



COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
1401 EAST BROAD STREET
RICHMOND, VIRGINIA 23219-2000

David S. Ekern, P.E.
COMMISSIONER

January 30, 2007

MEMORANDUM

To: All Holders of the Virginia Department of Transportation's 2001 Road and Bridge Standards

The current design standards for Transition Curves (TC-5.01 and TC-5.04) have been revised and the attached revision documents are to be added to your copy of the VDOT 2001 Road and Bridge Standards. The revision updates specific terminology in the TC-5.01 Standards to conform to the terminology used in the AASHTO 2004 A Policy on Geometric Design of Highways and Streets ("Green Book"). These changes include:

- The "Crown Runoff" (CR) has been changed to "Tangent Run out" (Lt). This term denotes the transition distance from normal crown to the 0% grade on the high side of the superelevation.
- The "Length of Spiral" (LS) has been changed to "Super Runoff" (Lr). This term denotes the transition distance from 0% grade on the high side of the superelevation to full superelevation.

In addition to these changes, all references to Appendix A of the VDOT Road Design Manual have been revised to reference Chapter 3 of the AASHTO Green Book. An insertable sheet will not be required in plan assemblies for this revision. To avoid confusion, the old TC-5 Standard has also been revised to reflect the AASHTO Green Book terminology.

If you have any questions or comments regarding the listed revisions to this publication, please contact Steve Van Cleef of the Standards and Special Design Section at (804) 786-2532.

Sincerely,

Mohammad Mirshahi, P.E.
State Location and Design Engineer

STANDARD SYMBOLS

- LOCATION EALIGNMENT ON WHICH THE PROPOSED RIGHT-OF-WAY AND CONSTRUCTION IS BASED.
- STANDARD PAVEMENT.....THE TYPICAL PAVEMENT SECTION TO BE SHOWN ON THE ROAD PLANS.
- P.C.POINT OF BEGINNING OF BASELINE CIRCULAR CURVE.
- P.T.POINT OF ENDING OF BASELINE CIRCULAR CURVE.
- P.C.C.POINT OF BASELINE COMPOUND CURVATURE.
- P.R.C.....POINT OF BASELINE REVERSE CURVE.
- T.S.POINT OF CHANGE FROM TANGENT TO TRANSITION CURVE. (TANGENT TO SPIRAL)
- S.C.POINT OF CHANGE FROM TRANSITION CURVE TO CIRCULAR CURVE. (SPIRAL TO CIRCULAR)
- C.S.POINT OF CHANGE FROM CIRCULAR CURVE TO TRANSITION CURVE. (CIRCULAR TO SPIRAL)
- S.T.POINT OF CHANGE FROM TRANSITION CURVE TO TANGENT. (SPIRAL TO TANGENT)
- RADIUSRADIUS OF BASELINE CIRCULAR CURVE.
- DVAPPROXIMATE MAXIMUM SAFE SPEED IN MILES PER HOUR USING STANDARD RATE OF SUPER-ELEVATION.
- NCAPPROXIMATE MAXIMUM SAFE SPEED IN MILES PER HOUR WITH NO SUPERELEVATION. FACTORS APPLY ONLY TO URBAN LOW SPEED CONDITIONS.
- LrLENGTH OF TRANSITION CURVE MEASURED ALONG BASELINE. WHERE NO TRANSITION CURVE IS APPLIED Lr IS LENGTH OF SUPERELEVATION RUNOFF SECTION.
- W OR PWWIDTH OF STANDARD PAVEMENT.
- ZTDISTANCE FROM TRANSITIONED BASELINE TO EDGES OF TRANSITIONED PAVEMENT ($\frac{W}{2} + \frac{w}{2}$)
- wMAXIMUM TOTAL PAVEMENT WIDENING.
- ERATE OF SUPERELEVATION.
- FSAFE SIDE FRICTION FACTOR.
- SAMOUNT OF SUPERELEVATION TO BE APPLIED TO THE BASELINE GRADE TO OBTAIN THE ELEVATIONS OF THE EDGES OF TRANSITIONED PAVEMENT.
- CDIFFERENCE IN ELEVATION BETWEEN BASELINE (CENTER) AND EDGE OF PAVEMENT FOR STANDARD PAVEMENT CROWN.
- LtSTANDARD PAVEMENT CROWN TRANSITION OR TANGENT RUNOUT SECTION.
- CPCHORD POINT (1/10 INCREMENTS OF TRANSITION CURVE).
- NPC.....NORMAL PAVEMENT CROWN.

ALL DISTANCES (HORIZONTAL AND VERTICAL) ARE MEASURED IN FEET.

SPECIFICATION REFERENCE

TRANSITION CURVES FOR RURAL AND URBAN
HIGHWAYS AND STREET CONDITIONS

URBAN CONDITION

URBAN CONDITIONS APPLY TO URBAN STREET SYSTEMS AND ANY OTHER ROAD WITH PRESENT OR FUTURE URBAN STREET OPERATING CONDITIONS.

THESE TABLES CONTAIN SUPERELEVATION RATES AND TRANSITION LENGTHS FOR STANDARD URBAN PAVEMENT WIDTHS THROUGH A RANGE OF CURVES AND DESIGN VELOCITIES CONSIDERED MOST LIKELY TO BE USED IN URBAN ROAD DESIGN.

DEFINITIONS FOR THE STANDARD SYMBOLS USED THROUGHOUT THESE TABLES ARE FOUND ON SHEET 801.01.

A TABLE FOR "LOW SPEED URBAN" DESIGNS IS ON SHEET 801.20 WITH A RANGE OF STANDARD PAVEMENT WIDTHS (W), TRANSITION LENGTHS (L_r), AND RADII OF CURVE WHEN SUPERELEVATED BY AN AMOUNT EQUAL TO THE NORMAL CROWN AND THE APPROXIMATE MAXIMUM SAFE SPEEDS (DV) AFFORDED THEREBY. VALUES IN THIS TABLE CAN BE USED ON STREETS WITH OPERATING SPEEDS LESS THAN OR EQUAL TO 45 MPH. ALSO SHOWN ARE THE APPROXIMATE MAXIMUM SAFE SPEEDS (NC) WITH NO SUPERELEVATION. VALUES FOR (NC) CAN BE USED ON URBAN ARTERIAL, COLLECTOR, AND LOCAL STREETS.

FOR MINIMUM DESIGN FACTORS FOR VARIOUS DESIGN SPEEDS FOR URBAN CONDITIONS SEE SHEETS 801.21 THRU 801.29

WHEN URBAN CONDITIONS APPLY THERE WILL BE NO BASELINE TRANSITION OR PAVEMENT WIDENING. THE LENGTH OF SUPERELEVATION RUNOFF (L_r) DETERMINES THE LENGTH OF SUPERELEVATION TRANSITION THROUGH WHICH THE OUTER EDGE OF PAVEMENT IS RAISED ABOVE THE BASELINE GRADE TO A MAXIMUM OF $E \left(\frac{W}{2}\right)$. SEE SHEET 801.06 FOR A GRAPHICAL ILLUSTRATION OF THE APPLICATION OF THIS CORRECTION.

