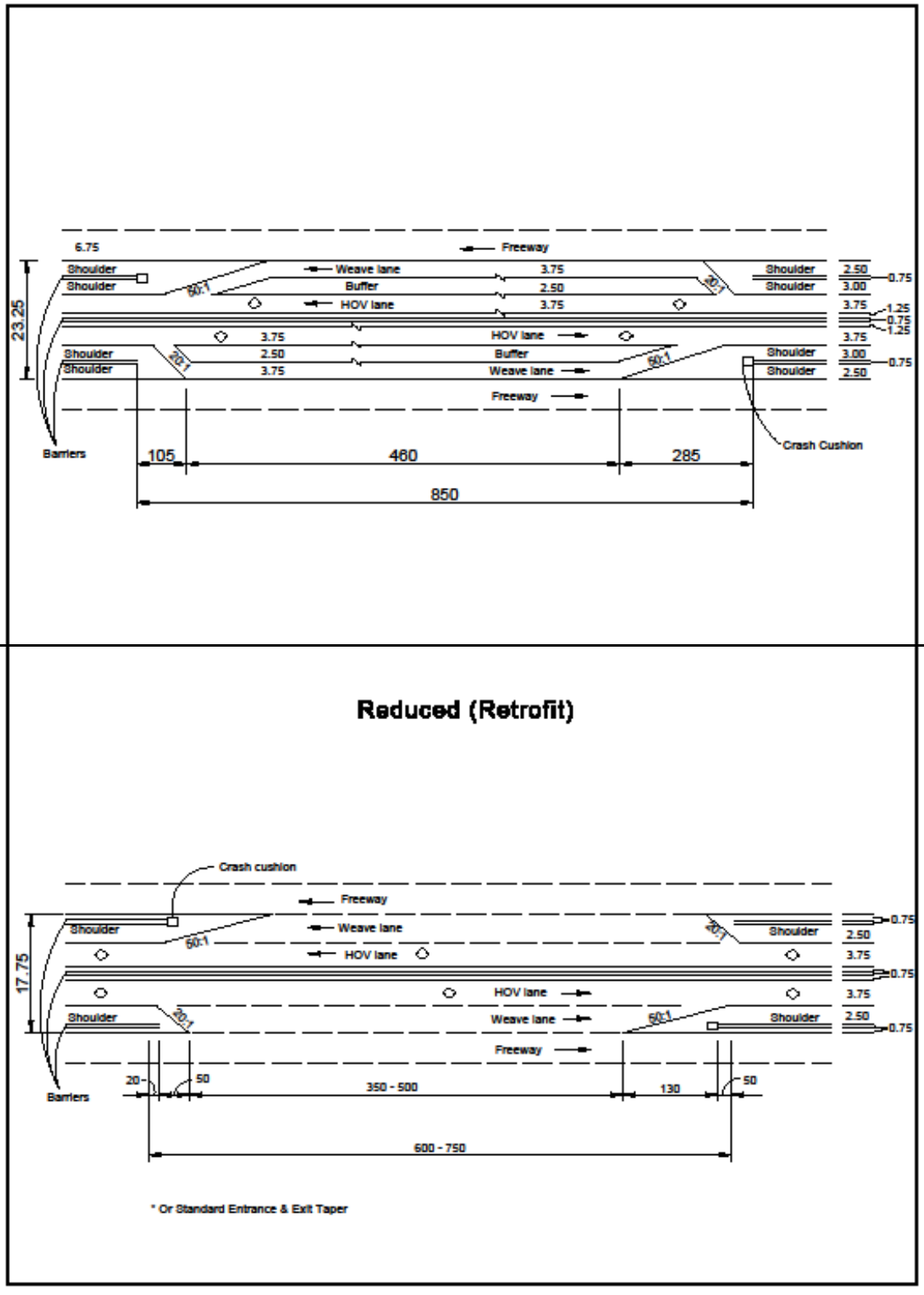
If grade separated access / egress provisions can be well-located, physically feasible, and cost-effective with respect to the demands, they can provide many benefits: high capacity, good level of service, safety, control of traffic flow, time savings / HOV priority, elimination of need for at-grade weaving zones / lanes, enforceability and visible HOV priority, with marketing / public impression benefits.

Grade separated access ramps take two basic forms:~~-~~ "drop ramps" from crossing roadways, and "Tee ramps" serving adjacent off-line nodes.~~-~~ Other unique configurations may occur at freeway-to-freeway interchanges; as shown in **Exhibit 12BH**~~Figures 12.5.39~~, ~~**12.5.40**~~**Exhibit 12BI** and ~~**12.5.41**~~**Exhibit 12BJ**.

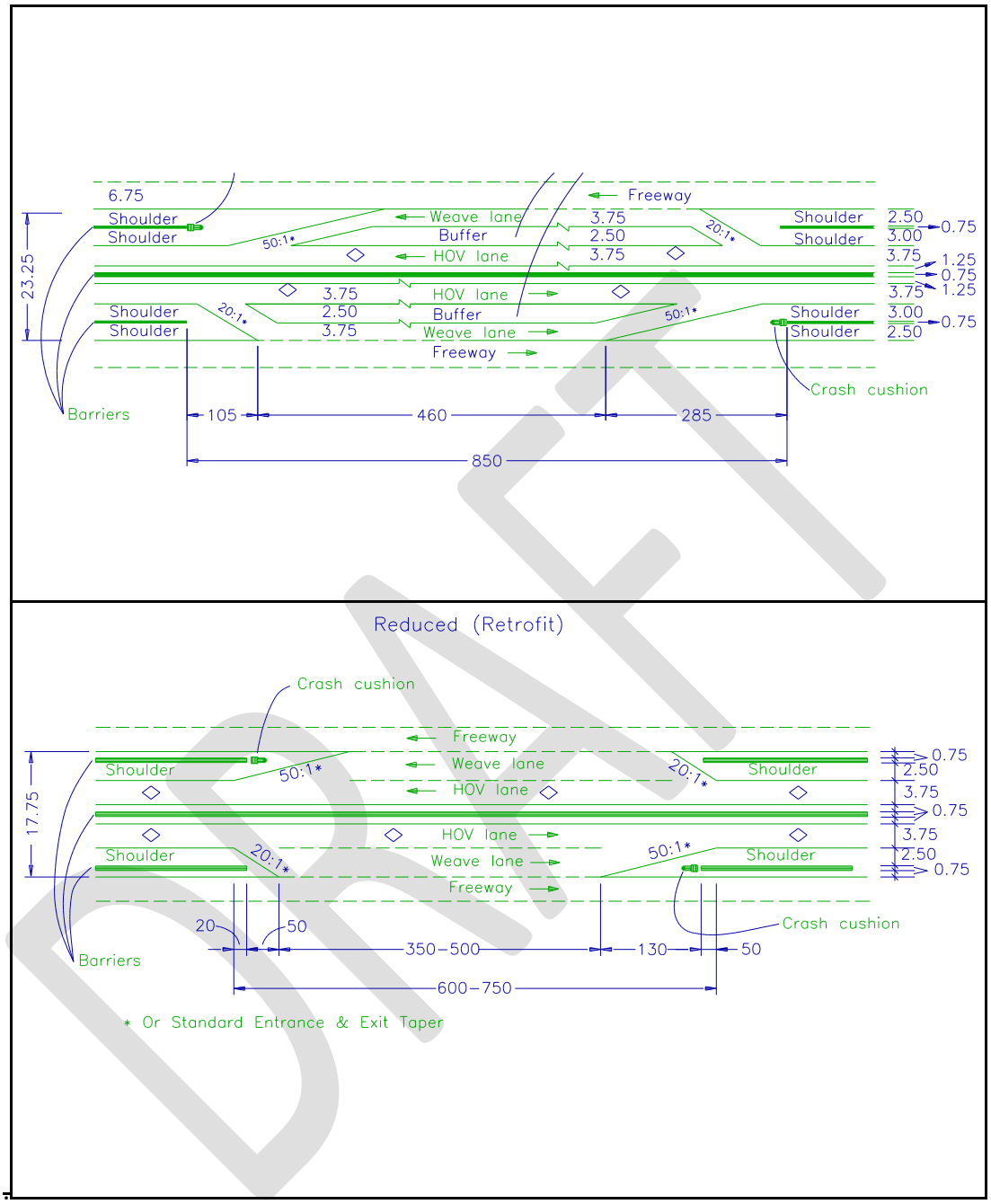
Exhibit 12AU

Dedicated Weaving Lane for Barrier-Separated HOV Access


Freeway
Shoulder
Weave lane
Buffer
HOV lane
Barrier
Crash Cushion
105
490
285
850
23.25
Reduced (Retrofit)
Crash cushion
17.75
20
58
350 - 500
130
600 - 750
* Or Standard Entrance & Exit Taper



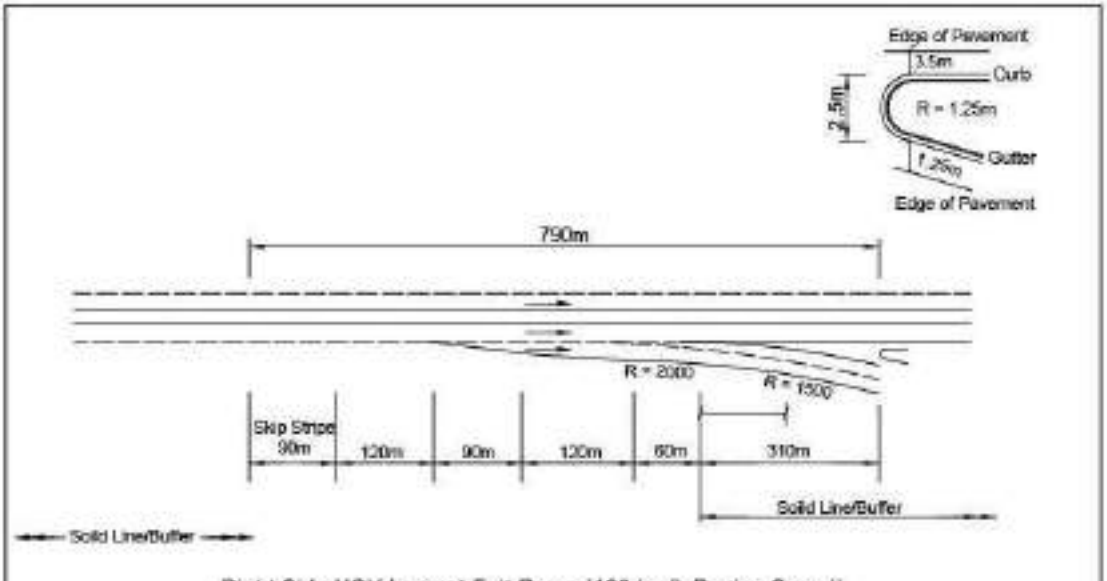
Reduced (Retrofit)



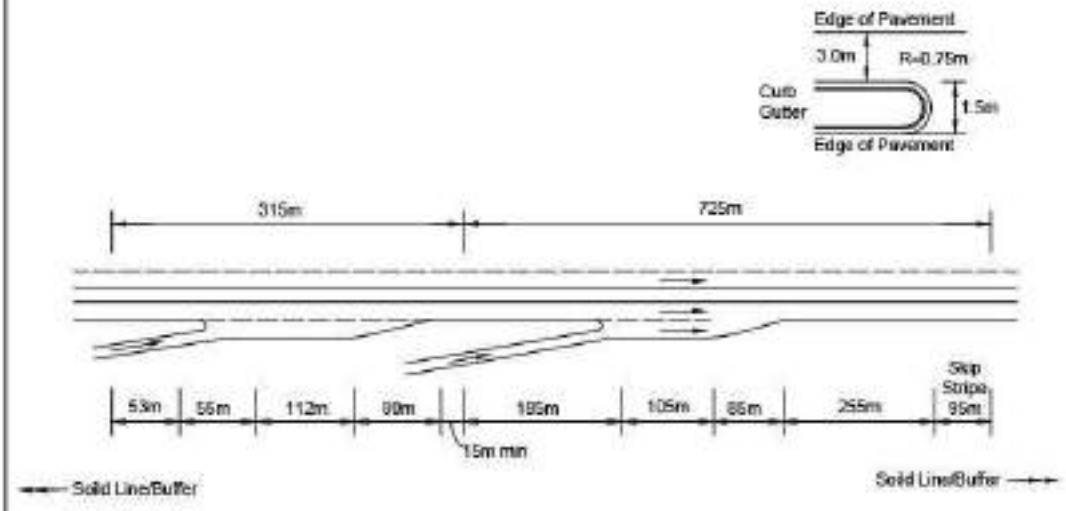
~~Figure 12.5.26 Dedicated Weaving Lane for Barrier Separated HOV Access~~

Exhibit 12AV

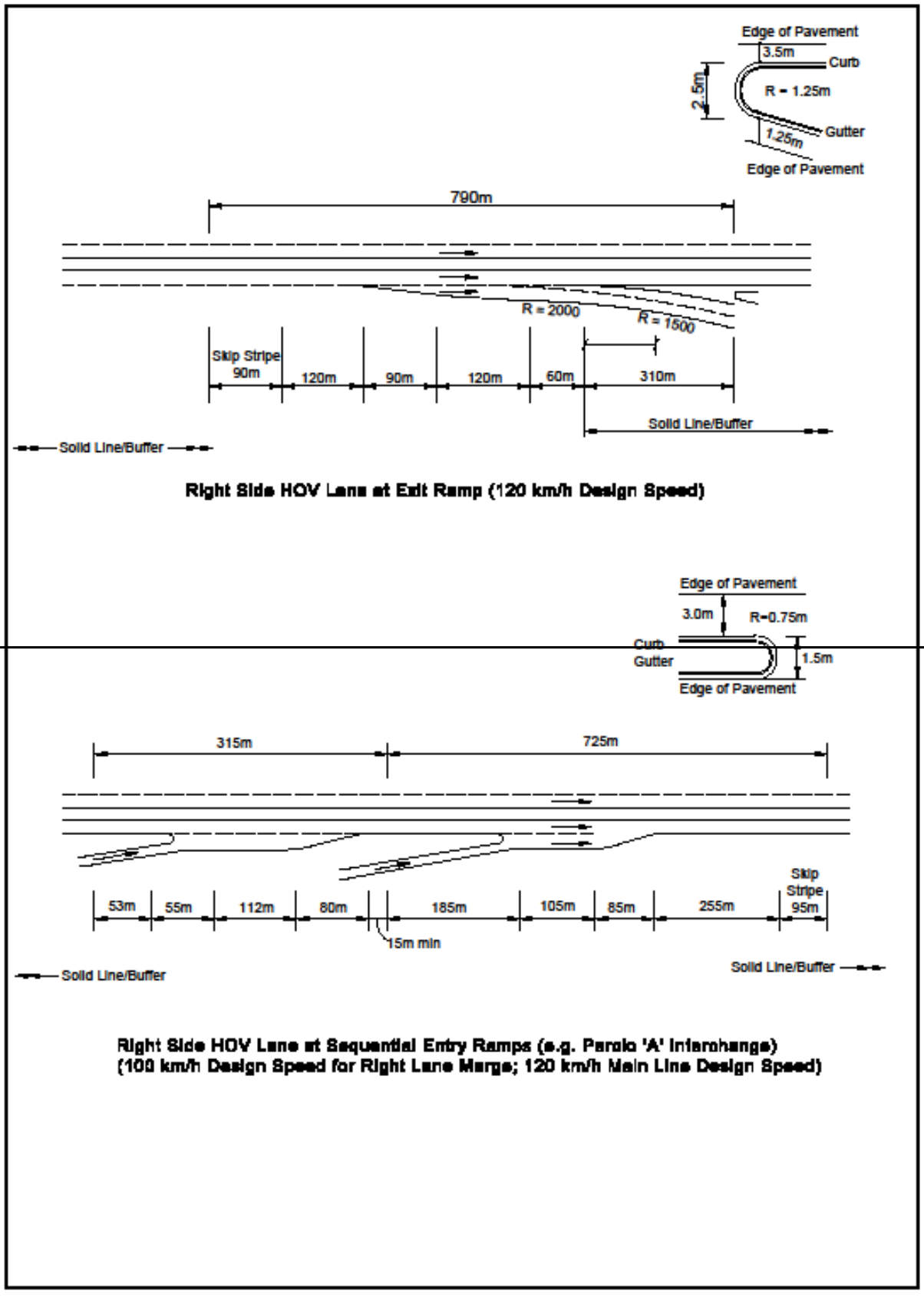
Right Side HOV Lane Through Treatment at Interchange Ramps



Right Side HOV Lane at Exit Ramp (120 km/h Design Speed)

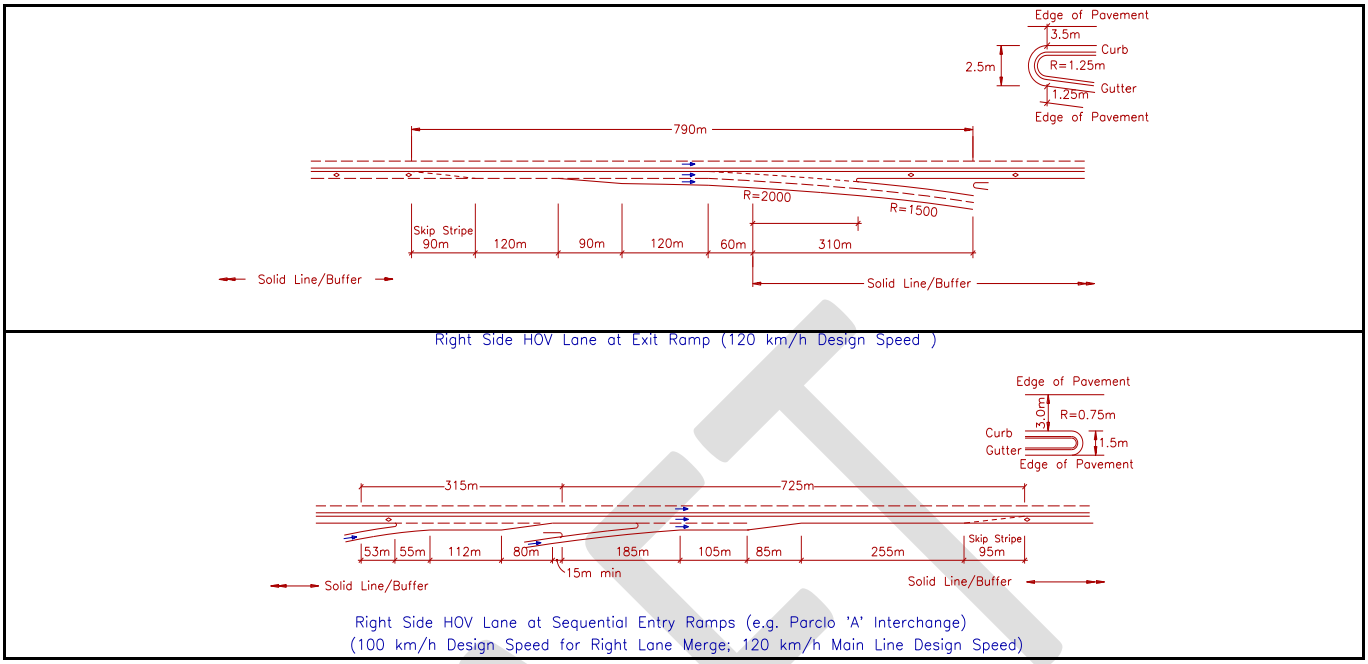


Right Side HOV Lane at Sequential Entry Ramps (e.g. Parclo 'A' Interchange)
(100 km/h Design Speed for Right Lane Merge; 120 km/h Main Line Design Speed)



Right Side HOV Lane at Exit Ramp (120 km/h Design Speed)

Right Side HOV Lane at Sequential Entry Ramps (e.g. Parclo 'A' Interchange)
(100 km/h Design Speed for Right Lane Merge; 120 km/h Main Line Design Speed)



~~Figure 12.5.27 Right Side HOV Lane Through Treatment at Interchange Ramps~~

12.5.2.7.4.1 Direct Ramp from Crossing Road

Direct access ramps improve safety, reduce congestion, save time, and increase travel time reliability for both HOVs and general-purpose freeway traffic. High occupancy vehicles can have a hard time merging left through general purpose lanes to gain access to an HOV lane during congested periods, creating a safety problem for all freeway users. When buses, particularly long ones, attempt this merge, they may cause congestion in the lanes they pass through for quite a distance back.