FOR CURVE RADII NOT LISTED IN TABLES REFER TO SHEET 801.18 TO CALCULATE TRANSITION LENGTHS (L_r).

L_r SHOULD BE SHOWN ON THE PLANS FOR ALL CURVES.

E SHOULD BE SHOWN ON THE PLANS FOR ALL CURVES WITH URBAN STREET CONDITIONS.

FOR GRAPHICAL ILLUSTRATION OF DESIGN SUPERELEVATION RATES FOR URBAN CONDITIONS SEE SHEET 801.15.

FOR ADDITIONAL GENERAL INSTRUCTIONS (BOTH URBAN AND RURAL) SEE SHEET 801.04.

EXPLANATION OF TABLES AND INSTRUCTIONS FOR USE
URBAN CONDITION

RURAL CONDITION

RURAL CONDITIONS APPLY TO INTERSTATE, ARTERIAL, PRIMARY AND SECONDARY SYSTEMS OR TO ANY OTHER ROAD WITH RURAL TYPE DESIGN AND OPERATING CONDITIONS.

THESE TABLES CONTAIN SUPERELEVATION AND WIDENING CORRECTIONS FOR STANDARD RURAL PAVEMENT WIDTHS THROUGH A RANGE OF RADII AND DESIGN VELOCITIES CONSIDERED MOST LIKELY TO BE USED IN RURAL HIGHWAY DESIGN.

DEFINITIONS FOR THE STANDARD SYMBOLS USED THROUGHOUT THESE TABLES ARE FOUND ON SHEET 801.01.

FOR MINIMUM DESIGN FACTORS FOR VARIOUS DESIGN SPEEDS FOR RURAL CONDITIONS SEE SHEETS 801.30 THRU 801.40.

ON CURVES WITH GREATER THAN 2865 FT RADIUS THERE WILL BE NO SPIRAL TRANSITION OR PAVEMENT WIDENING. PAVEMENT WILL BE SUPERELEVATED BY AN AMOUNT EQUAL TO THE RATE SHOWN IN THE TABLES. SEE SHEET 801.06 FOR A GRAPHICAL ILLUSTRATION OF THE APPLICATION OF THIS CORRECTION.

ON CURVES WITH PAVEMENT WIDTHS OF 24' OR WIDER AND A RADIUS OF 881 FT. OR GREATER, THERE WILL BE NO SPIRAL TRANSITION OR PAVEMENT WIDENING. PAVEMENT WILL BE SUPERELEVATED BY AN AMOUNT EQUAL TO THE RATE SHOWN IN THESE TABLES.

FOR CURVE RADII NOT LISTED IN TABLES REFER TO SHEET 801.18 TO CALCULATE SUPERELEVATION RUNOFF LENGTHS (L_r) AND PAVEMENT WIDENING (w).

L_r AND E SHOULD BE SHOWN ON THE PLANS FOR ALL CURVES..

FOR GRAPHICAL ILLUSTRATION OF DESIGN SUPERELEVATION RATES FOR RURAL CONDITIONS SEE SHEET 801.16.

FOR ADDITIONAL GENERAL INSTRUCTIONS (BOTH URBAN AND RURAL) SEE SHEET 801.04.

EXPLANATION OF TABLES AND INSTRUCTIONS FOR USE
RURAL CONDITION

VIRGINIA DEPARTMENT OF TRANSPORTATION

GENERAL CONDITION

ALL ORIGINAL CROSS SECTIONS SHALL BE TAKEN FROM THE BASELINE AT STATIONS, PLUS FIFTIES, AND UNUSUAL BREAKS IN THE GROUND AS ON TANGENT ALIGNMENT.

WHERE A PART OR ALL OF A SUPERELEVATION TRANSITION CURVE FALLS ON A VERTICAL CURVE, ELEVATIONS ON THE VERTICAL CURVE SHOULD BE COMPUTED FOR THE POSITIONS GIVEN ON SHEET 801.12 FOR CROWN TRANSITIONS, SHEET 801.13 FOR URBAN PROJECTS AND SHEET 801.14 FOR RURAL PROJECTS. THESE ELEVATIONS AND PLUSES SHOULD BE SHOWN ON THE PLANS FOR THE CONVENIENCE OF THE SURVEY PARTY IN STAKING OUT THE PROJECT. THROUGHOUT THESE SECTIONS OF THE GRADE, ELEVATIONS AT EVEN STATIONS AND PLUS FIFTIES SHOULD BE OMITTED.

SLOPE STAKES SHOULD BE SET AT THE POSITIONS ON THE TRANSITION GIVEN ON SHEETS 801.12, 801.13 AND 801.14 AND GROUND CROSS SECTIONS TAKEN AT THESE POSITIONS OMITTING THE STATIONS AND PLUS FIFTIES THROUGHOUT THE TRANSITION. IF UNUSUAL BREAKS IN THE GROUND OCCUR, ADDITIONAL SECTIONS SHOULD, OF COURSE, BE TAKEN. ADDITIONAL SECTIONS SHOULD ALSO BE TAKEN WHERE LOCATION IS THROUGH ROCK CUT IN ANTICIPATION OF UNUSUAL BREAKAGE WHICH MAY OCCUR DURING CONSTRUCTION.

AFTER ROUGH GRADING HAS BEEN DONE, FINE GRADING (BLUE TOP) AND FORM STAKES SHOULD BE SET AT THE POSITIONS GIVEN ON SHEET 801.12 FOR CROWN TRANSITIONS, SHEET 801.13 FOR URBAN PROJECTS OR AS GIVEN ON SHEET 801.14 FOR RURAL PROJECTS.

FINAL CROSS SECTIONS SHOULD, OF COURSE, BE TAKEN AT THOSE POSITIONS AT WHICH THE SLOPE STAKE SECTIONS WERE TAKEN. WHERE UNUSUAL BREAKAGE IN ROCK OCCURS AND THIS WAS NOT ANTICIPATED, ADDITIONAL FINAL SECTIONS SHOULD BE TAKEN AND ORIGINAL GROUND SECTIONS INTERPOLATED.

BASELINE STAKES SHOULD BE SET AT ALL P.C.'S, P.T.'S, T.S.'S, S.T.'S, S.C.'S, AND C.S.'S IN STAKING OUT ALIGNMENT, BUT SLOPE STAKES NEED NOT BE SET NOR CROSS SECTIONS TAKEN AT P.C.'S OR P.T.'S EXCEPT WHERE CALLED FOR IN THE ACCOMPANYING TABLES. THE TRANSITION WILL TAKE ITS FORM FROM THE POSITIONS GIVEN ON SHEETS 801.13 AND 801.14.

THE RIGHT OF WAY SHALL, IN ALL CASES, BE REFERENCED FROM THE BASELINE.

THE DESIGNER SHOULD AVOID SITUATIONS NECESSITATING REVERSE CURVES AND CURVES WITH OVERLAPPING TRANSITIONS WHERE POSSIBLE.

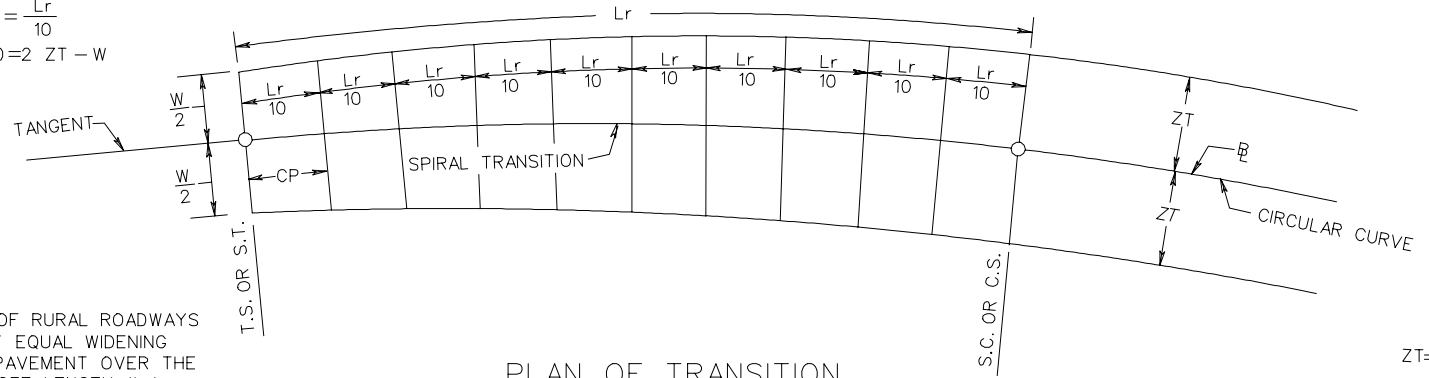
A DESIGN EXCEPTION IS NOT REQUIRED WHEN USING VALUES FROM SHEETS 801.21 THRU 801.40 SINCE THESE TABLES WERE DERIVED WITHIN AASHTO GUIDELINES.

ALL TANGENT RUNOUT SECTION VALUES LISTED IN THE TABLES HAVE BEEN ROUNDED UP TO THE NEAREST FOOT. ALL L_t VALUES ARE BASED ON A 2% CROWN.

EXPLANATION OF TABLES AND INSTRUCTIONS FOR USE
GENERAL CONDITION

VIRGINIA DEPARTMENT OF TRANSPORTATION

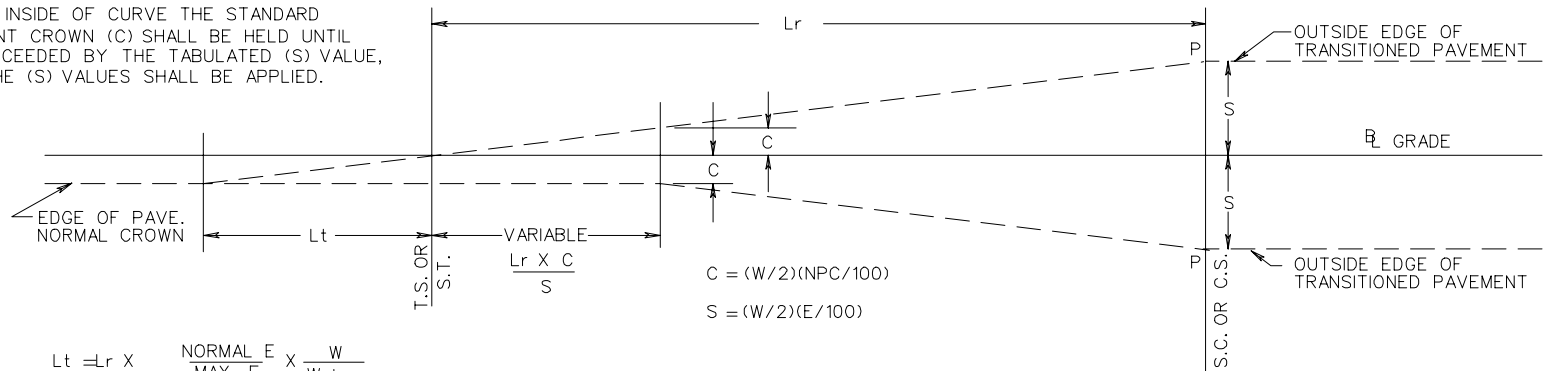
CHORD POINTS (CP) = $\frac{Lr}{10}$
 TOTAL WIDENING (W) = $2 ZT - W$



NOTE:
 PAVEMENT WIDENING OF RURAL ROADWAYS
 WILL BE ACHIEVED BY EQUAL WIDENING
 OF BOTH EDGES OF PAVEMENT OVER THE
 SUPERELEVATION RUNOFF LENGTH (L_r).

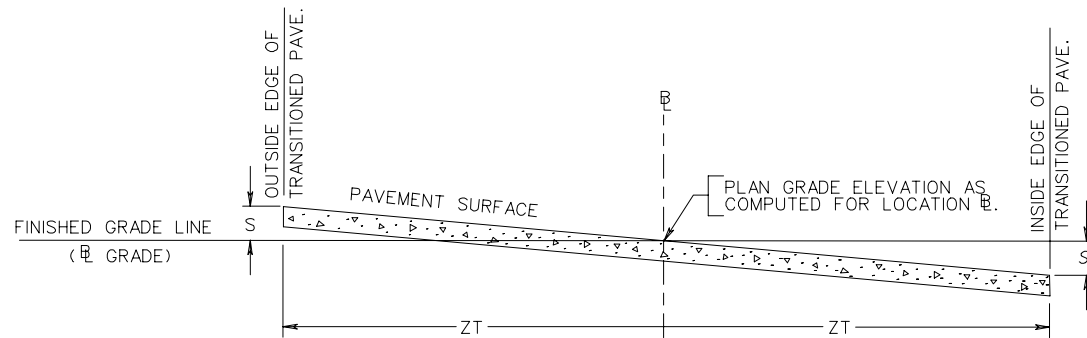
PLAN OF TRANSITION

NOTE:
 ON THE INSIDE OF CURVE THE STANDARD
 PAVEMENT CROWN (C) SHALL BE HELD UNTIL
 IT IS EXCEEDED BY THE TABULATED (S) VALUE,
 THEN THE (S) VALUES SHALL BE APPLIED.