A direct ramp may be two-way, one-way or reversible, and may feed either a buffer separated, or barrier separated median HOV lane. As with any HOV infrastructure investment, operational decisions must be made prior to considering a direct ramp. If HOV lane is only to operate during peak periods, or if it is a "test case" which may be abandoned after a trial period, direct ramps should not be provided as the cost of constructing direct access ramps is substantial because they require separate structures above or below the freeway.

Exhibit 12AX~~**Figure 12.5.29**~~ illustrates a general design outline for a two-way ramp; **Exhibit 12AY**~~Figures 12.5.30~~, ~~**12.5.31**~~**Exhibit 12AZ**, ~~**12.5.32**~~**Exhibit 12AB** and ~~**12.5.33**~~**Exhibit 12BB** show typical cross-sections for various median widths ranging from "optimum" to "minimum", for

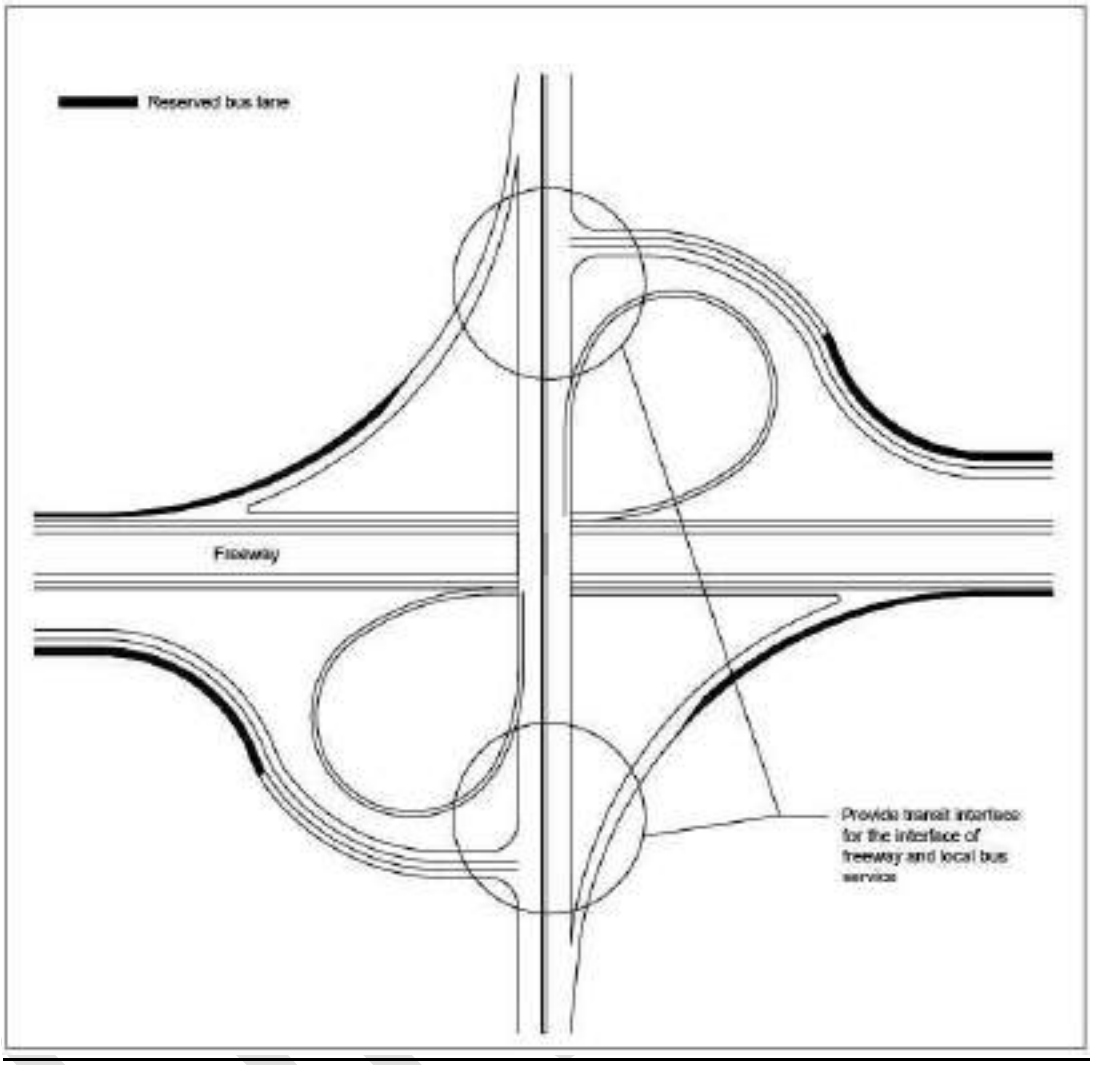
two-way and single lane (reversible) ramps respectively.~~-~~ Also, **Exhibit 12BC**~~**Figure 12.5.34**~~ provides examples of direct ramp applications.

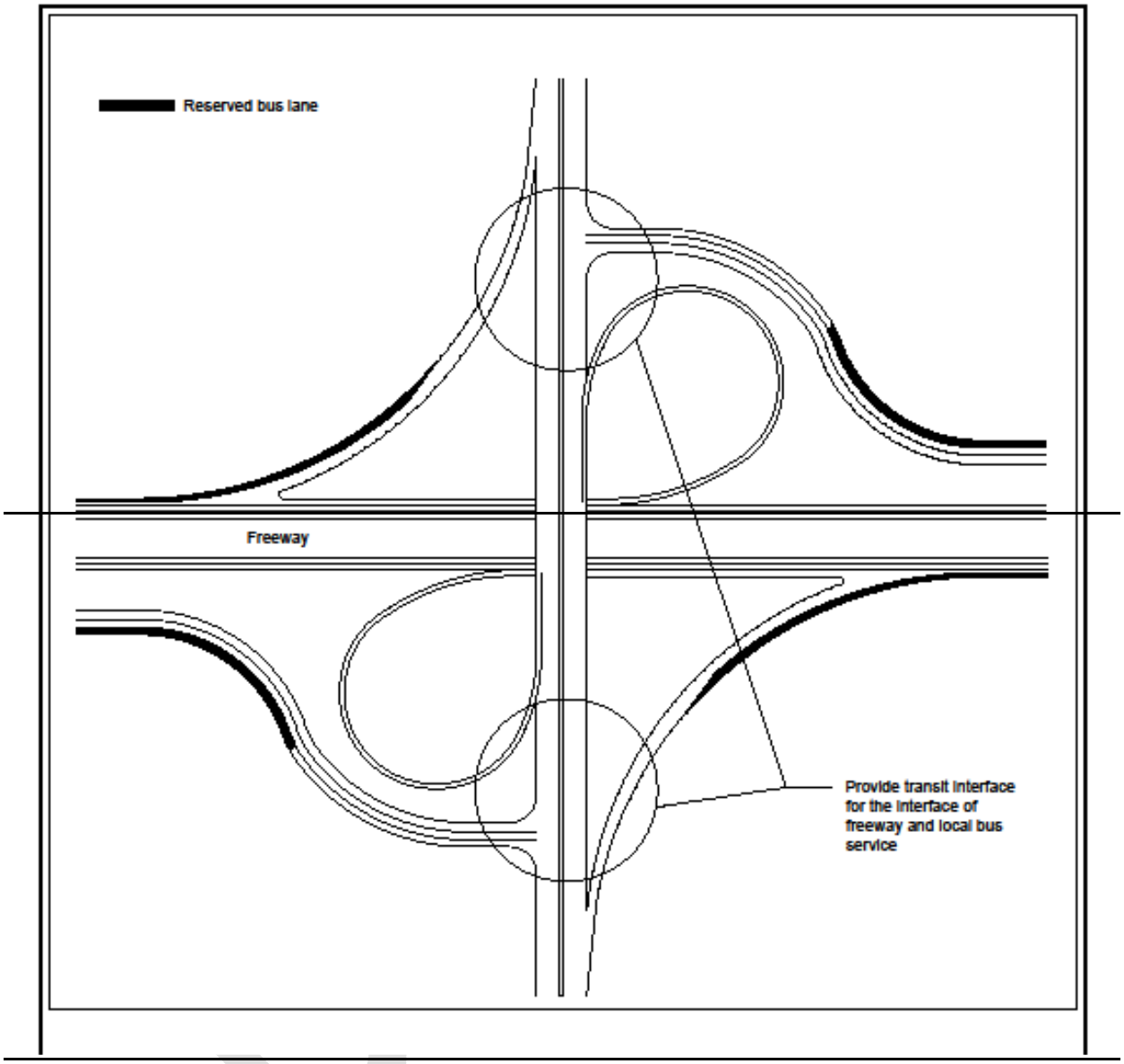
A key issue in consideration of a direct ramp is whether the crossing roadway already has an interchange with the freeway.~~-~~ In many retrofit situations, the provision of a direct ramp may not be desirable, but it could be essential, or it may be the best of the available alternatives. **Exhibit 12BD**~~Figures 12.5.35~~, ~~**12.5.36**~~**Exhibit 12BE** and ~~**12.5.37**~~**Exhibit 12BF** outline the implications and configurations of several design situations, using interchange layouts typically found in Ontario.

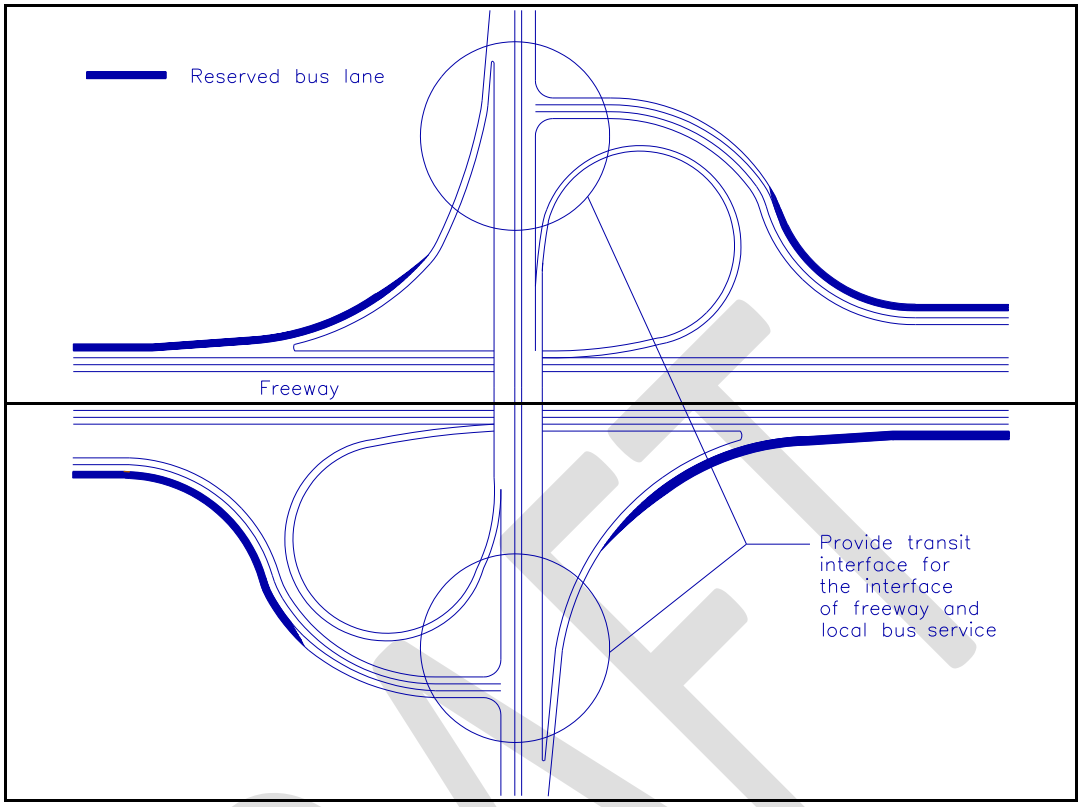
Several structural issues may be posed by introduction of a new mid-span connection; rather than raising the direct ramp on a structure per se, it would generally be preferable to provide a walled ramp of earth fill, thereby reducing costs and structural complexity at the ramp's upper end. ~~-~~Another important factor is the ability, at an existing structure, to widen the freeway to allow new median lanes (two ramp lanes, two main line HOV lanes, and associated shoulders) while maintaining pre-existing number of lanes through the available span opening.

For these reasons, it is often preferable to introduce direct HOV ramps only at either a new / future crossing road or at an existing structure with an adequate span and no other interchange ramps. ~~-~~In such case, an integrated design, or at least protection for a later introduction of a direct ramp (through adequate deck width for mid-span turning lanes, etc.) would yield benefits.

Exhibit 12AW
Right Side HOV Lane Access/Egress at Interchange Ramps


Reserved bus lane
Freeway
Provide transit interface for the interface of freeway and local bus service

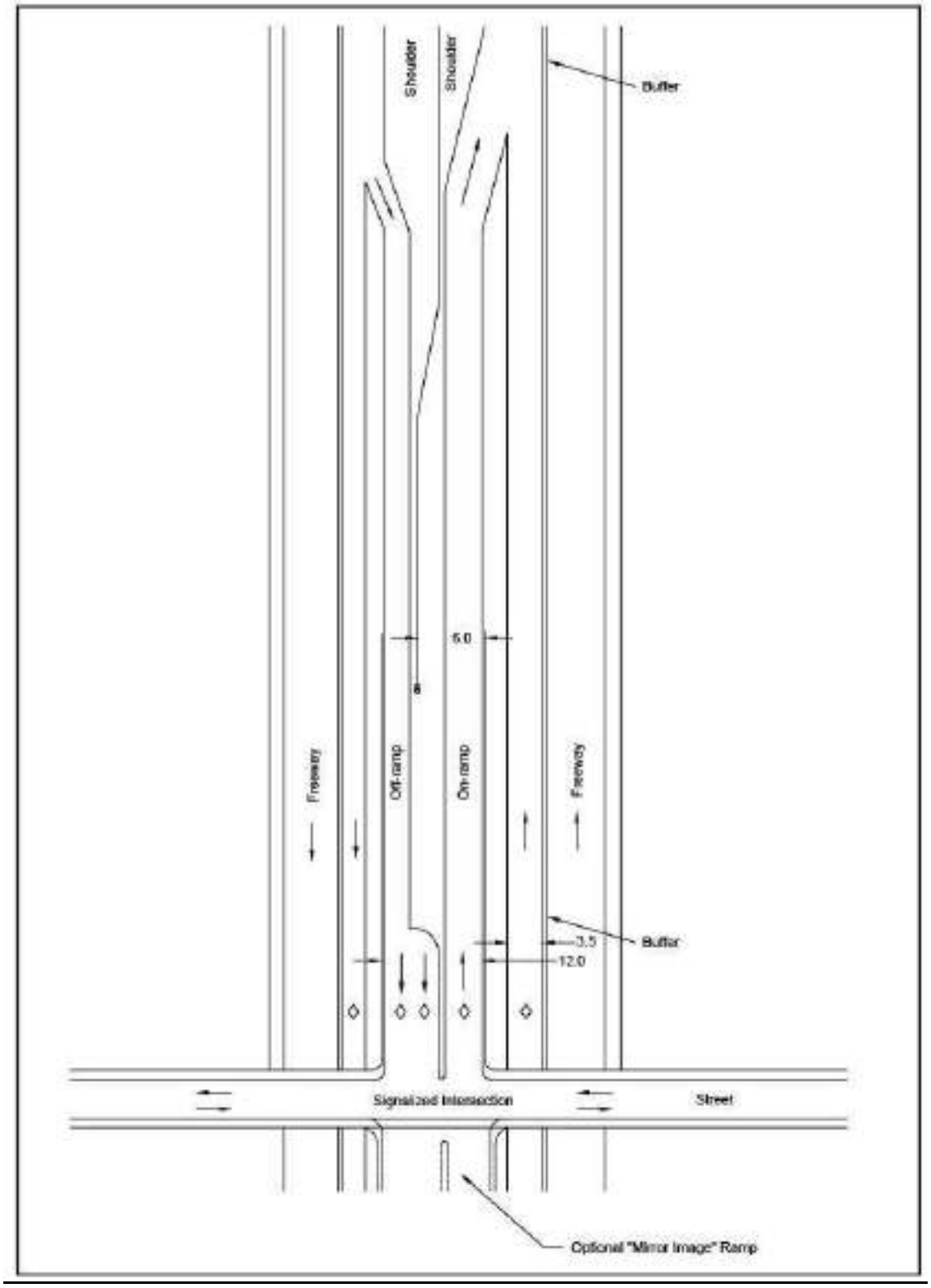

Reserved bus lane
Freeway
Provide transit interface for the interface of freeway and local bus service