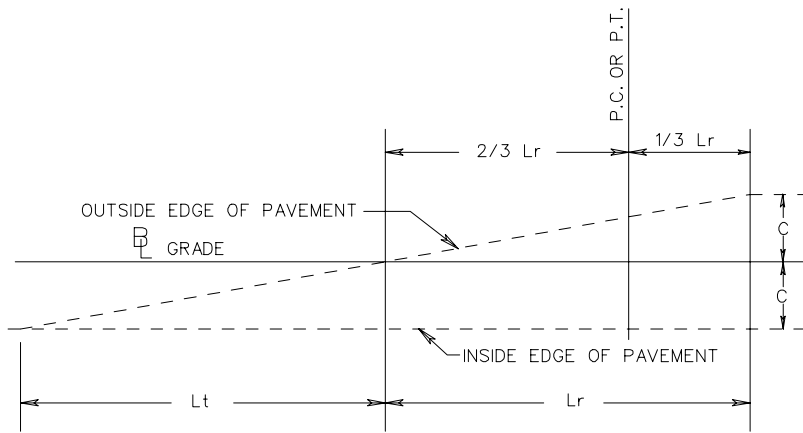
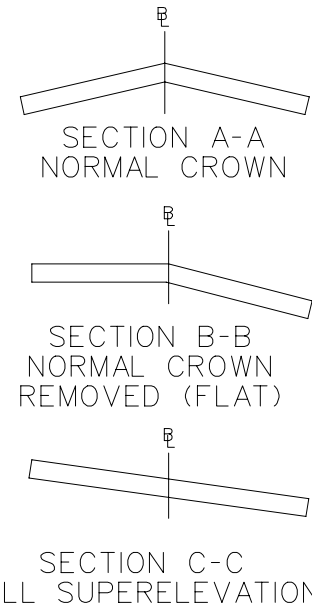
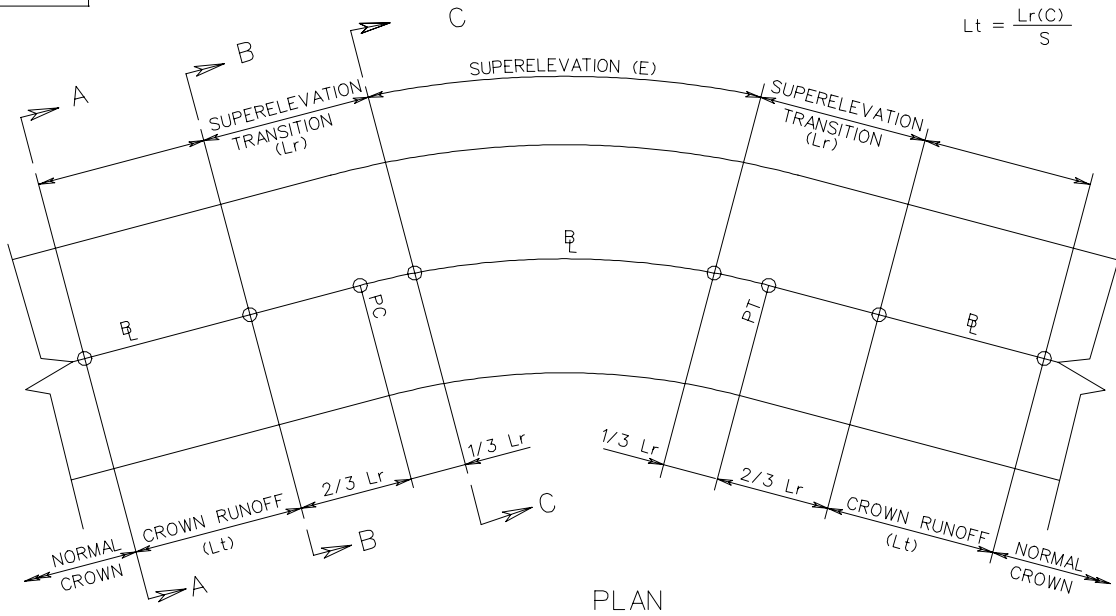
PROFILE OF TRANSITION

NOTE: SHORT VERTICAL CURVES SHOULD BE INSERTED
 BY EYE AT POINTS (P) IF CONSIDERED NECESSARY.

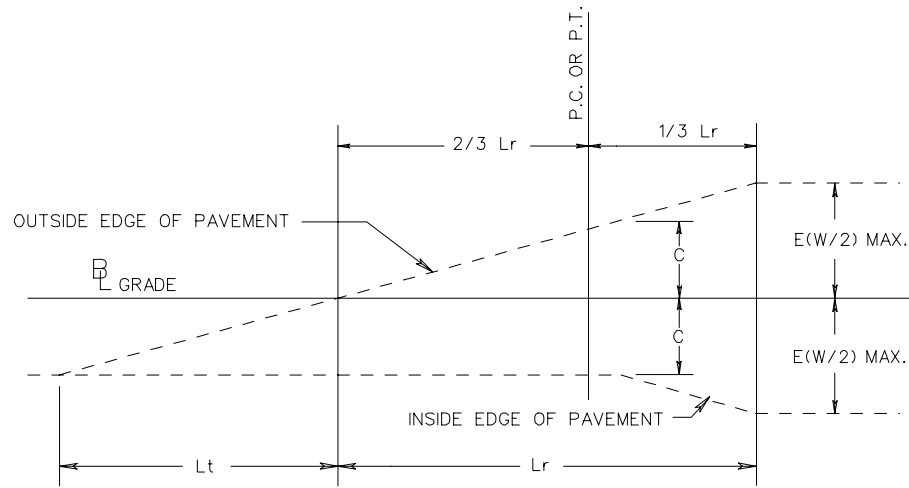


CROSS SECTION THRU TRANSITION

DETAILS FOR TRANSITIONED \mathcal{E} RURAL CONDITION WITH PAVEMENT WIDENING



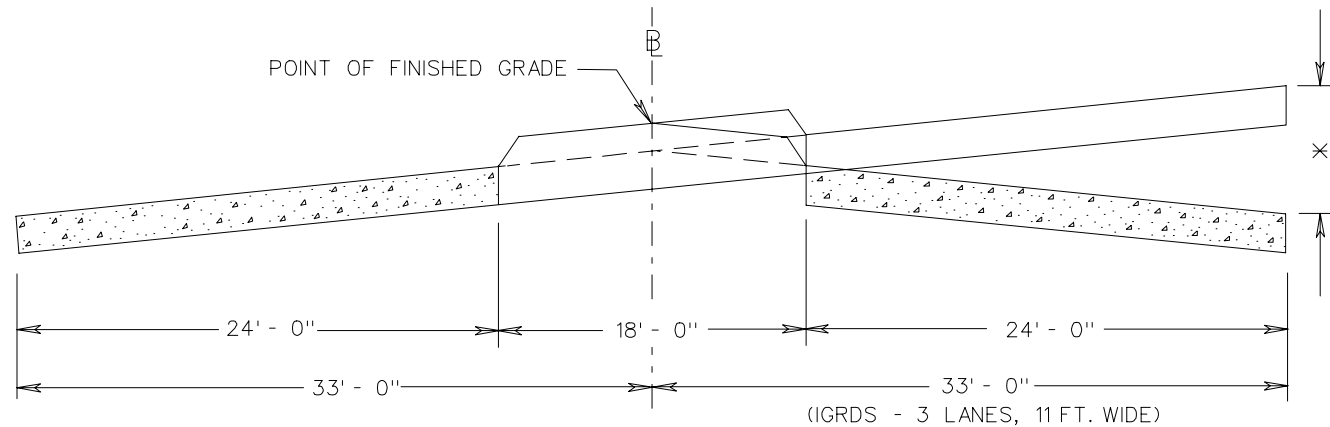
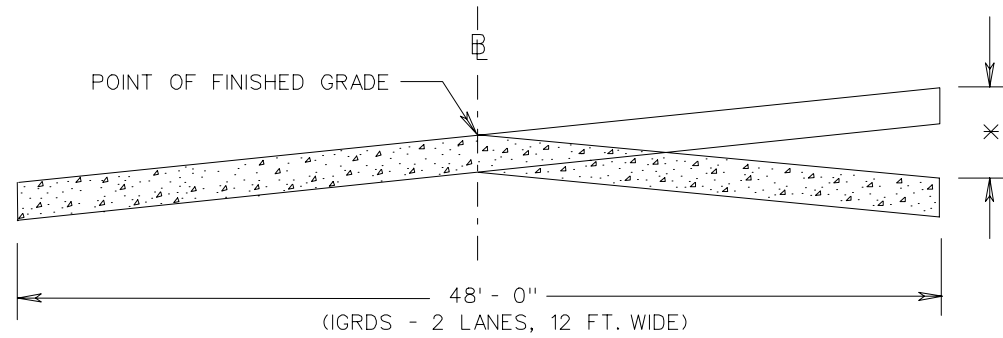
SUPERELEVATED BY AN AMOUNT EQUAL TO THE STANDARD PAVEMENT CROWN



NOTE : ON THE INSIDE OF CURVE THE STANDARD PAVEMENT CROWN (C) SHALL BE HELD UNTIL IT IS EXCEEDED BY THE TABULATED RATE OF SUPERELEVATION (E).

SUPERELEVATED BY AN AMOUNT EXCEEDING THE STANDARD PAVEMENT CROWN

DETAILS FOR NON-TRANSITION $\frac{E}{S}$

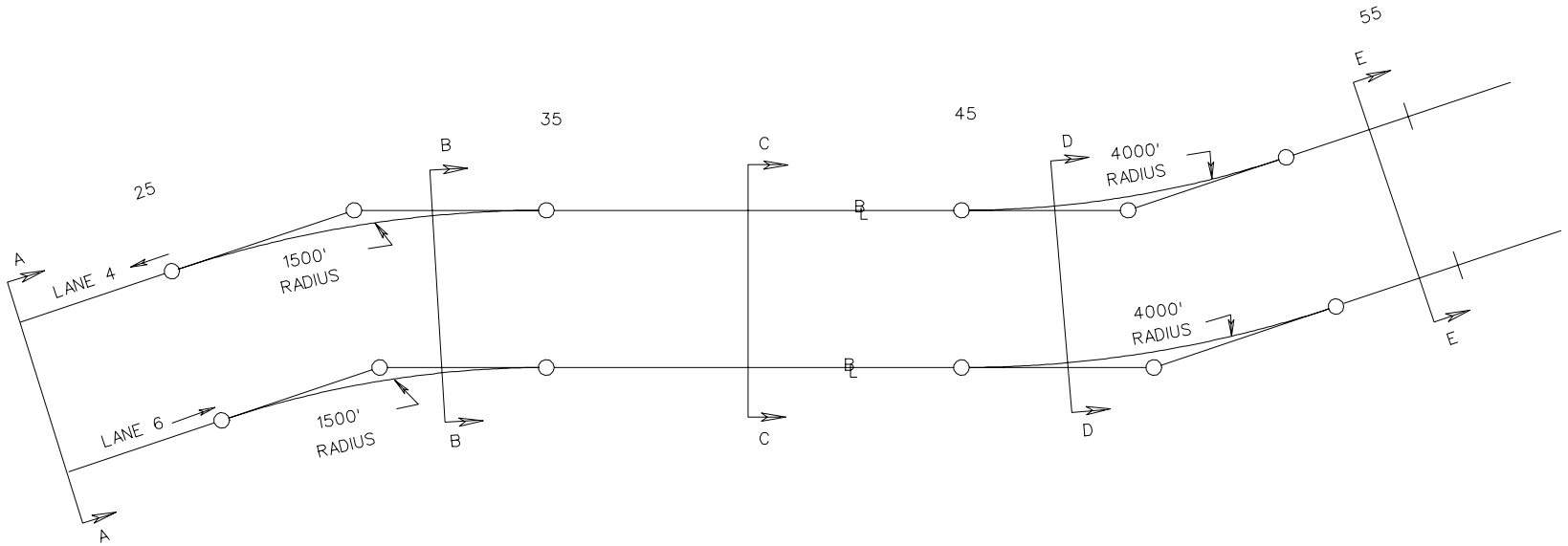


✕ THE ELEVATION DIFFERENTIAL BETWEEN NORMAL CROWN AND MAXIMUM SUPERELEVATION, RELATIVE TO THE BASELINE PROFILE.

ADDITIONAL INFORMATION MAY BE OBTAINED FROM A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (AASHTO) BOOK, CHAPTER III - ELEMENTS OF DESIGN (SUPERELEVATION RUNOFF).

ON STANDARD TC-5ULS, TC-5U, AND TC-5R (WITHOUT PAVEMENT WIDENING) SUPERELEVATED CURVES, POSITION THE L_r TWO THIRDS ($2/3$) ON THE TANGENT AND ONE THIRD ($1/3$) INTO THE CURVE. STATIONS AND ELEVATIONS FOR THESE TRANSITIONS WILL NEED TO BE COMPUTED FOR ALL CHORD POINTS AND SHOWN ON THE PROFILES.