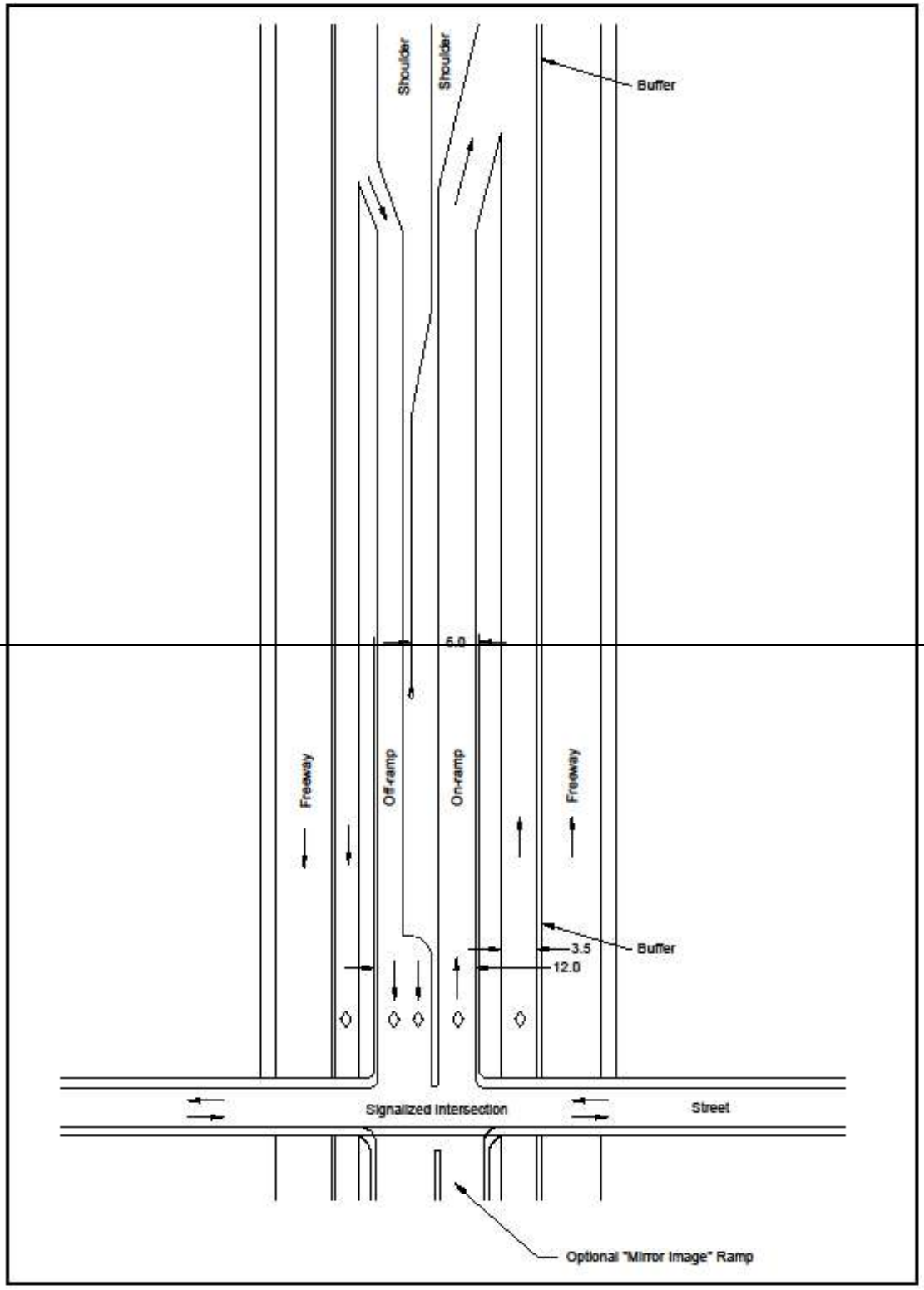


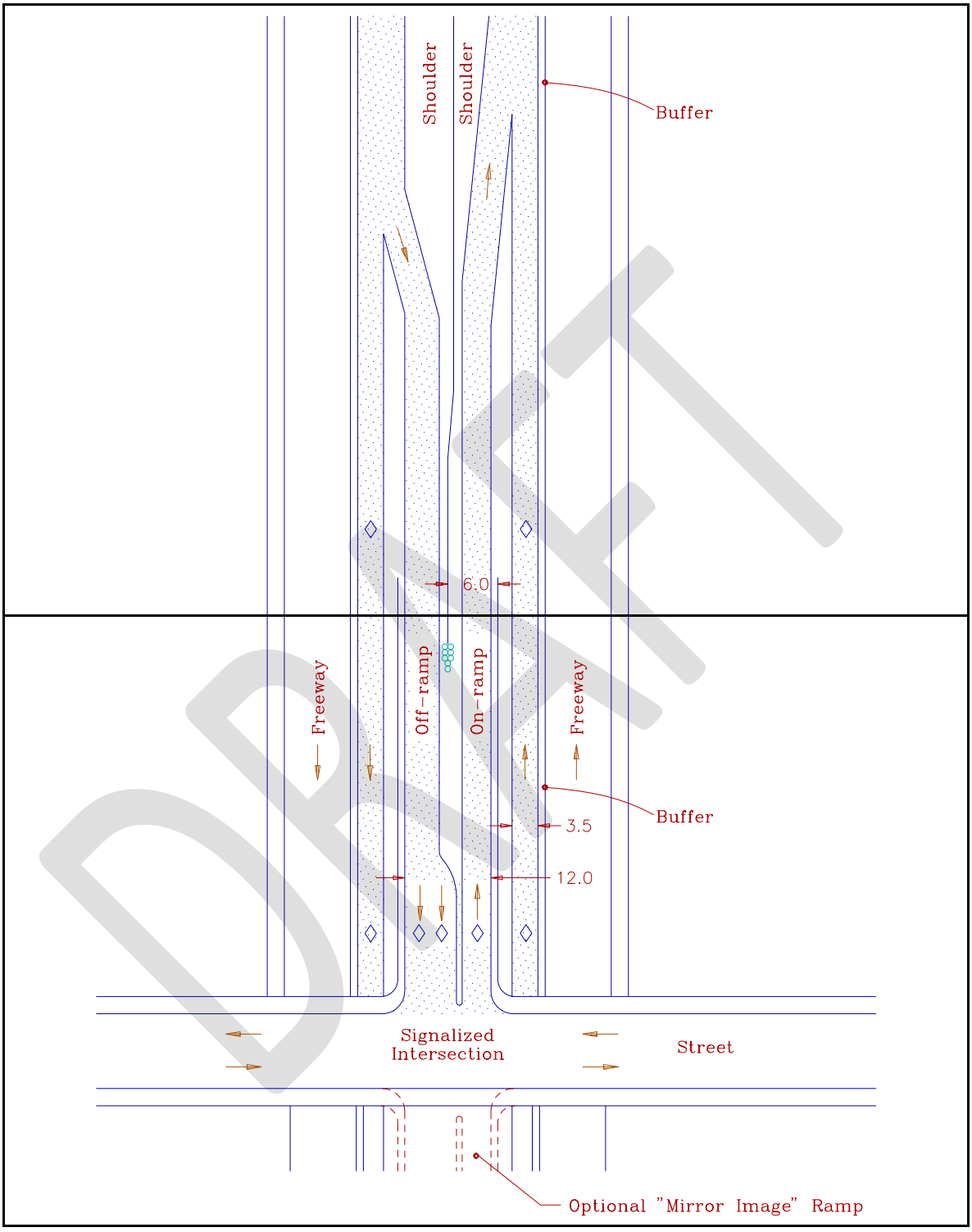
~~**Figure 12.5.28 Right Side HOV Lane Access/Egress at Interchange Ramps**~~

Exhibit 12AX

Two-Way Median Ramp for a Buffer-Separated HOV Facility


Shoulder
Shoulder
Buffer
6.0
a
Freeway
Off-ramp
On-ramp
Freeway
Buffer
3.5
12.0
Signalized Intersection
Street
Optional "Mirror Image" Ramp

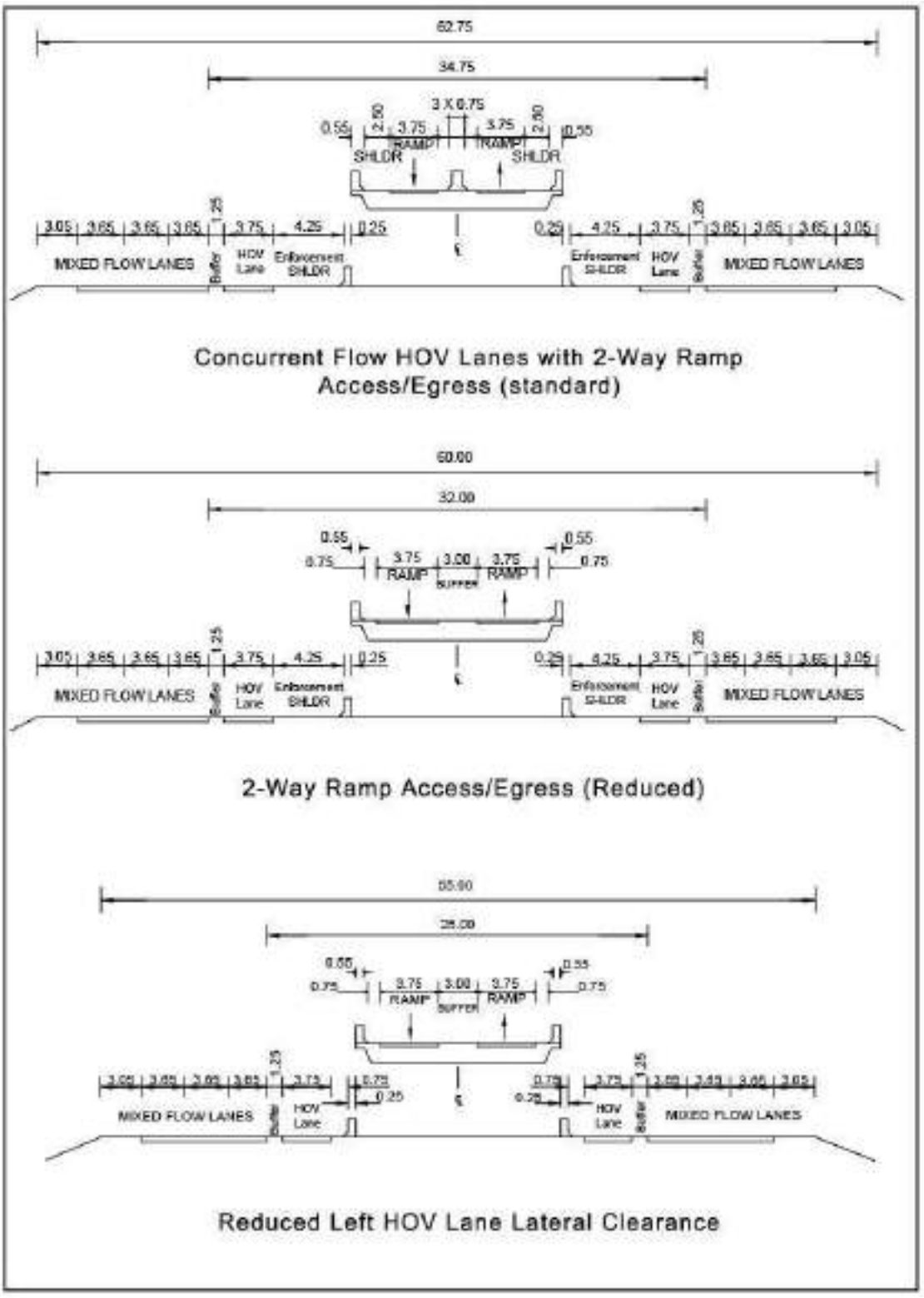

Shoulder
Shoulder
Buffer
6.0
Freeway
Off-ramp
On-ramp
Freeway
Buffer
3.5
12.0
Signalized Intersection
Street
Optional "Mirror Image" Ramp

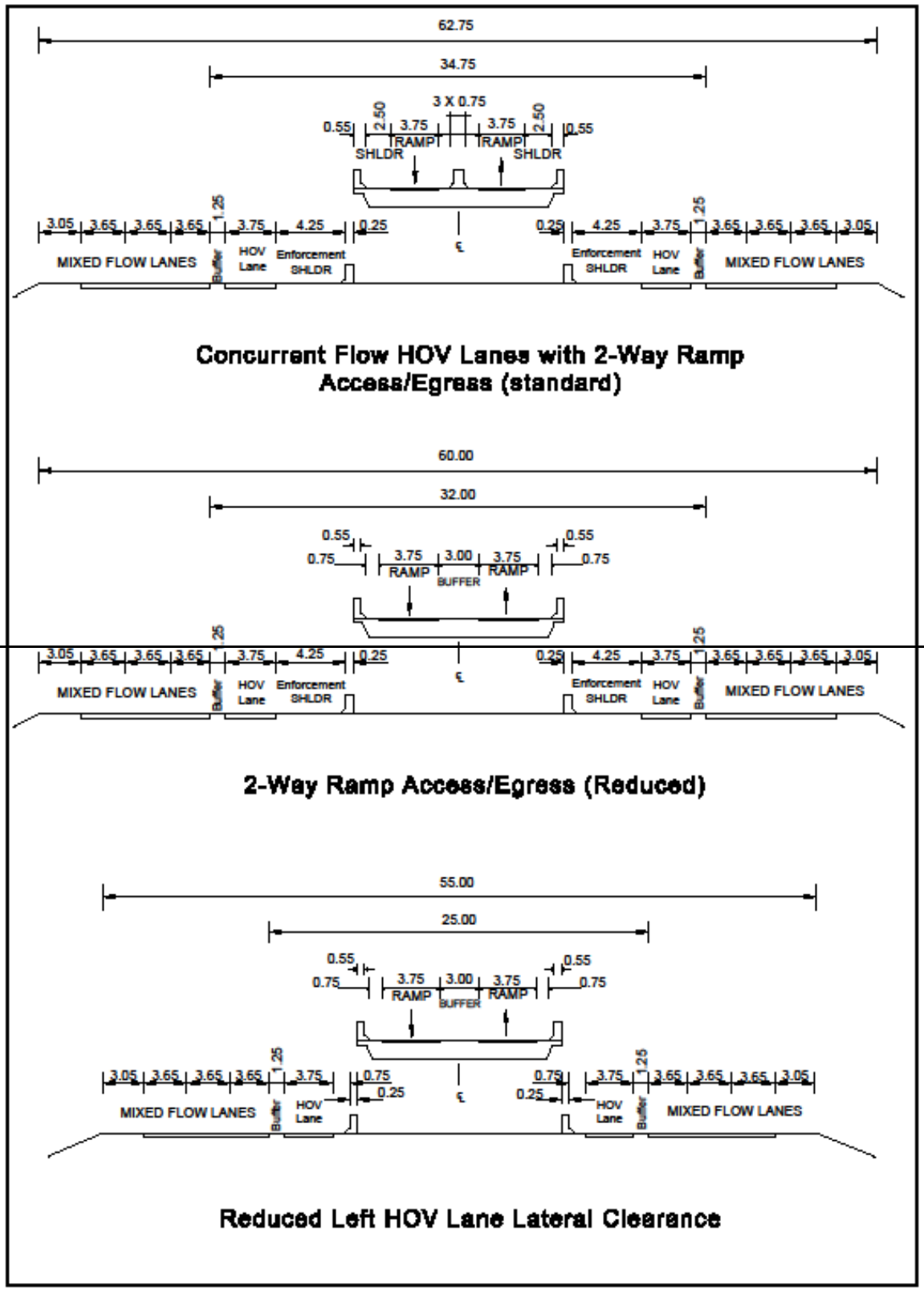


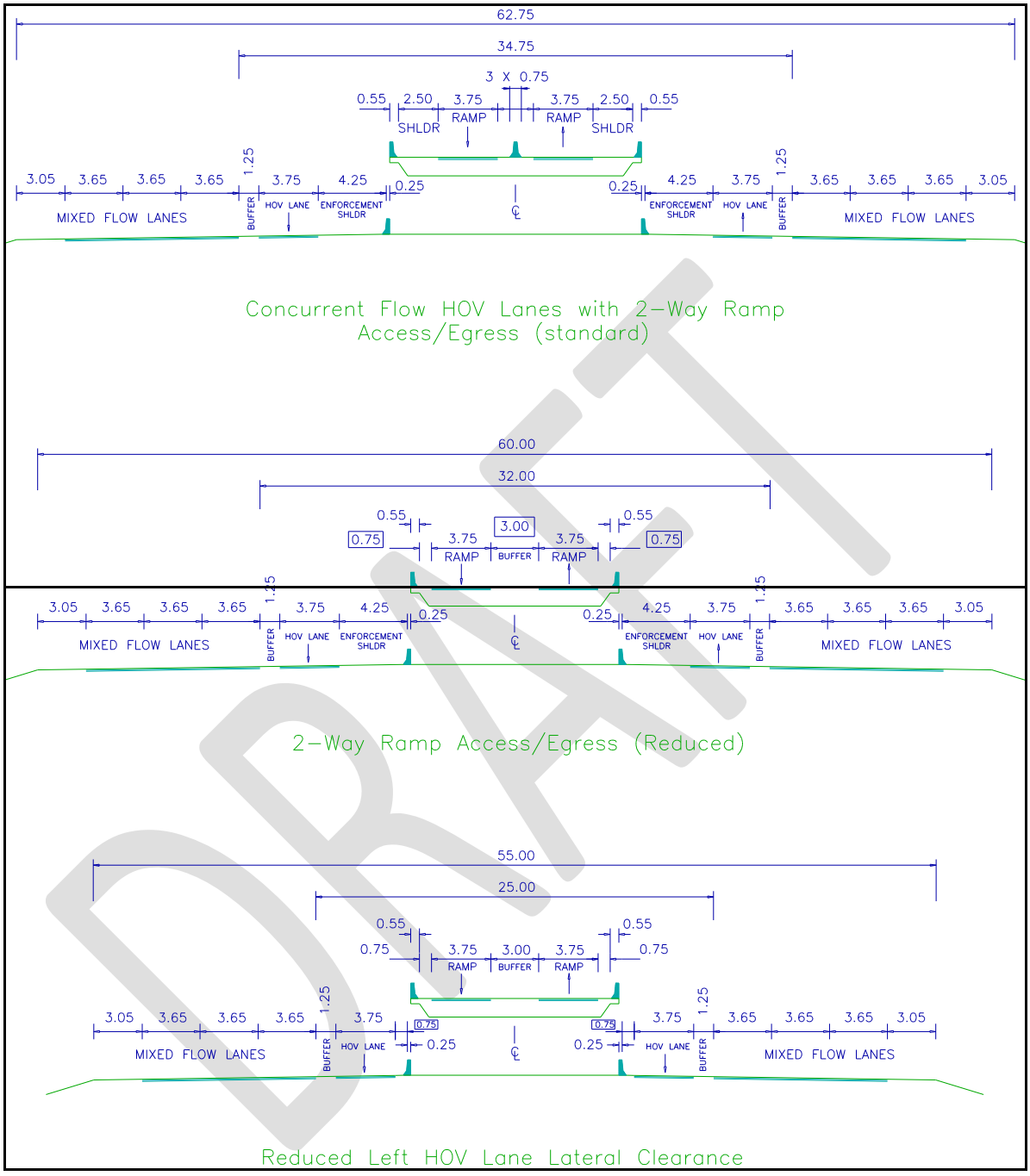
~~Figure 12.5.29 Two-Way Median Ramp for a Buffer-Separated HOV Facility~~