DETAILS OF SUPERELEVATION ABOUT BASELINE



EXAMPLE FOR FOUR LANE ROADWAYS

VIRGINIA DEPARTMENT OF TRANSPORTATION

TRANSITION TABLE

LENGTH OF TANGENT RUNOUT (Lt)	START/END OF SUPERELEVATION RUNOFF SECTION (Lr)	DISTANCE IN FEET FROM START/END OF SUPERELEVATION RUNOFF SECTION				NORMAL CROWN
		1	2	3	4	
220	0	44	88	132	176	220
200	0	40	80	120	140	200
180	0	36	72	108	144	180
160	0	32	64	96	128	160
140	0	28	56	84	112	140
120	0	24	48	72	96	120
100	0	20	40	60	80	100
90	0	18	36	54	72	90
80	0	16	32	48	64	80
60	0	15	30	45	———	60
40	0	20	———	———	———	40

NOTE:

TABLE LISTS POSITIONS ON TRANSITIONS AT WHICH SLOPE STAKES SHOULD BE SET, CONSTRUCTION AND FINAL CROSS-SECTIONS TAKEN, FINE GRADING STAKES (BLUE TOP) SET, AND FORM STAKES SET (CONCRETE PAVEMENT ONLY).

SUPERELEVATION RUNOFF (Lr) / TANGENT RUNOUT (Lt) TABLE

URBAN CONDITIONS

RURAL CONDITIONS WITHOUT PAVEMENT WIDENING

FOR USE WITH FLEXIBLE AND CONCRETE PAVEMENT
(Lr POSITIONED 2/3 ±ON TANGENT, 1/3 ±ON CURVE)

LENGTH OF SUPERELEVATION RUNOFF SECTION (Lr)	END/ BEGIN TANGENT RUNOUT (Lt)	DISTANCE IN FEET FROM P.C. OR P.T. ON TANGENT						P.C. OR P.T.	DISTANCE IN FEET FROM P.C. OR P.T. ON CURVE			FULL SUPER ELEVATION (E)
		1	2	3	4	5	6		7	8	9	
480	320	272	224	176	128	80	32	STAKE	16	64	112	160
460	307	261	215	169	123	77	31	STAKE	15	61	107	153
440	293	249	205	161	117	73	29	STAKE	15	59	103	147
420	280	238	196	154	112	70	28	STAKE	14	56	98	140
400	267	227	187	147	107	67	27	STAKE	13	53	93	133
380	253	215	177	139	101	63	25	STAKE	13	51	89	127
360	240	204	168	132	96	60	24	STAKE	12	48	84	120
340	227	193	159	125	91	57	23	STAKE	11	45	79	113
320	213	181	149	117	85	53	21	STAKE	11	43	75	107
300	200	170	140	110	80	50	20	STAKE	10	40	70	100
280	187	159	131	103	75	47	19	STAKE	9	37	65	93
260	173	147 *	121	95 *	69	43 *	17	STAKE *	9	35 *	61	87
240	160	136 *	112	88 *	64	40 *	16	STAKE *	8	32 *	56	80
220	147	125 *	103	81 *	59	37 *	15	STAKE *	7	29 *	51	73
200	133	113 *	93	73 *	53	33 *	13	STAKE *	7	27 *	47	67
180	120	102 *	84	66 *	48	30 *	12	STAKE *	6	24 *	42	60
160	107	91 *	75	59 *	43	27 *	11	STAKE *	5	21 *	37	53

NOTE :

TABLE GIVING POSITIONS ON CURVES AT WHICH SLOPE STAKES SHOULD BE SET,
CONSTRUCTION AND FINAL CROSS-SECTIONS TAKEN, FINE GRADING STAKES (BLUE TOP) SET,
AND FORM STAKES SET (CONCRETE PAVEMENT ONLY).

* DENOTES ADDITIONAL STAKING POSITIONS FOR USE WITH CONCRETE PAVEMENT ONLY.

TABLE I

RURAL CONDITIONS WITH PAVEMENT WIDENING

FOR USE WITH FLEXIBLE AND CONCRETE PAVEMENT

SUPERELEVATION RUNOFF SECTION (Lr)	T.S. OR S.T.	DISTANCE IN FEET FROM T.S. OR S.T. ALONG SPIRAL TRANSITION									S.C. OR C.S.
		1	2	3	4	5	6	7	8	9	
		480	0	48	96	144	192	240	288	336	
460	0	46	92	138	184	230	276	322	368	414	460
440	0	44	88	132	176	220	264	308	352	396	440
420	0	42	84	126	168	210	252	294	336	378	420
400	0	40	80	120	160	200	240	280	320	360	400
380	0	38	76	114	152	190	228	266	304	342	380
360	0	36	72	108	144	180	216	252	288	324	360
340	0	34	68	102	136	170	204	238	272	306	340
320	0	32	64	96	128	160	192	224	256	288	320
300	0	30	60	90	120	150	180	210	240	270	300
280	0	28	56	84	112	140	168	196	224	252	280
260	0	26 *	52	78 *	104	130 *	156	182 *	208	234 *	260
240	0	24 *	48	72 *	96	120 *	144	168 *	192	216 *	240
220	0	22 *	44	66 *	88	110 *	132	154 *	176	198 *	220
200	0	20 *	40	60 *	80	100 *	120	140 *	160	180 *	200
180	0	18 *	36	54 *	72	90 *	108	126 *	144	162 *	180
160	0	16 *	32	48 *	64	80 *	96	112 *	128	144 *	160

NOTE :

TABLE GIVING POSITIONS ON TRANSITION CURVES AT WHICH SLOPE STAKES SHOULD BE SET,
CONSTRUCTION AND FINAL CROSS-SECTIONS TAKEN, FINE GRADING STAKES (BLUE TOP) SET,
AND FORM STAKES SET (CONCRETE PAVEMENT ONLY).

* DENOTES ADDITIONAL STAKING POSITIONS FOR USE WITH CONCRETE PAVEMENT ONLY.

TABLE 2

VIRGINIA DEPARTMENT OF TRANSPORTATION

CURVE WIDENING TABLES

SU DESIGN VEHICLE

COMPONENT	SIZE
OVERALL WIDTH (u)	8.5 ft
WHEELBASE (L)	20 ft
FRONT OVERHANG (A)	4 ft

LATERAL CLEARANCE

LANE WIDTH	CLEARANCE (C)
8 ft	1 ft
9 ft	1.5 ft
10 ft	2 ft
11 ft	2.5 ft
12 ft	3 ft
16 ft	5 ft

EFFECTIVE WIDTHS

NUMBER OF LANES	EFFECTIVE WIDTHS (W)						EFFECTIVE WIDTH FACTOR (f)
	8 ft LANES	9 ft LANES	10 ft LANES	11 ft LANES	12 ft LANES	16 ft LANES	
1	8.0	9.0	10.0	11.0	12.0	16.0	1
1.5	9.6	10.8	12.0	13.2	14.4	19.2	1.2
2	12.0	13.5	15.0	16.5	18.0	24.0	1.5
3	16.0	18.0	20.0	22.0	24.0	32.0	2
4	32.0	36.0	40.0	44.0	48.0	64.0	4
5	40.0	45.0	50.0	55.0	60.0	80.0	5
6	48.0	54.0	60.0	66.0	72.0	96.0	6
7	56.0	63.0	70.0	77.0	84.0	112.0	7
8	64.0	72.0	80.0	88.0	96.0	128.0	8