Exhibit 12AY

Median HOV Two-Way Ramp Cross-Sections

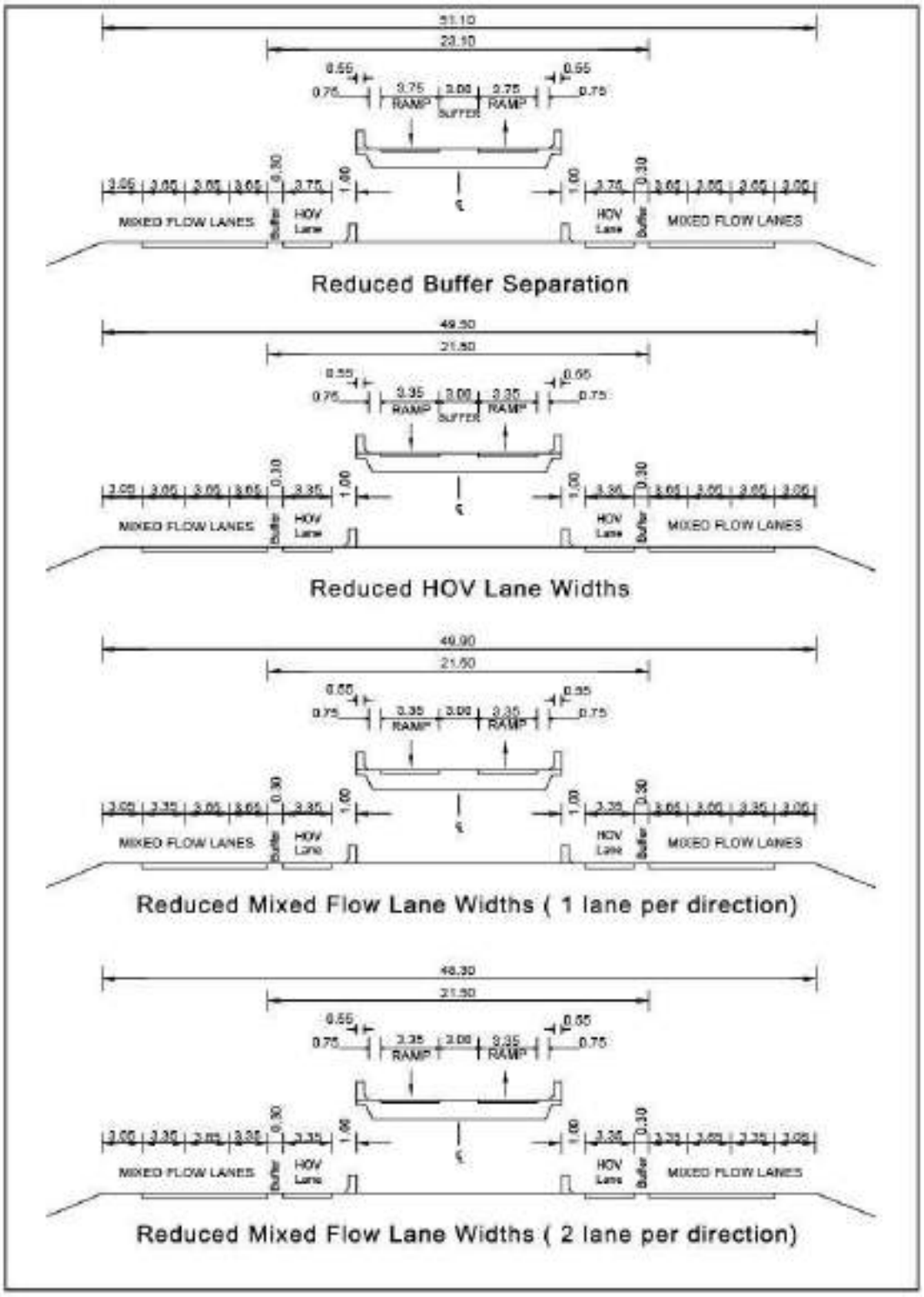


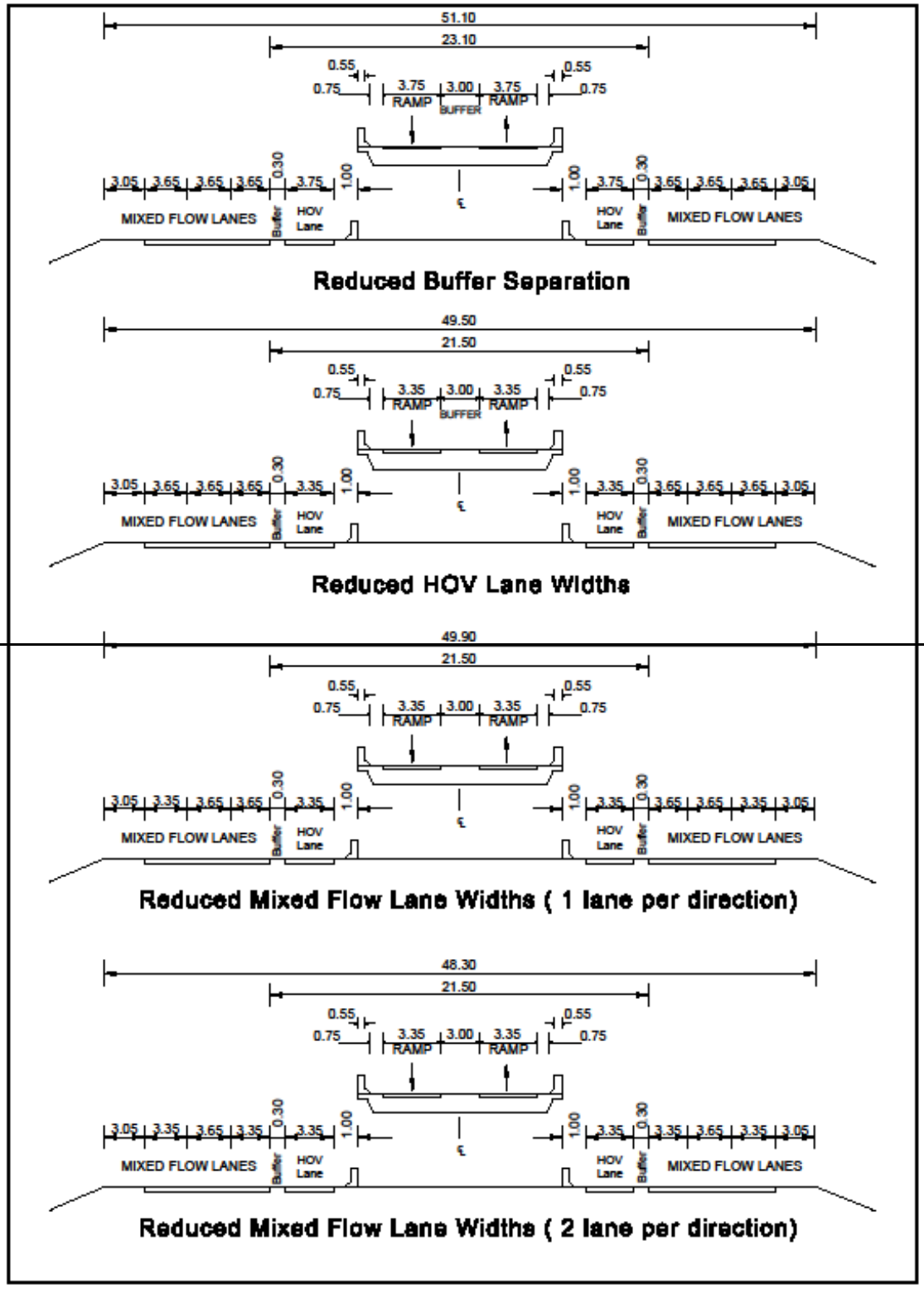

62.75
34.75
3 X 0.75
0.55
2.50
3.75
RAMP
3.75
RAMP
2.50
0.55
SHLDR
SHLDR
3.05
3.65
3.65
3.65
1.25
3.75
4.25
0.25
0.25
4.25
3.75
1.25
3.65
3.65
3.65
3.05
MIXED FLOW LANES
Buffer
HOV Lane
Enforcement SHLDR
℄
Enforcement SHLDR
HOV Lane
Buffer
MIXED FLOW LANES
Concurrent Flow HOV Lanes with 2-Way Ramp Access/Egress (standard)
60.00
32.00
0.55
0.75
3.75
RAMP
3.00
BUFFER
3.75
RAMP
0.55
0.75
2-Way Ramp Access/Egress (Reduced)
55.00
25.00
Reduced Left HOV Lane Lateral Clearance

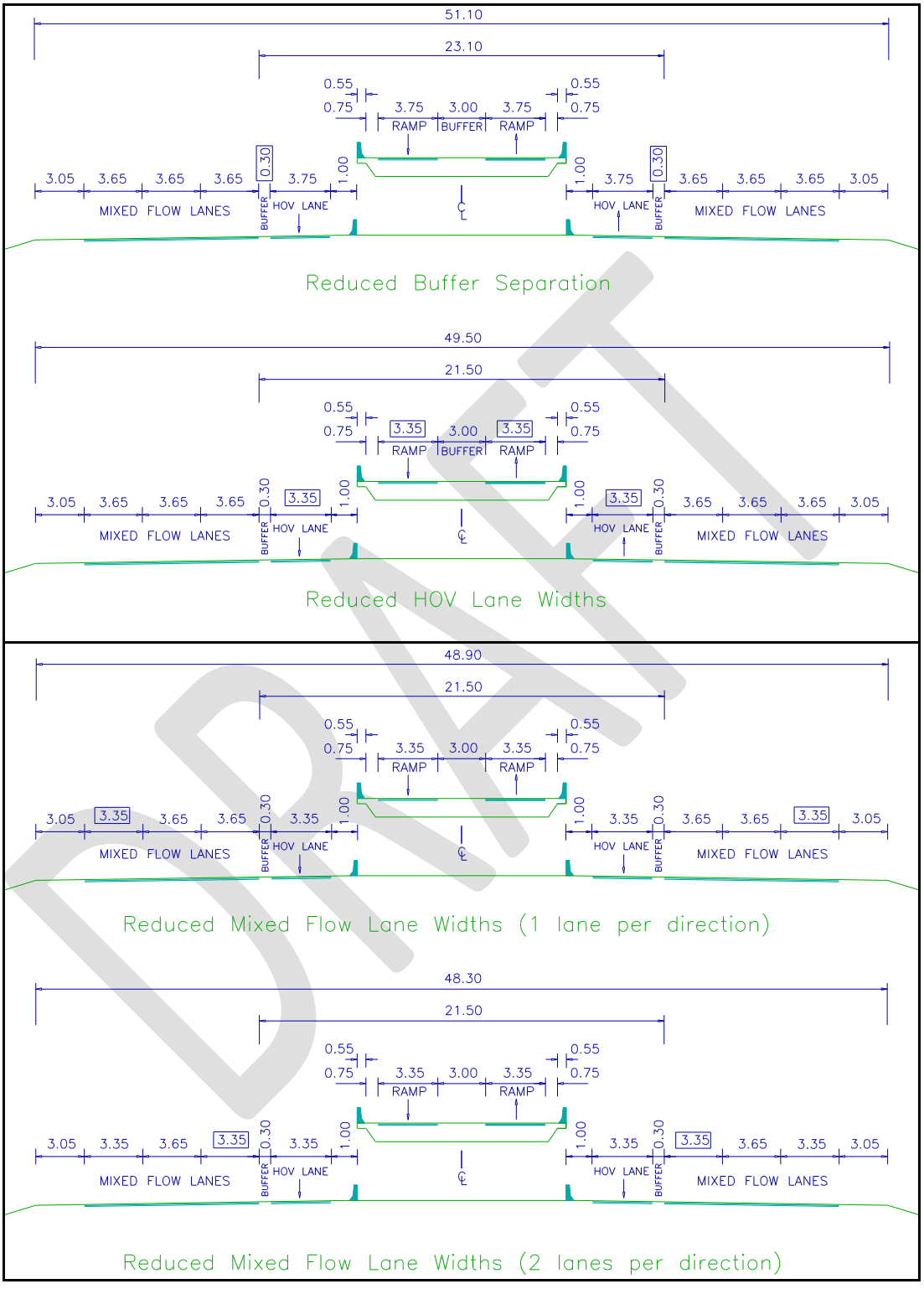


~~Figure 12.5.30 Median HOV Two-Way Ramp Cross-Sections~~

Exhibit 12AZ
Median HOV Two-Way Ramp Cross-Sections


51.10
23.10
0.55
0.75
3.75
RAMP
3.00
Buffer
3.75
RAMP
0.55
0.75
3.05
3.05
3.05
3.05
0.30
3.75
1.00
1.00
3.75
0.30
3.05
3.05
3.05
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced Buffer Separation
49.30
21.50
0.55
0.75
3.35
RAMP
3.00
Buffer
3.35
RAMP
0.55
0.75
3.05
3.05
3.05
3.05
0.30
3.35
1.00
1.00
3.35
0.30
3.05
3.05
3.05
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced HOV Lane Widths
49.90
21.50
0.55
0.75
3.35
RAMP
3.00
3.35
RAMP
0.55
0.75
3.05
3.35
3.05
3.05
0.30
3.35
1.00
1.00
3.35
0.30
3.05
3.05
3.35
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced Mixed Flow Lane Widths (1 lane per direction)
49.30
21.50
0.55
0.75
3.35
RAMP
3.00
3.35
RAMP
0.55
0.75
3.05
3.35
3.05
3.05
0.30
3.35
1.00
1.00
3.35
0.30
3.05
3.35
3.05
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced Mixed Flow Lane Widths (2 lane per direction)

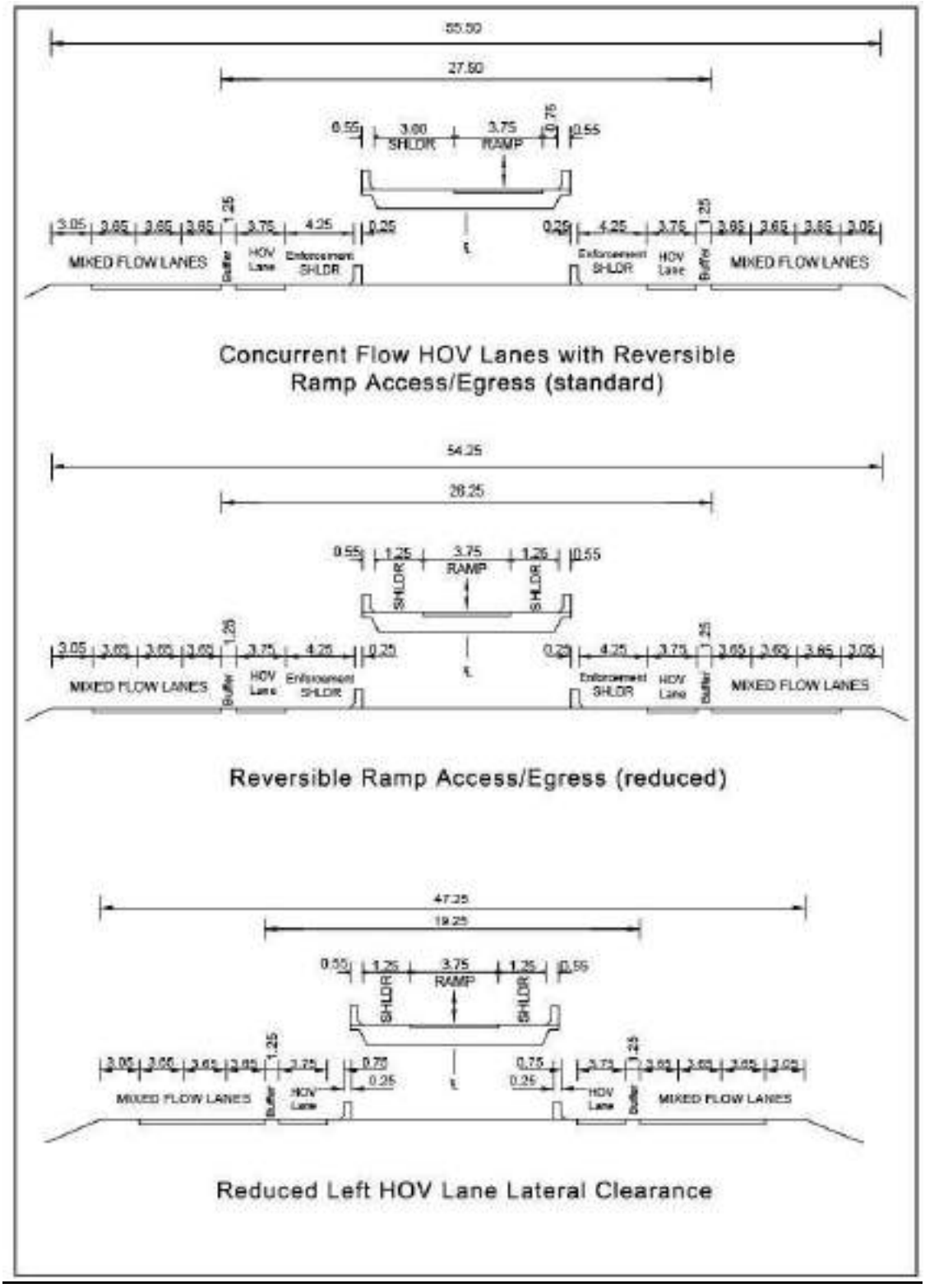

51.10
23.10
0.55
0.75
3.75
RAMP
3.00
BUFFER
3.75
RAMP
0.55
0.75
3.05
3.65
3.65
3.65
0.30
3.75
1.00
1.00
3.75
0.30
3.65
3.65
3.65
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced Buffer Separation
49.50
21.50
0.55
0.75
3.35
RAMP
3.00
BUFFER
3.35
RAMP
0.55
0.75
3.05
3.65
3.65
3.65
0.30
3.35
1.00
1.00
3.35
0.30
3.65
3.65
3.65
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced HOV Lane Widths
49.90
21.50
0.55
0.75
3.35
RAMP
3.00
3.35
RAMP
0.55
0.75
3.05
3.35
3.65
3.65
0.30
3.35
1.00
1.00
3.35
0.30
3.65
3.65
3.35
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced Mixed Flow Lane Widths (1 lane per direction)
48.30
21.50
0.55
0.75
3.35
RAMP
3.00
3.35
RAMP
0.55
0.75
3.05
3.35
3.65
3.35
0.30
3.35
1.00
1.00
3.35
0.30
3.35
3.65
3.35
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced Mixed Flow Lane Widths (2 lane per direction)

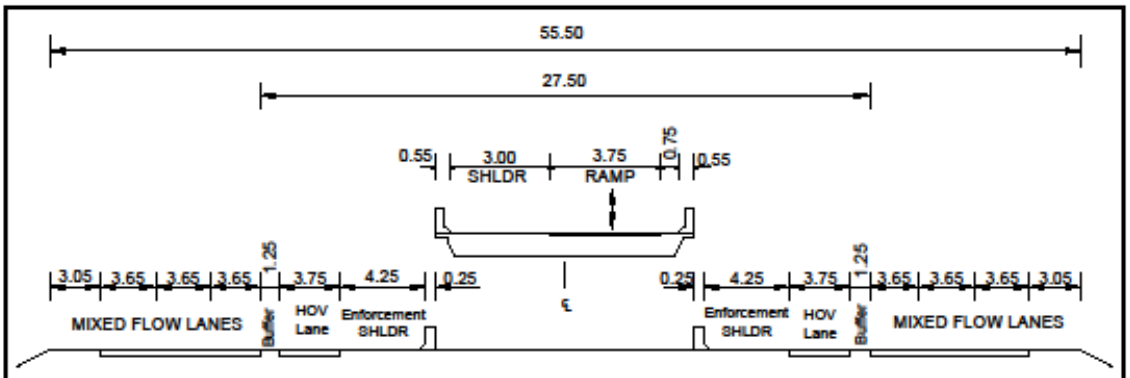


~~Figure 12.5.31 Median HOV Two-Way Ramp Cross-Sections~~

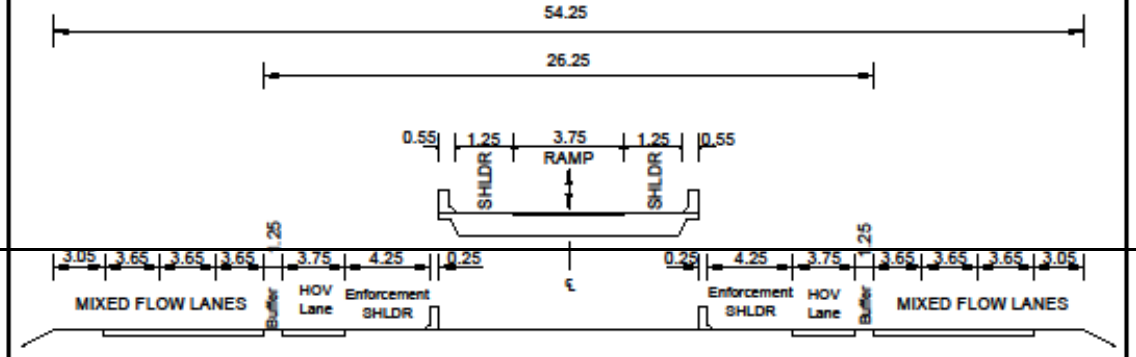
Exhibit 12BA

Median HOV Reversible Ramp Cross-Sections

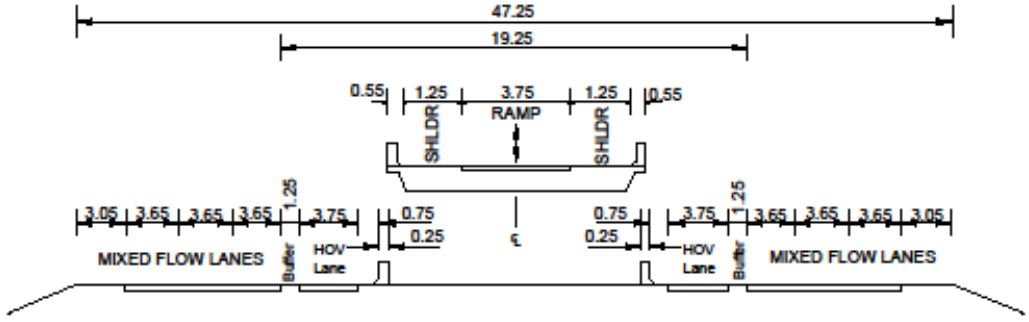




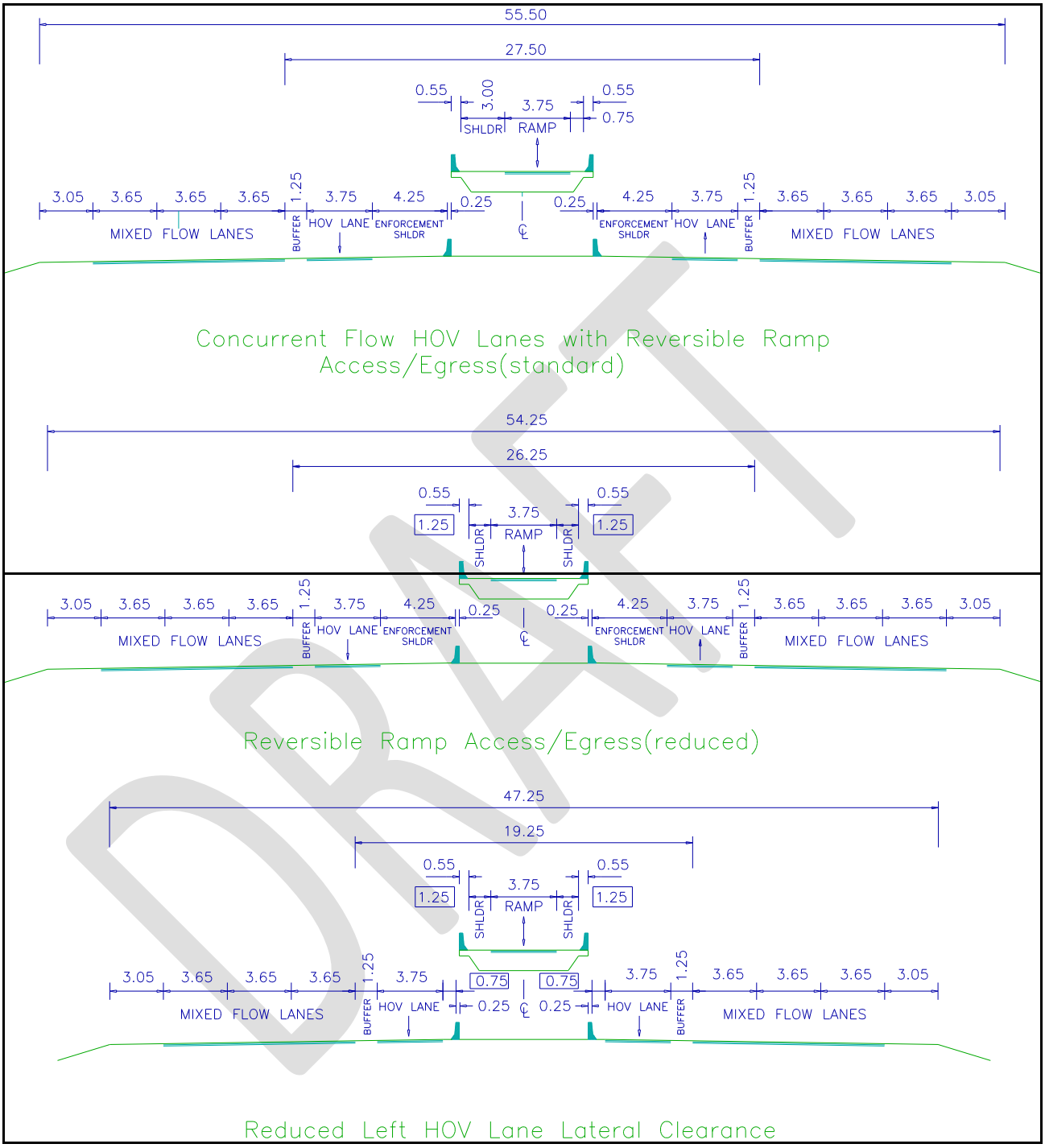
Concurrent Flow HOV Lanes with Reversible Ramp Access/Egress (standard)