DESIGN SPEED V _D MPH	RELATIVE GRADIENT (rg)		MIN. TRANSITION LENGTH IN FEET 2 SECOND RULE	
	UP TO 3 LANES	4 OR MORE LANES		
			URBAN	RURAL
20	0.75	1.14	100	60
25	0.71	1.07	100	80
30	0.67	1.00	100	100
35	0.63	0.93	120	120
40	0.58	0.86	120	120
45	0.54	0.81	140	140
50	0.50	0.75	160	160
55	0.47	0.69	180	180
60	0.45	0.67	180	180
65	0.41	0.62	200	200
70	0.40	0.60	220	220

DEFINITIONS

- A - FRONT OVERHANG OF DESIGN VEHICLE FROM APPROPRIATE TABLE.
- C - LATERAL CLEARANCE OF DESIGN VEHICLE FROM APPROPRIATE TABLE.
- E - SUPERELEVATION RATE IN DECIMAL FROM APPROPRIATE TABLE OR CALCULATED PER AASHTO METHOD 5.
- F_A - CALCULATED WIDTH OF OVERHANG FOR DESIGN VEHICLE.
- L - WHEELBASE OF DESIGN VEHICLE FROM APPROPRIATE TABLE.
- U - CALCULATED TRACK WIDTH OF DESIGN VEHICLE.
- L_r - LENGTH OF SPIRAL OR SUPERELEVATION RUNOFF SECTION.
- L_t - LENGTH OF TANGENT RUNOUT SECTION.
- M - MULTIPLE LANE (2 +) FACTOR.
- N - NUMBER OF LANES.
- P_w - PAVEMENT WIDTH.
- R - RADIUS OF CURVE.
- rg - RELATIVE GRADIENT FROM APPROPRIATE TABLE.
- u - TRACK WIDTH OF DESIGN VEHICLE FROM APPROPRIATE TABLE.
- V_D - DESIGN VELOCITY.
- w - CALCULATED WIDENING.
- W - EFFECTIVE WIDTH FROM APPROPRIATE TABLE.
- W_C - CALCULATED TOTAL CURVE WIDTH.
- W_n - WIDTH OF LANE.
- Z - CALCULATED EXTRA WIDTH ALLOWANCE.

GENERAL DESIGN CONSIDERATIONS

1. WHERE PAVEMENT WIDENING IS REQUIRED, THE APPROPRIATE WIDENING IS ADDED TO THE LANE WIDTH WHEN CALCULATING THE SUPERELEVATION RUNOFF SECTION (L_r).
2. THE COMPUTED TRANSITION LENGTH (L_r) IS ROUNDED UP TO THE NEAREST TWENTY FOOT INCREMENT. COMPUTED LENGTHS THAT FALL ON THE TWENTY FOOT INCREMENT ARE NOT ROUNDED.
3. WHEN THE SUPERELEVATION RUNOFF SECTION (L_r) IS CALCULATED, IT MUST BE COMPARED WITH THE MINIMUM VALUE LISTED IN THE APPROPRIATE COLUMN ON THE RELATIVE GRADIENT TABLE.
4. TANGENT RUNOUT SECTION (L_t) IS ALWAYS ACHIEVED OUTSIDE OF THE TRANSITION.
5. NO PAVEMENT WIDENING IS REQUIRED FOR URBAN ROADWAYS.
6. NO PAVEMENT WIDENING IS REQUIRED FOR RURAL ROADWAYS WITH A CURVE RADIUS GREATER THAN 2865 FEET.
7. NO PAVEMENT WIDENING IS REQUIRED FOR RURAL ROADWAYS WITH 12 FOOT WIDE LANES AND A CURVE RADIUS GREATER THAN 881 FEET.
8. PAVEMENT WIDENING IS APPLIED ONLY WHEN CALCULATED WIDENING (w) IS EQUAL TO OR GREATER THAN 2 FEET.
9. WHEN CALCULATING WIDENING (w) FOR MULTI-LANE RURAL ROADWAYS, WIDENING IS FIRST CALCULATED USING THE SINGLE LANE WIDTH FOR "W" AND THE ANSWER (w) IS THEN MULTIPLIED BY THE MULTIPLE LANE FACTOR (M). FOR FOUR LANE UNDIVIDED PAVEMENTS (48'), THE L_r IS 1.5 TIMES (M=1.5) THE CORRESPONDING LENGTH FOR TWO LANE HIGHWAYS; AND FOR SIX LANE UNDIVIDED PAVEMENTS (72'), THE L_r IS TWO TIMES (M=2) THE CORRESPONDING LENGTH FOR TWO LANE HIGHWAYS.
10. CALCULATED WIDENING IS ROUNDED UP TO THE NEAREST 0.1 FOOT.

FORMULAS USED TO CALCULATE TRANSITION LENGTH (L_r) AND WIDENING (W)

$$L_r = (100WE) / rg \quad (\text{NO WIDENING REQUIRED})$$

$$L_r = [100(W + w/2)E] / rg \quad (\text{WIDENING REQUIRED})$$

$$L_r = M[100(P_w/N + w/N)E] / rg \quad (\text{MULTI-LANE WIDENING REQUIRED})$$

$$U = u + R - \sqrt{R^2 - L^2}$$

$$F = \sqrt{R^2 + A(2L + A)} - R$$

$$Z = (V_D / \sqrt{R})$$

$$W_C = N(U + C) + F + Z A$$

$$w = W_C - 2W_n$$

FOR SOLVED PROBLEMS USING THIS METHODOLOGY, SEE THE EXAMPLES ON PAGE 801.19.