Reversible Ramp Access/Egress (reduced)



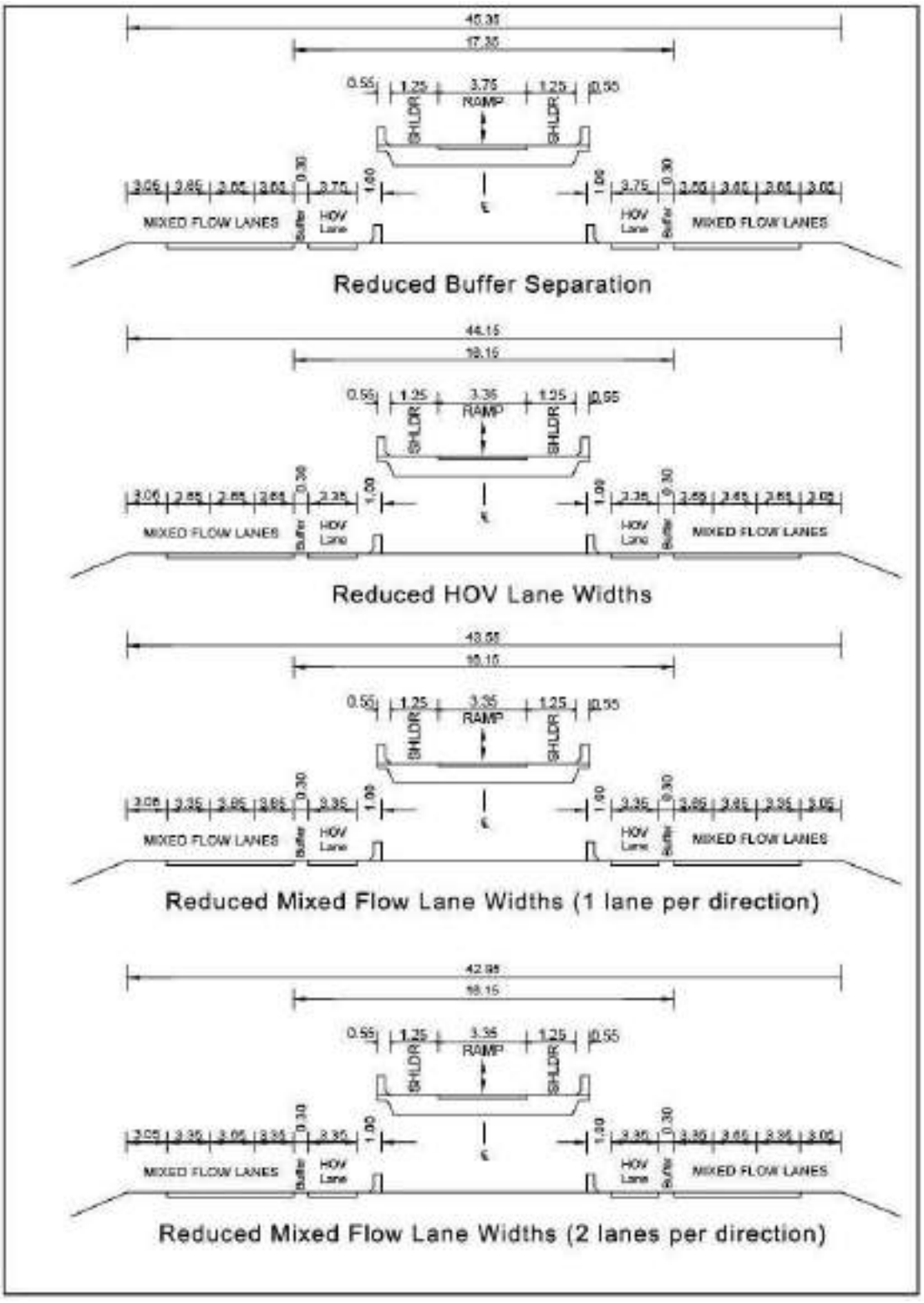
Reduced Left HOV Lane Lateral Clearance

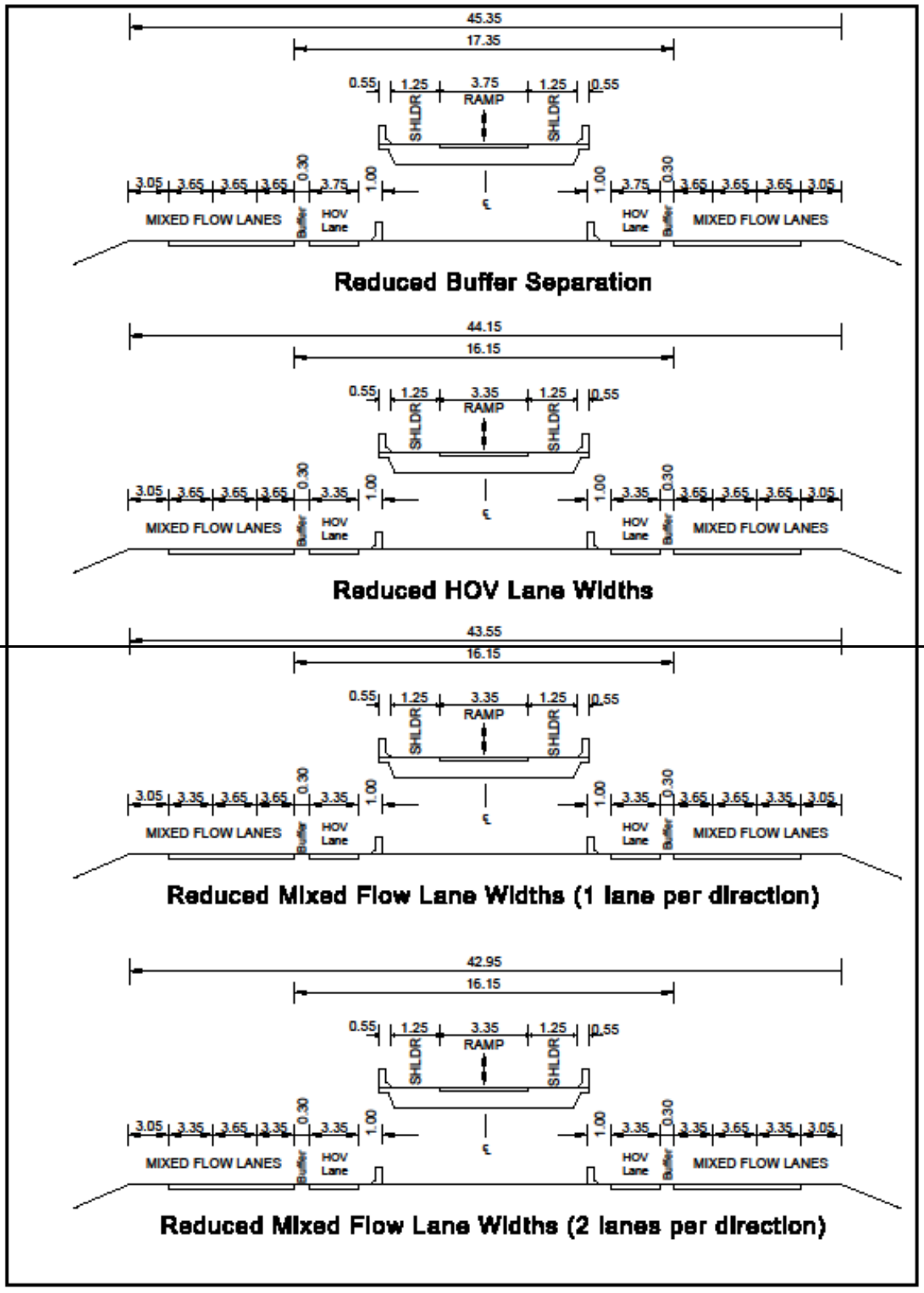


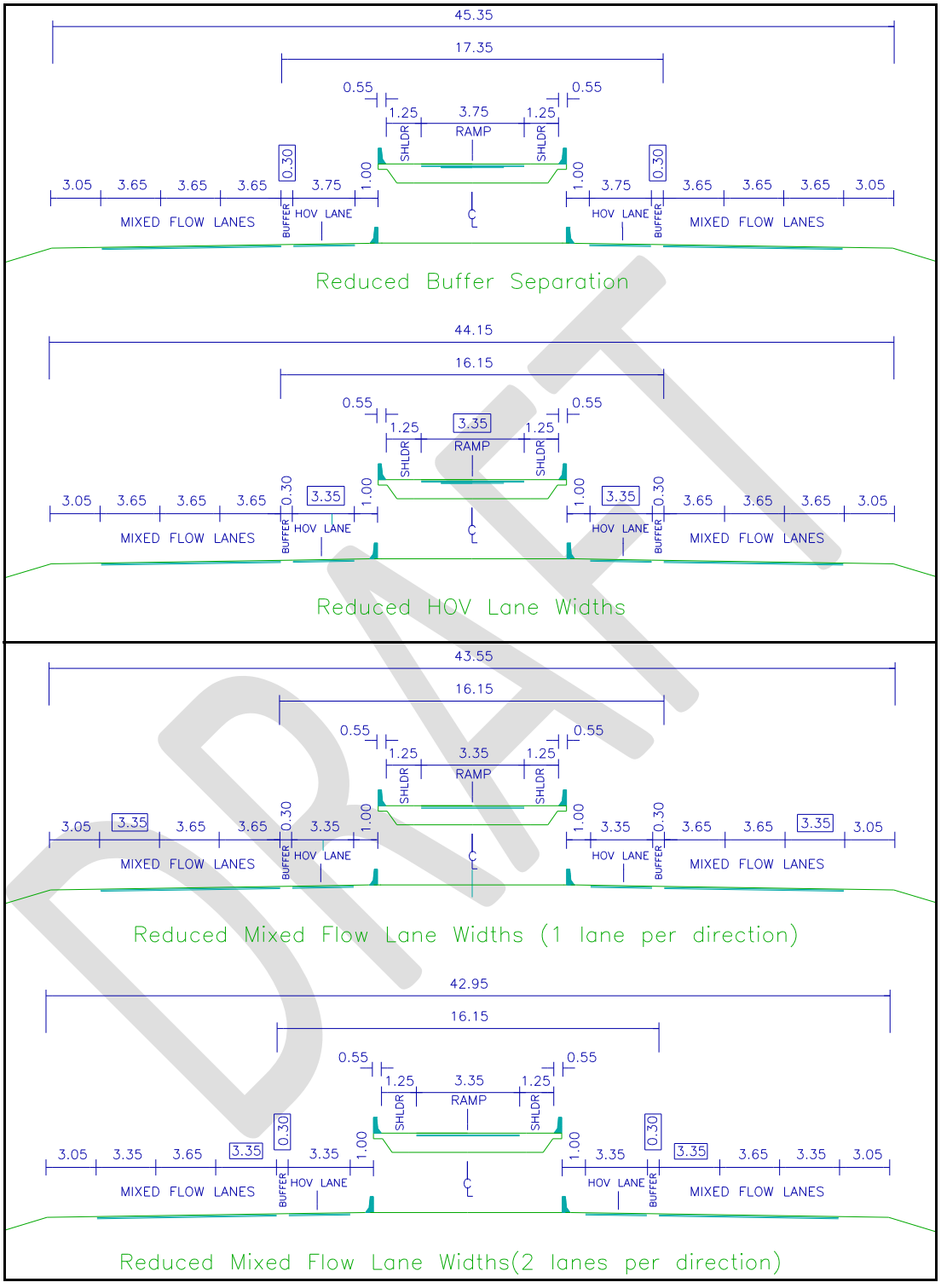
~~Figure 12.5.32 Median HOV Reversible Ramp Cross-Sections~~

Exhibit 12BB

Reduced Median HOV Reversible Ramp Cross-Sections


Reduced Buffer Separation
Reduced HOV Lane Widths
Reduced Mixed Flow Lane Widths (1 lane per direction)
Reduced Mixed Flow Lane Widths (2 lanes per direction)
MIXED FLOW LANES
HOV Lane
SHLDR
RAMP

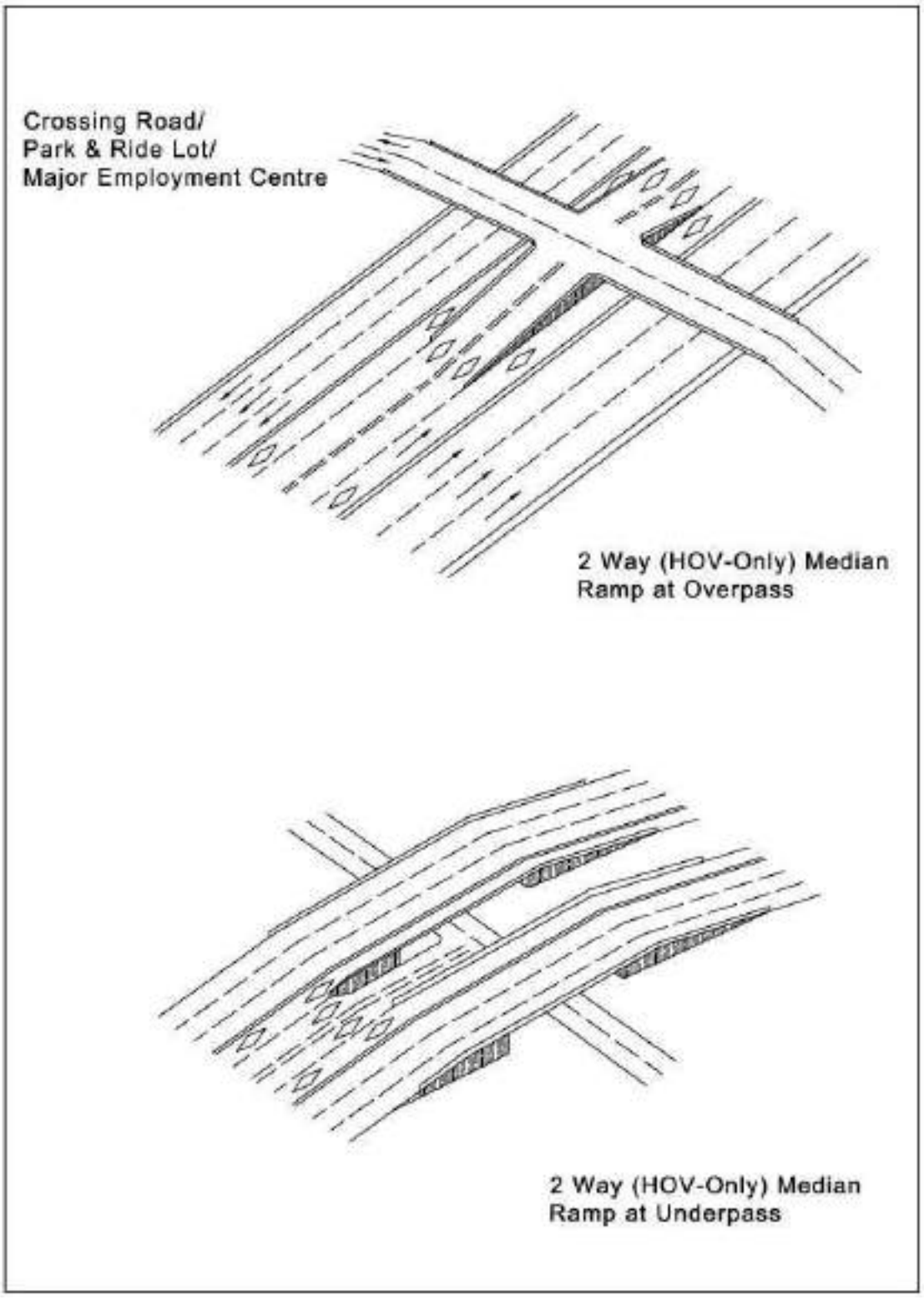

45.35
17.35
0.55
1.25
3.75
RAMP
1.25
0.55
SHLDR
SHLDR
3.05
3.65
3.65
3.65
0.30
3.75
1.00
℄
1.00
3.75
0.30
3.65
3.65
3.65
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced Buffer Separation
44.15
16.15
0.55
1.25
3.35
RAMP
1.25
0.55
SHLDR
SHLDR
3.05
3.65
3.65
3.65
0.30
3.35
1.00
℄
1.00
3.35
0.30
3.65
3.65
3.65
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced HOV Lane Widths
43.55
16.15
0.55
1.25
3.35
RAMP
1.25
0.55
SHLDR
SHLDR
3.05
3.35
3.65
3.65
0.30
3.35
1.00
℄
1.00
3.35
0.30
3.65
3.65
3.35
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced Mixed Flow Lane Widths (1 lane per direction)
42.95
16.15
0.55
1.25
3.35
RAMP
1.25
0.55
SHLDR
SHLDR
3.05
3.35
3.65
3.35
0.30
3.35
1.00
℄
1.00
3.35
0.30
3.35
3.65
3.35
3.05
MIXED FLOW LANES
Buffer
HOV Lane
HOV Lane
Buffer
MIXED FLOW LANES
Reduced Mixed Flow Lane Widths (2 lanes per direction)

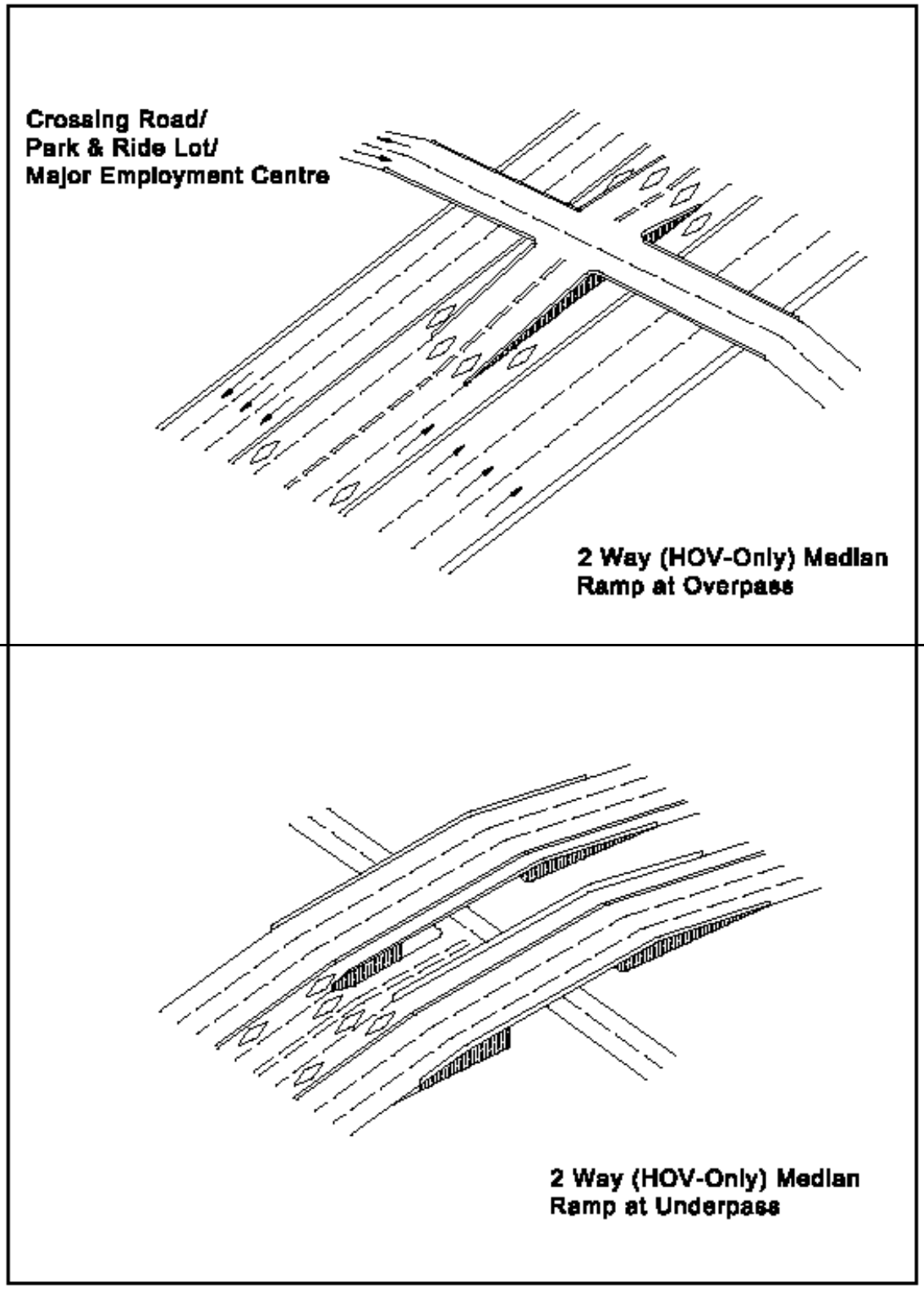


~~Figure 12.5.33 Reduced Median HOV Reversible Ramp Cross-Sections~~

Exhibit 12BC

Direct Median Ramp at Crossing Roads




Crossing Road/
Park & Ride Lot/
Major Employment Centre
2 Way (HOV-Only) Median
Ramp at Overpass
2 Way (HOV-Only) Median
Ramp at Underpass

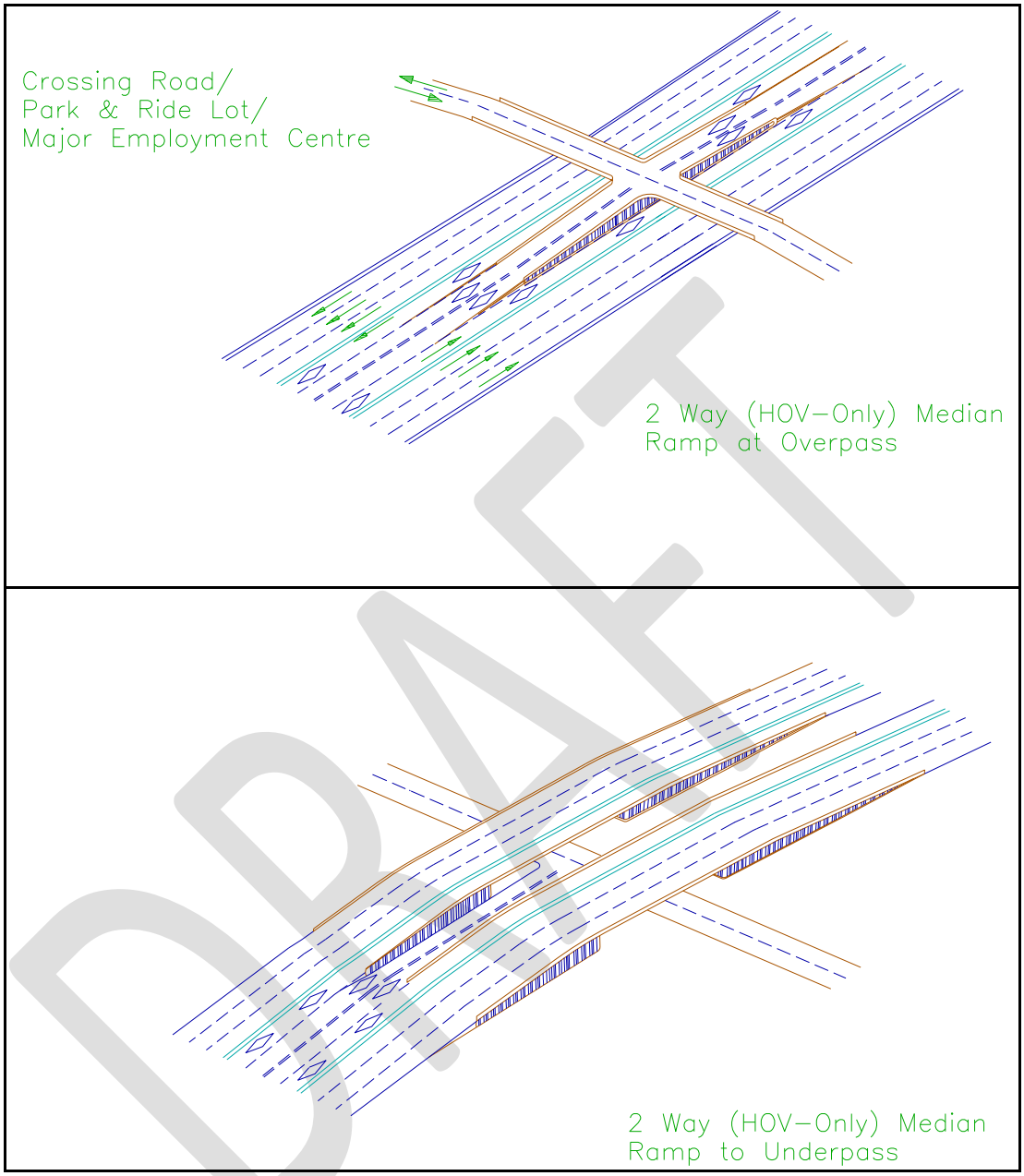
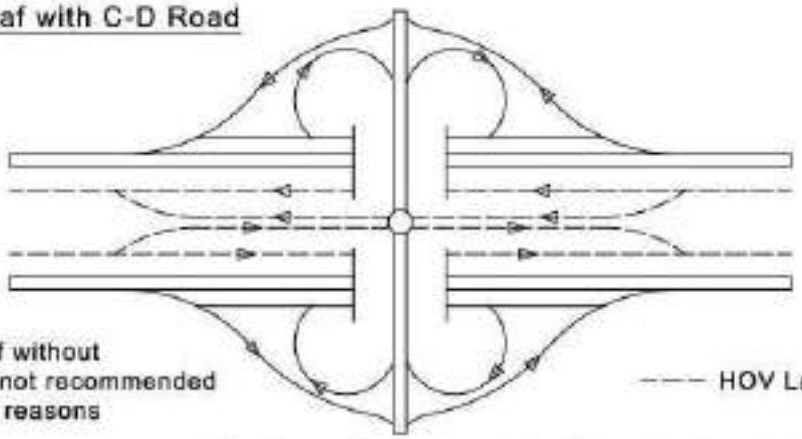


Exhibit 12BD

HOV Direct Ramp/Interchange Combinations (Parclo A4)

~~**Figure 12.5.34 Direct Median Ramp at Crossing Roads**~~

Cloverleaf with C-D Road

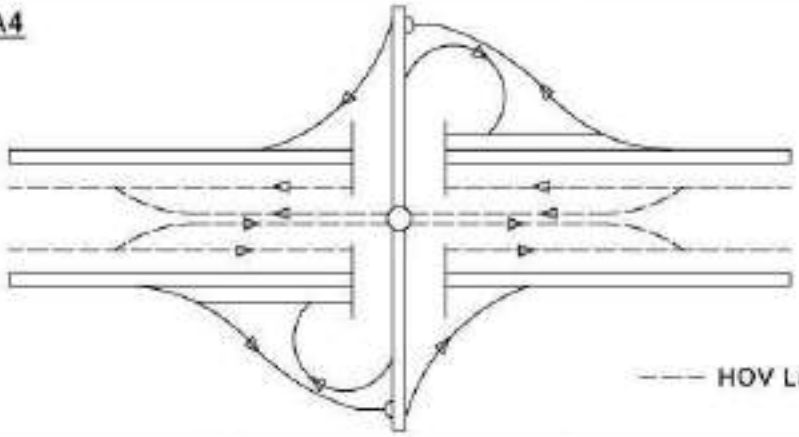


Cloverleaf without C-D road not recommended for safety reasons

HOV Lane

BENEFITS	DISADVANTAGES	APPLICATIONS
Free flow of most freeway and arterial traffic. Minimum impact on arterial operation. Can prioritize HOV signal without synchronization problems.	Difficult to retrofit to parclo interchange due to property and structural requirements. Potential weaving concerns on C-D road and arterial. Higher cost for arterial structure.	Newinterchange plans where property available. Low - moderate volume interchanges. High volume directionally skewed "tidal flow" interchanges where entry/exit weaving is minor.

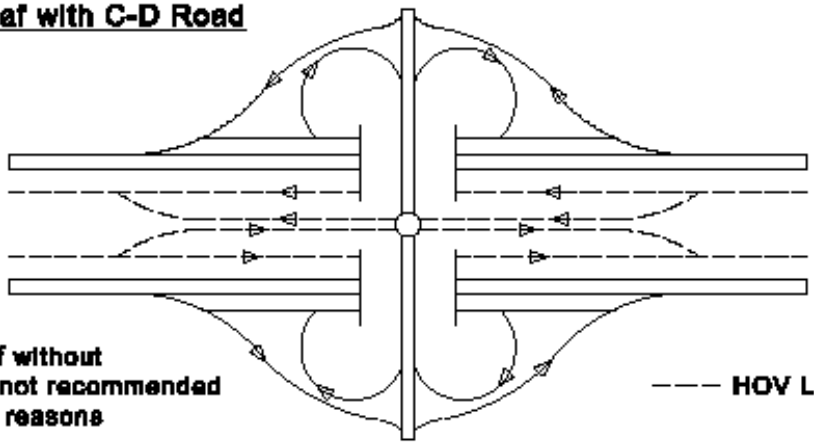
Parclo A4



HOV Lane

BENEFITS	DISADVANTAGES	APPLICATIONS
Conventional interchange layout. Can be readily retrofit to existing I.C. No weaving and Moderate Cost. Allow HOV service/interface in existing demand corridor	Signal synchronization arterial is key issue. Turing moves and queue storage on bridge structure (esp. if retrofit).	Retrofit to existing parclo interchange if traffic conditions on arterial permit. New interchanges plans, esp. if one signal can be eliminated.

Cloverleaf with C-D Road

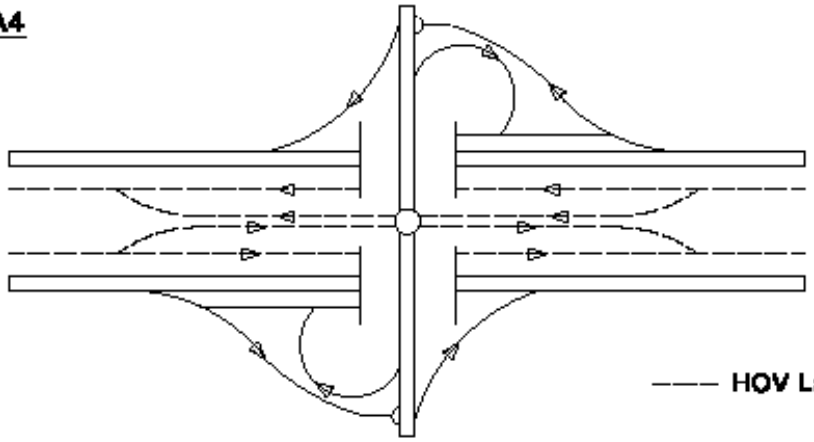


Cloverleaf without C-D road not recommended for safety reasons

---- HOV Lane

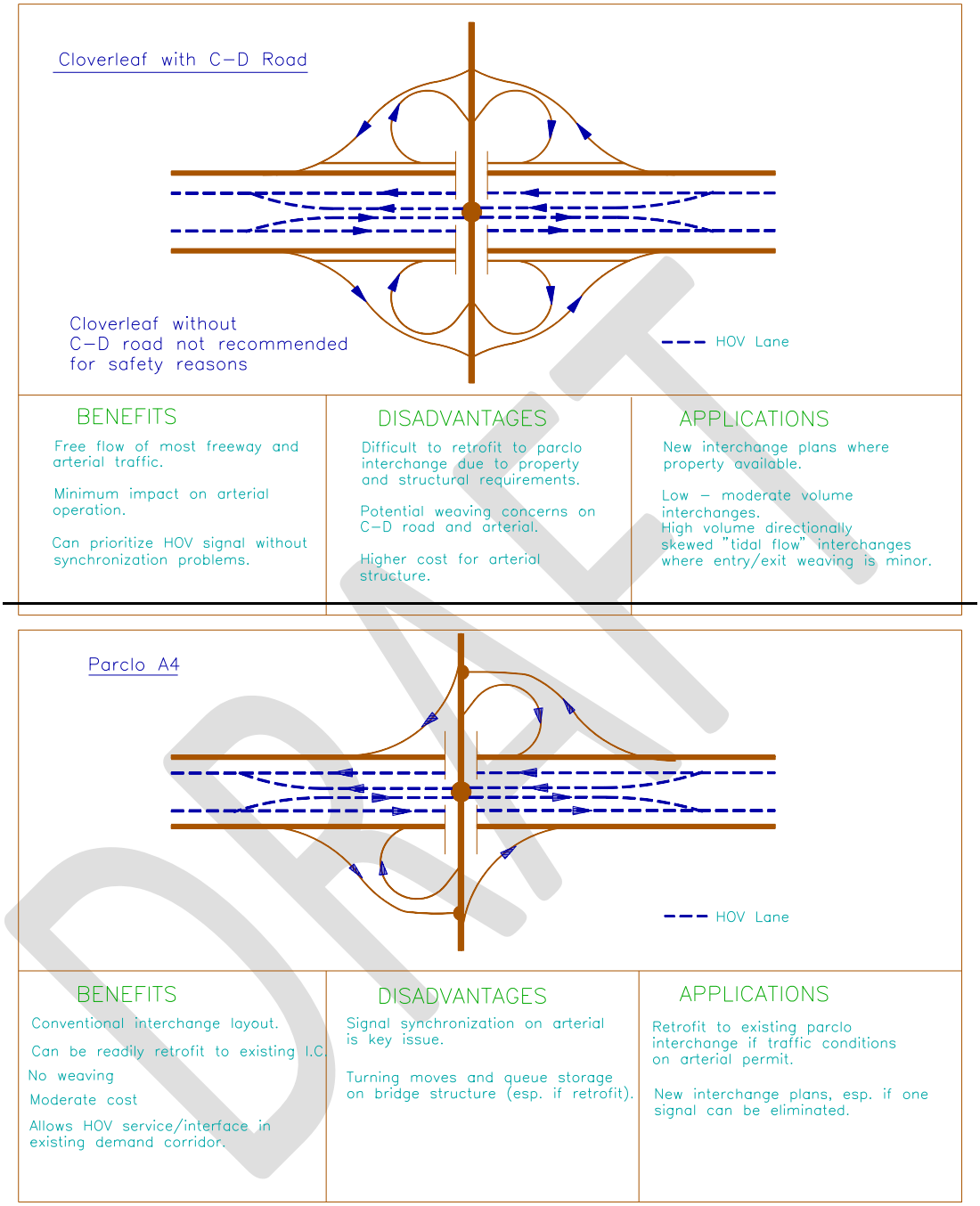
BENEFITS	DISADVANTAGES	APPLICATIONS
Free flow of most freeway and arterial traffic. Minimum impact on arterial operation. Can prioritize HOV signal without synchronization problems.	Difficult to retrofit to parclo interchange due to property and structural requirements. Potential weaving concerns on C-D road and arterial. Higher cost for arterial structure.	New interchange plans where property available. Low - moderate volume interchanges. High volume directionally skewed "tidal flow" interchanges where entry/exit weaving is minor.

Parclo A4



---- HOV Lane

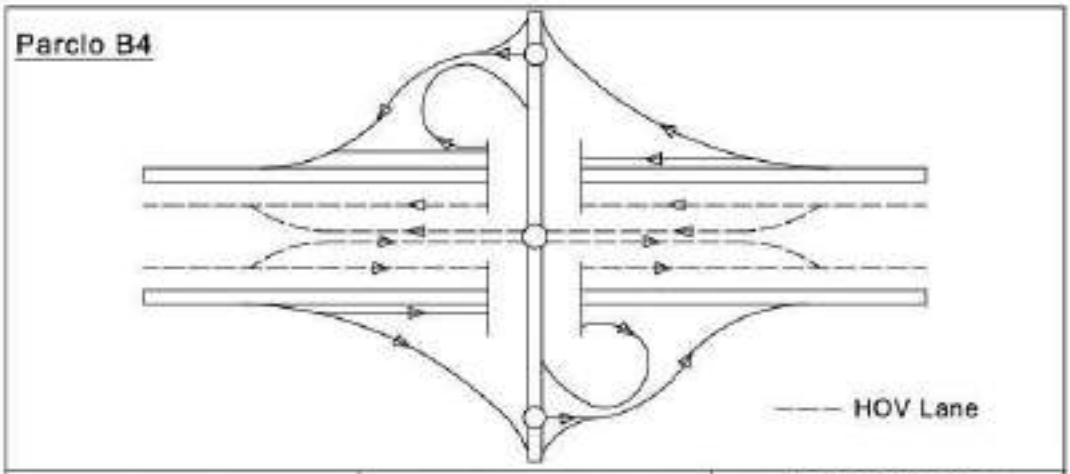
BENEFITS	DISADVANTAGES	APPLICATIONS
Conventional interchange layout. Can be readily retrofit to existing I.C. No weaving and Moderate Cost. Allow HOV service/interface in existing demand corridor	Signal synchronization arterial is key issue. Turing moves and queue storage on bridge structure (esp. if retrofit).	Retrofit to existing parclo interchange if traffic conditions on arterial permit. New interchanges plans, esp. if one signal can be eliminated.



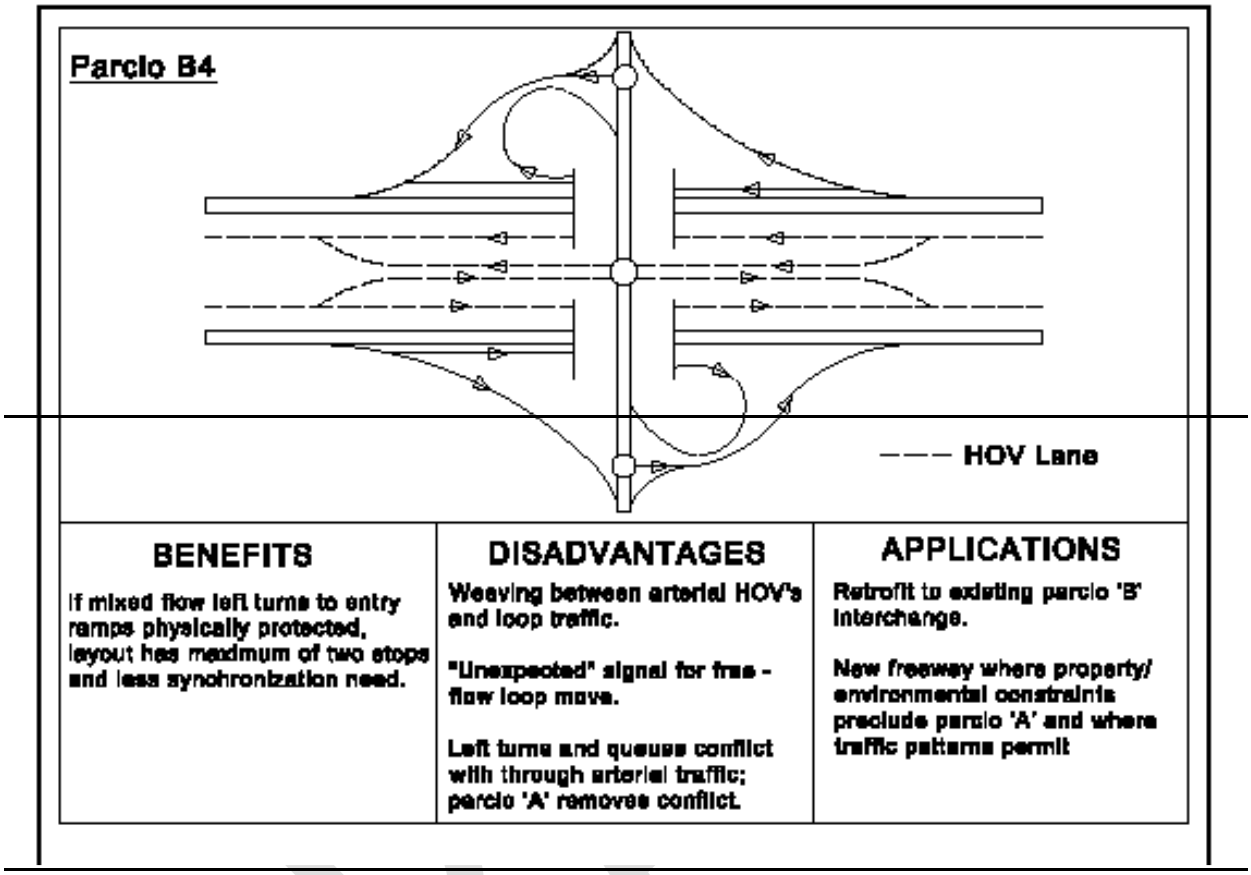
~~Figure 12.5.35 HOV Direct Ramp/Interchange Combinations (Parclo A4)~~

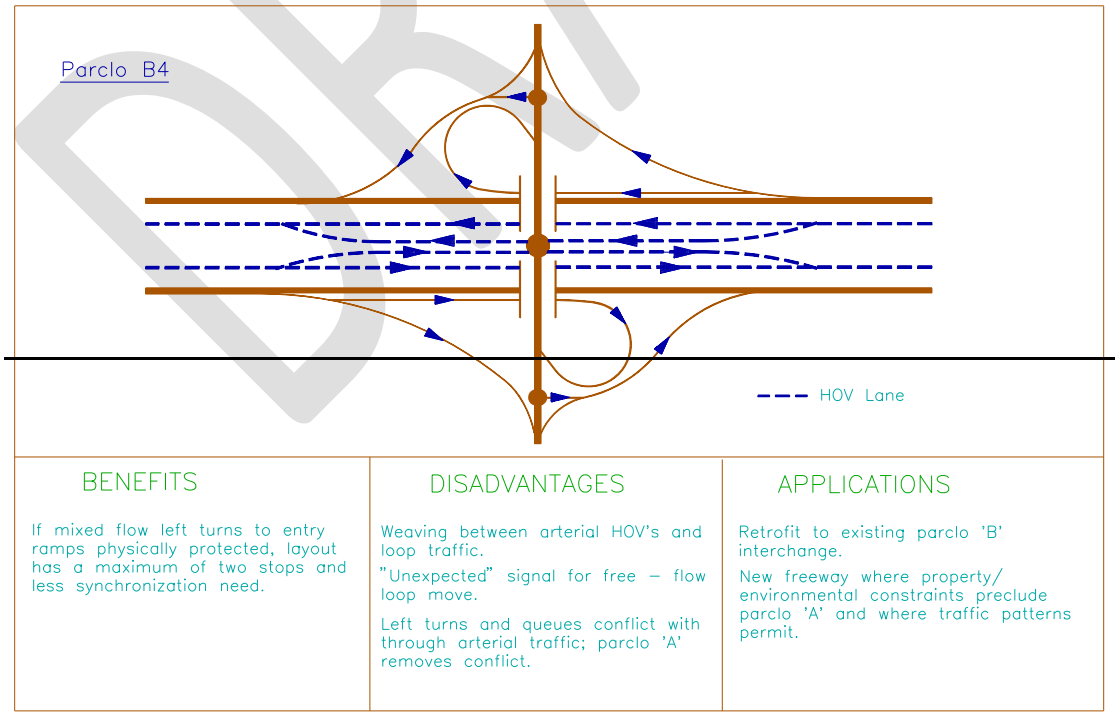
Exhibit 12BE

HOV Direct Ramp/Interchange Combinations (Parclo B4)



BENEFITS	DISADVANTAGES	APPLICATIONS
If mixed flow left turns to entry ramps physically protected, layout has maximum of two stops and less synchronization need.	Weaving between arterial HOV's and loop traffic. "Unexpected" signal for free - flow loop move. Left turns and queues conflict with through arterial traffic; parclo 'A' removes conflict.	Retrofit to existing parclo 'B' interchange. New freeway where property/ environmental constraints preclude parclo 'A' and where traffic patterns permit



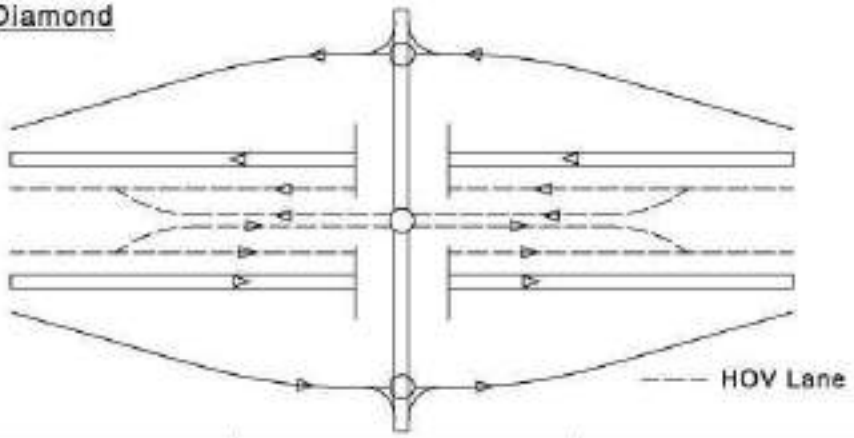


~~Figure 12.5.36 HOV Direct Ramp/Interchange Combinations (Parclo B4)~~

Exhibit 12BF

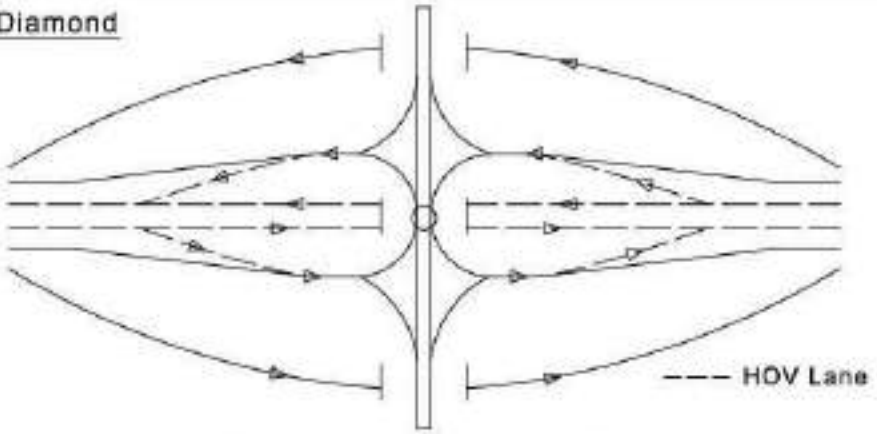
HOV Direct Ramp / Interchange Combinations (Simple Diamond)

Simple Diamond



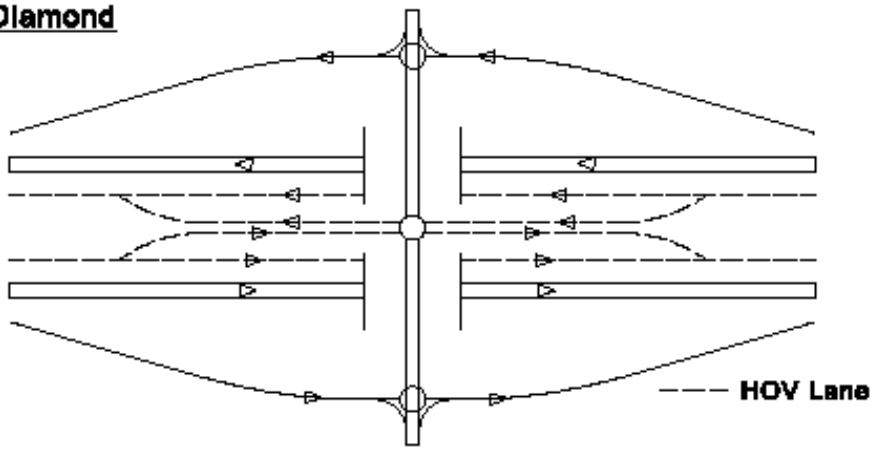
BENEFITS	DISADVANTAGES	APPLICATIONS
Minimal right of way requirements. Efficient transit interface opportunity. Can be retrofit in constrained area. Conventional freeway operation.	Signal synchronization and vehicle storage made difficult by signal proximity. Additional left turns introduced on arterial (compared to parclo).	Where signal synchronization can be accommodated either by operational measures or by adequate intersection spacing. In constrained right of way where access is essential.

Point Diamond



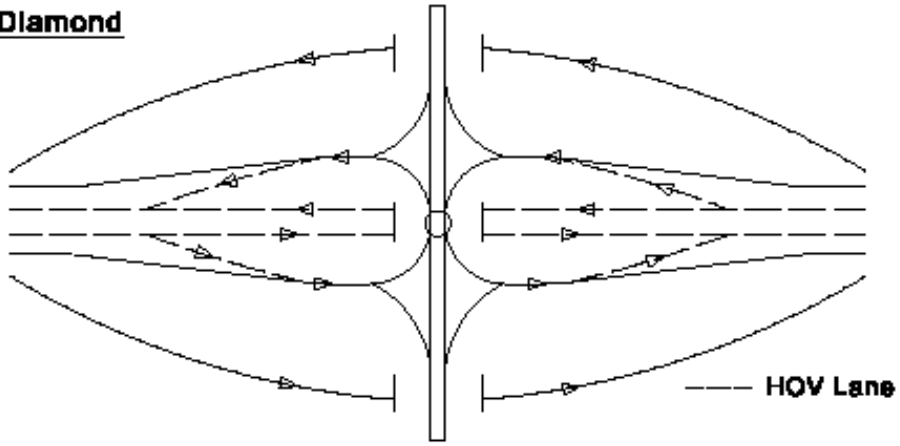
BENEFITS	DISADVANTAGES	APPLICATIONS
Right of way requirements minimized. Can be retrofit in constrained area. Single signal on arterial; synchronization not an issue. Freeway buses can interface with arterial buses by using freeway - grade bus turnouts.	Heavy demand on single intersection. Weaving/merging on ramps. Double ramp structures required. Unconventional left side freeway exits/entrances.	Where traffic conditions/demands on arterial allow effective signal operation. In severely constrained corridor where access is essential.

Simple Diamond

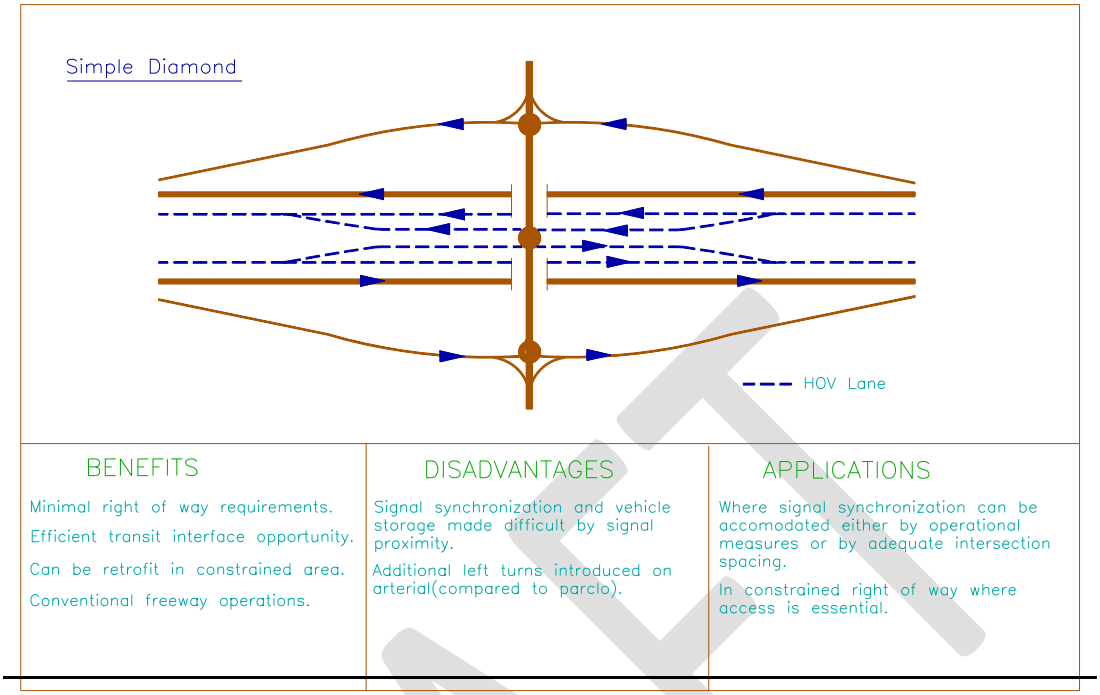


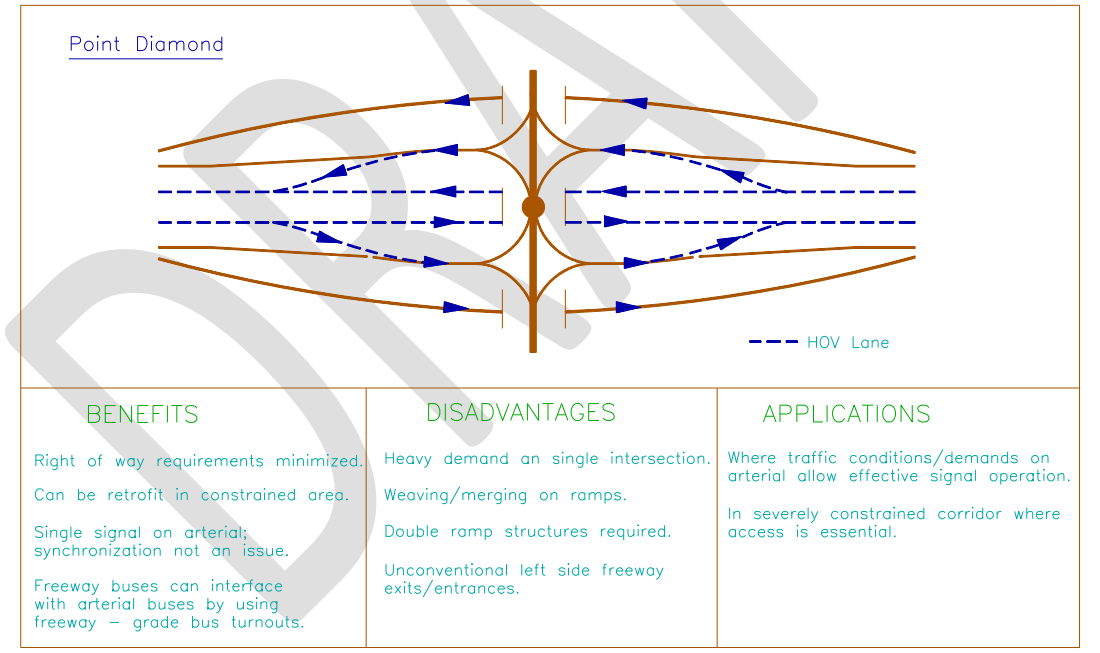
BENEFITS	DISADVANTAGES	APPLICATIONS
Minimal right of way requirements. Efficient transit interface opportunity. Can be retrofit in constrained area. Conventional freeway operation.	Signal synchronization and vehicle storage made difficult by signal proximity. Additional left turns introduced on arterial (compared to parclo).	Where signal synchronization can be accommodated either by operational measures or by adequate intersection spacing. In constrained right of way where access is essential.

Point Diamond



BENEFITS	DISADVANTAGES	APPLICATIONS
Right of way requirements minimized. Can be retrofit in constrained area. Single signal on arterial; synchronization not an issue. Freeway buses can interface with arterial buses by using freeway - grade bus turnouts.	Heavy demand on single intersection. Weaving/merging on ramps. Double ramp structures required. Unconventional left side freeway exits/entrances.	Where traffic conditions/demands on arterial allow effective signal operation. In severely constrained corridor where access is essential.





~~Figure 12.5.37 HOV Direct Ramp / Interchange Combinations (Simple Diamond)~~

12.5.2.7.4.2 Ramps to Parallel Routes / Off Line Nodes

A new HOV-only crossing structure could be provided where there is no reasonable way to provide HOV lane access at a major node through use of an existing structure, or where no structure exists or planned. Such ramps are costly, but can be designed to optimum standards and, if serving a major HOV generator or providing an essential link, would cost-effective than other alternatives. In some cases, a single direct ramp alone could provide 5 - 10 minutes time savings and such ramps may also eliminate an unacceptable at-grade weaving operation. Since these ramps tend to be site-specific in design, the HOV-related guidelines have cross-sections and design criteria identical to mixed flow ramps. **Exhibit 12BG** ~~**Figures 12.5.38, 12.5.39**~~ **Exhibit 12BH, Exhibit 12BI, Exhibit 12BJ** and ~~**12.5.42**~~ **Exhibit 12BK** provide examples of such cases and possible design applications at Parclo "A" interchanges.

12.5.2.7.5 Terminal Points

12.5.2.7.5.1 Start of HOV Lane

An HOV lane can start as a new lane on the left side of the left-most mixed-flow lane. Entry to the HOV lane should require conscious movement by HOVs; the HOV lane should not begin as a direct continuation of a mixed flow lane from which non-HOVs are directed to exit. Consistency with intermediate weaving zones should be maintained: a 300 - 600 m long dashed white line located at least 300 - 500 m (as appropriate depending on HOV volume and freeway width) downstream of the nearest right-side freeway entry ramp bullnose should be used to designate the access area. A dedicated weaving lane is not required for this entry-only manoeuvre, although consideration should be given to protecting the ability to provide such a lane if the HOV lane is to be extended upstream in future.

12.5.2.7.5.2 End of HOV Lane

The preferred means of terminating an HOV lane is as a direct continuation into a free flow mixed-flow lane. If the HOV lane must physically end, a left side lane drops after a minimum 750 m (1000 m desirable) merging zone is adequate. Alternatively, the right-side mixed flow lane could be dropped at an interchange or downstream of the end of HOV designation on the left lane. If possible, the lane drop should be in an area where a high-volume right side mixed-flow ramp relieves traffic volumes on the freeway. The introduction of mainline congestion due to merging HOV lane traffic is to be avoided.

As with any weaving zone, a minimum of 200 m per lane change should be provided between

the end of buffer / barrier and the next downstream right-side exit ramp.~~-~~ A dedicated weaving lane is not required for this egress-only move, however, future downstream extension of HOV lane may warrant protection for the later provided extra lane.

12.5.2.7.6 Freeway-To-Freeway Interchanges

For HOVs to transfer between freeway corridors, mixed flow ramps must generally be used, along with appropriately located weaving lanes / zones.~~-~~ If there are HOV lanes in both freeway corridors, an ultimate network plan may warrant provision of a direct HOV-only ramp between the two, as shown in **Exhibit 12BL**~~**Figure 12.5.43**~~.

Due to the complexity of most freeway-to-freeway interchanges, only one or two HOV-only moves can be provided within the interchange itself.~~-~~ There may be a restricted design speed on the HOV ramp to retrofit it into the area; it would obviously be preferable to protect for such a connection in the design stage.

Another impact is that, in order to introduce the ramp, the freeway main lines may require widening around the ramp terminus.~~-~~ As with any such complex situation, the design solution will be site-specific.

Exhibit 12BG
Direct Ramp from Parclo "A" Entry Ramp to Median HOV Lane

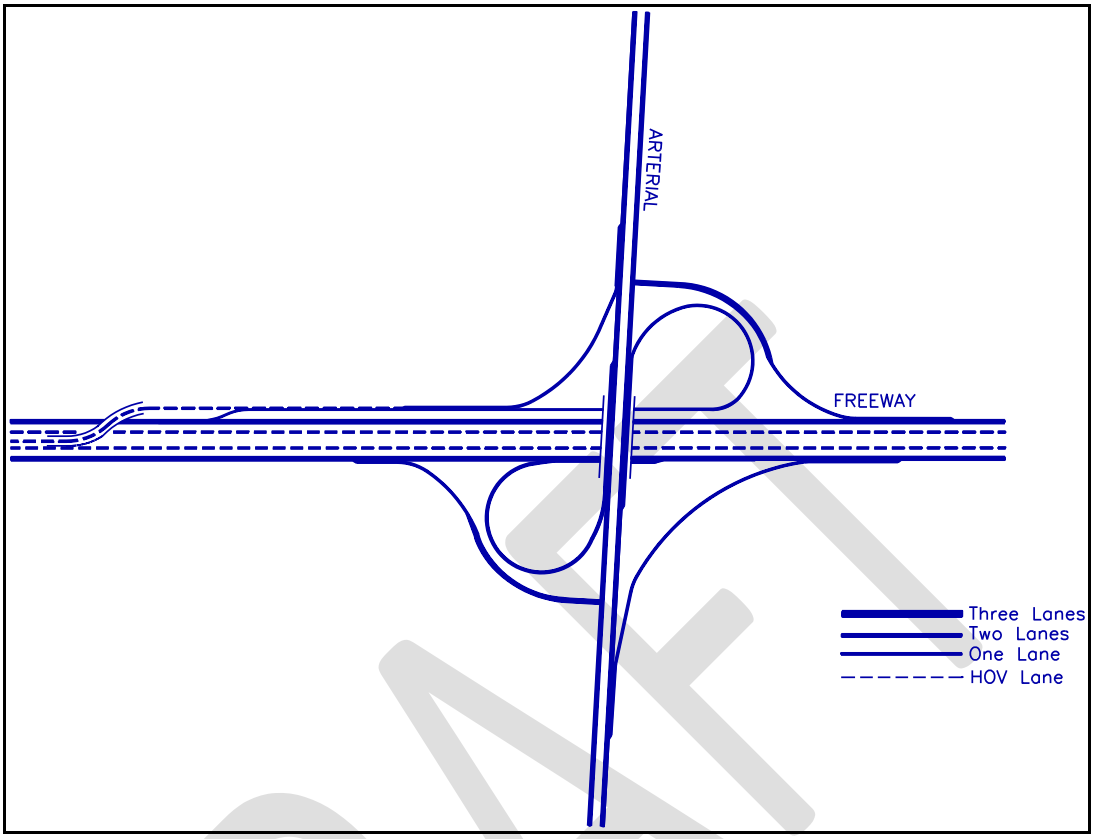
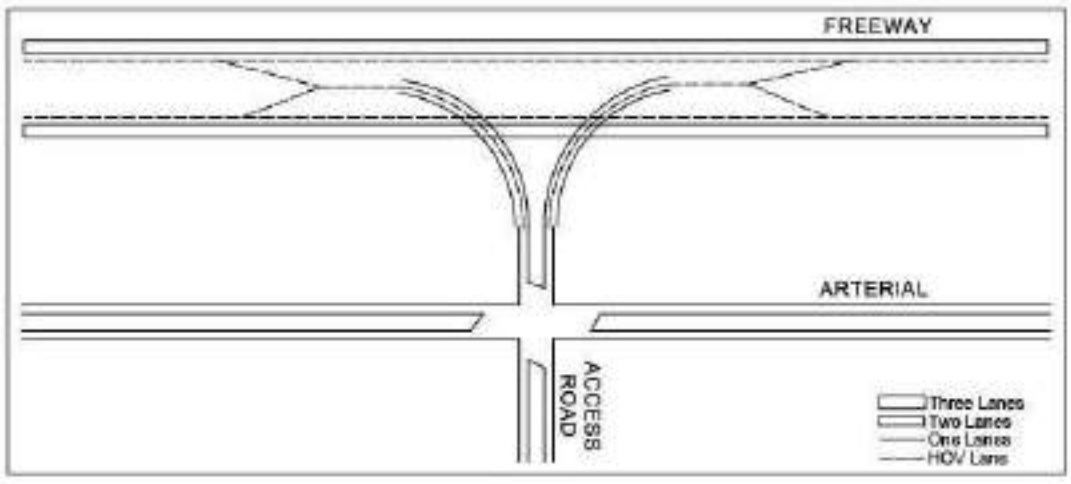
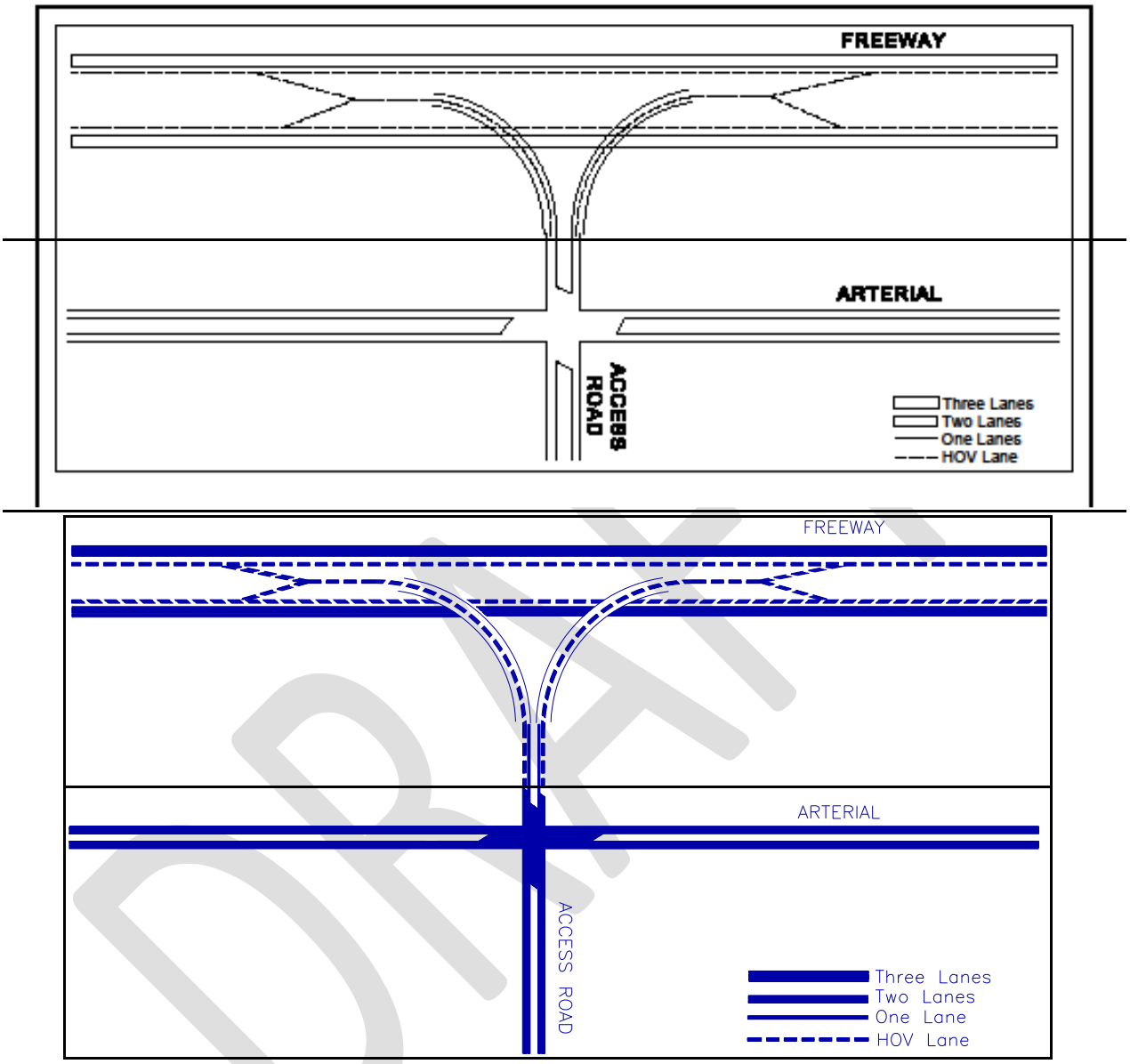


Exhibit 12BH

In / Out Ramp Between Median HOV Lane and Off-Line Activity Centre

~~**Figure 12.5.38 Direct Ramp from Parclo "A" Entry Ramp to Median HOV Lane**~~

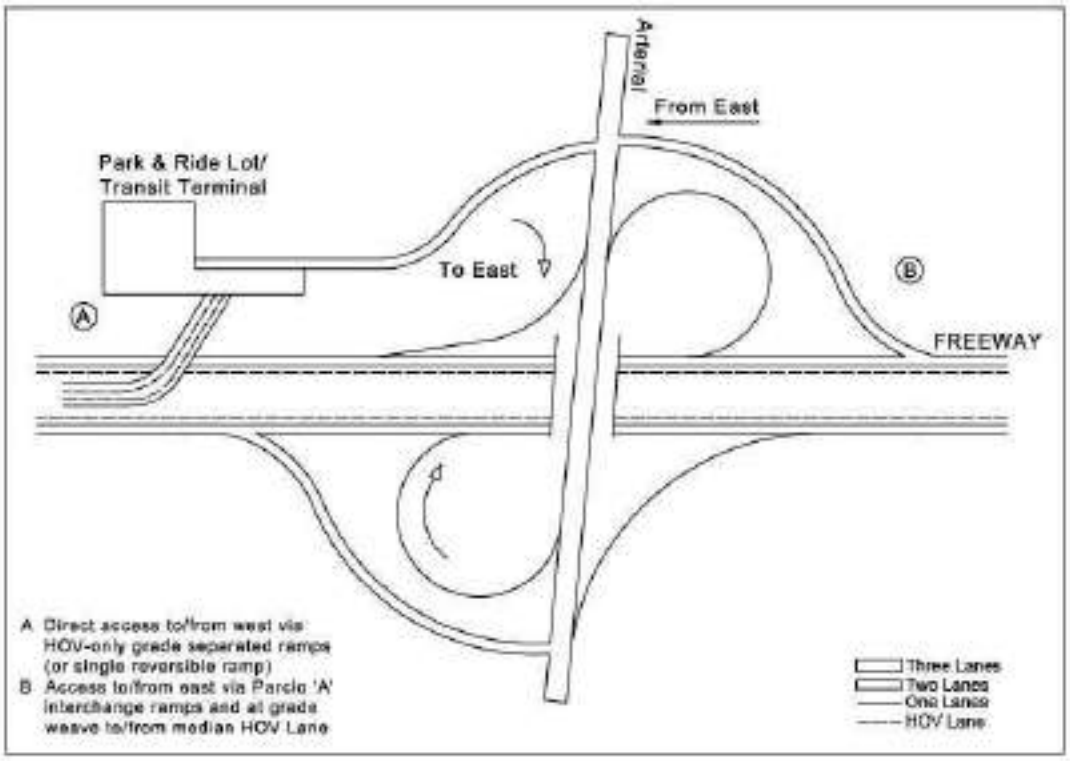


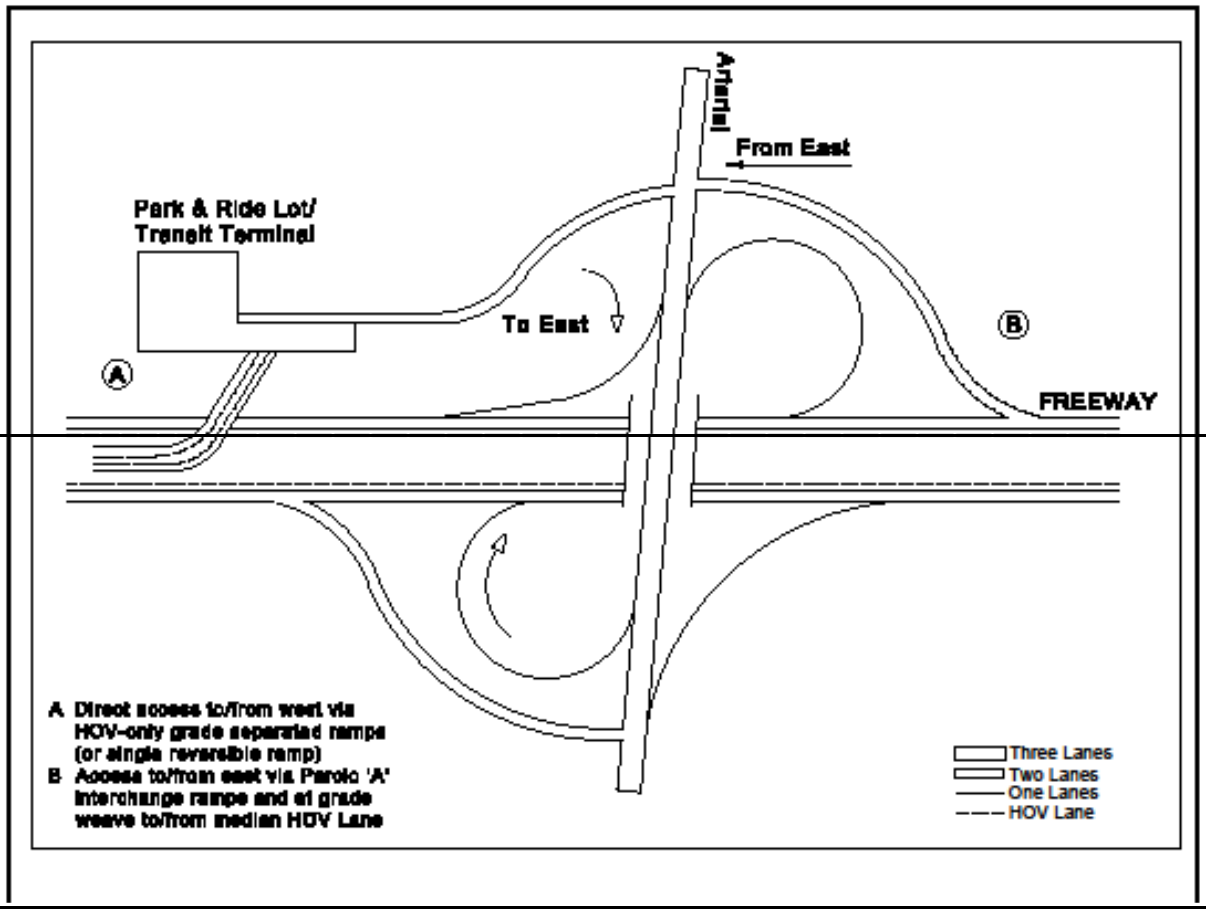


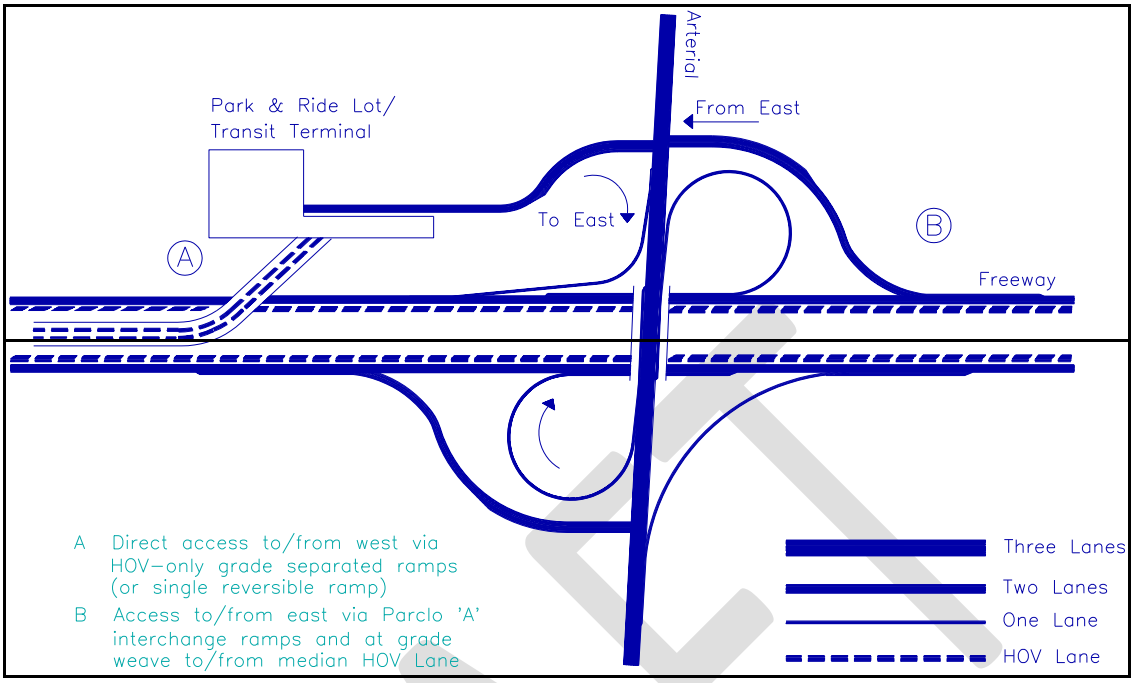
~~Figure 12.5.39 In / Out Ramp Between Median HOV Lane and Off-Line Activity Centre~~

Exhibit 12BI

Direct Ramp to Off-Line Parking / Transit Node at "Parclo A" Interchange


Arterial
From East
Park & Ride Lot/
Transit Terminal
To East
B
A
FREEWAY
A Direct access to/from west via HOV-only grade separated ramps (or single reversible ramp)
B Access to/from east via Parcio 'A' interchange ramps and at grade weave to/from median HOV Lane
Three Lanes
Two Lanes
One Lanes
HOV Lane


Arterial
From East
Park & Ride Lot/
Transit Terminal
To East
B
A
FREEWAY
A Direct access to/from west via HOV-only grade separated ramps (or single reversible ramp)
B Access to/from east via Parcio 'A' interchange ramps and at grade weave to/from median HOV Lane
Three Lanes
Two Lanes
One Lanes
HOV Lane



~~Figure 12-5.40 Direct Ramp to Off-Line Parking / Transit Node at "Parclo A" Interchange~~

Exhibit 12BJ

"Tee" Ramp for Direct Access Between Median HOV Lane and Off-Line Facility