METHODOLOGIES FOR CALCULATING TC-5 VALUES

RURAL EXAMPLE
20 FT PAVEMENT WIDTH
(IGRDS - 1 LANE AT 10 FT)

$$\begin{aligned} V_D &= 50 \text{ MPH} & R &= 1000 \text{ FT} \\ W_n &= 10 \text{ FT} & r_g &= 0.50 \\ E &= 0.076 \text{ (7.6\% CALCULATED PER AASHTO METHOD 5)} \end{aligned}$$

$$\begin{aligned} U &= u + R - \sqrt{R^2 - L^2} \\ U &= 8.5 + 1000 - \sqrt{(1000)^2 - (20)^2} \\ U &= 8.70002 \end{aligned}$$

$$\begin{aligned} F_A &= \sqrt{R^2 + A(2L + A)} - R \\ F_A &= \sqrt{(1000)^2 + 4[2(20) + 4]} - 1000 \\ F_A &= .087996 \end{aligned}$$

$$\begin{aligned} Z &= (V_D / \sqrt{R}) \\ Z &= (50 / \sqrt{1000}) \\ Z &= 1.58 \end{aligned}$$

$$\begin{aligned} W_C &= 2(U + C) + F_A + Z \\ W_C &= 2(8.70002 + 2) + 0.08996 + 1.58 \\ W_C &= 23.0692 \end{aligned}$$

$$w = W_C - 2W_n = 23.069 - 2(10) = 3.069$$

($R < 2865$ & $w > 2$ THEREFORE WIDENING IS REQUIRED)

$$\begin{aligned} L_r &= [100(W + w/2)E] / r_g \\ L_r &= [100(10 + 3.068/2)0.076] / 0.50 \\ L_r &= 175.56 \text{ (180 ROUNDED)} \end{aligned}$$

RURAL EXAMPLE
72 FT PAVEMENT WIDTH
(IGRDS - 3 LANES AT 12 FT)

$$\begin{aligned} V_D &= 40 \text{ MPH} & R &= 600 \text{ FT} \\ W_n &= 24 \text{ FT} & r_g &= 0.58 \\ E &= 0.077 \text{ (7.7\% CALCULATED PER AASHTO METHOD 5)} \end{aligned}$$

COMPUTE FOR 24' PAVEMENT WIDTH (IGRDS 1 @ 12')

$$\begin{aligned} U &= u + R - \sqrt{R^2 - L^2} \\ U &= 8.5 + 600 - \sqrt{(600)^2 - (20)^2} \\ U &= 8.8334 \end{aligned}$$

$$\begin{aligned} F_A &= \sqrt{R^2 + A(2L + A)} - R \\ F_A &= \sqrt{(600)^2 + 4[2(20) + 4]} - 600 \\ F_A &= .14665 \end{aligned}$$

$$\begin{aligned} Z &= (V_D / \sqrt{R}) \\ Z &= (40 / \sqrt{600}) \\ Z &= 1.6329 \end{aligned}$$

$$\begin{aligned} W_C &= 2(U + C) + F_A + Z \\ W_C &= 2(8.8334 + 3.0) + .14665 + 1.632 \\ W_C &= 25.4464 \end{aligned}$$

$$w = W_C - 2W_n = 25.4455 - 2(12) = 1.4464(1.5)$$

FOR 72' PAVEMENT WIDTH

$$w = 3(1.5) = 4.5$$

($R < 881$ & $w > 2$ THEREFORE WIDENING IS REQUIRED)

$$\begin{aligned} L_r &= M[100(P_w/N + w/N)E] / r_g \\ L_r &= 2[100(72/6 + 4.5/6)0.077] / 0.58 \\ L_r &= 2[100(12.75 + 0.77)] / 0.58 \\ L_r &= 2(98.175) / 0.58 \\ L_r &= 2(169.2672414) \\ L_r &= 338.5344828 \text{ (ROUNDED TO 340)} \end{aligned}$$

URBAN EXAMPLES

24 FT PAVEMENT WIDTH
(IGRDS - 1 LANE AT 12 FT)

$$\begin{aligned} V_D &= 40 \text{ MPH} & R &= 600 \text{ FT} \\ W_n &= 12 \text{ FT} & r_g &= 0.58 \\ E &= 0.04 \text{ (4\% PER PAGE 801.25)} \end{aligned}$$

(NO WIDENING REQUIRED)

$$\begin{aligned} L_r &= [100(12)(0.04)] / 0.58 \\ L_r &= 82.759 < 120 \text{ (MIN. LS) THEREFORE} \\ L_r &= 120 \end{aligned}$$

66 FT PAVEMENT WIDTH
(IGRDS - 3 LANES AT 11 FT)

$$\begin{aligned} V_D &= 40 \text{ MPH} & R &= 600 \text{ FT} \\ W_n &= 22 \text{ FT} & r_g &= 0.58 \\ E &= 0.04 \text{ (4\% PER PAGE 801.25)} \end{aligned}$$

(NO WIDENING REQUIRED)

$$\begin{aligned} L_r &= [100(22)(0.04)] / 0.58 \\ L_r &= 151.72 \text{ (ROUND TO 160)} > 120 \text{ (MIN. LS)} \\ L_r &= 160 \end{aligned}$$

CALCULATED TC-5 EXAMPLES

RADIUS (FEET)	E (%)	F	DV (MPH)	NC (MPH)	PAVEMENT WIDTH	
					W ≤ 72 FT.	W > 72 FT
					Lr (FEET)	
≥ 975	2.1	.161	45	45	140	NOTE: FOR PAVEMENTS WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY IGRDS WITH AN ABSOLUTE MINIMUM Lr OF 90 FEET.
750	2.1	.161	45	41	140	
700	2.1	.164	44	40	120	
550	2.1	.178	40	37	120	
475	2.1	.186	38	35	120	
375	2.1	.197	35	32	120	
300	2.1	.211	32	30	100	
250	2.1	.221	30	28	100	
200	2.1	.240	27	25	100	
175	2.1	.252	25	24	90	
100	2.1	.290	21	20	90	
90	2.1	.300	20	20	90	

SUMMARY OF STD. TC-5ULS (URBAN-LOW SPEED) DESIGN FACTORS

DESIGN FACTORS FOR A DESIGN SPEED OF 20 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
20000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
15000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
10000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
7000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
5000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
4000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
3000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
2500	2.1	100	100	100	100	100	100	100	100	100	100	100	100
2250	2.1	100	100	100	100	100	100	100	100	100	100	100	100
2000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1750	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1500	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1300	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1150	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
900	2.1	100	100	100	100	100	100	100	100	100	100	100	100
800	2.3	92	100	92	100	92	100	92	100	92	100	92	100
750	2.3	92	100	92	100	92	100	92	100	92	100	92	100
700	2.4	88	100	88	100	88	100	88	100	88	100	88	100
650	2.5	84	100	84	100	84	100	84	100	84	100	84	100
600	2.5	84	100	84	100	84	100	84	100	84	100	84	100
550	2.6	81	100	81	100	81	100	81	100	81	100	81	100
500	2.7	78	100	78	100	78	100	78	100	78	100	78	100
475	2.7	78	100	78	100	78	100	78	100	78	100	78	100
450	2.8	75	100	75	100	75	100	75	100	75	100	75	100
425	2.8	75	100	75	100	75	100	75	100	75	100	75	100
400	2.9	73	100	73	100	73	100	73	100	73	100	73	100
375	3.0	70	100	70	100	70	100	70	100	70	100	70	100
350	3.1	68	100	68	100	68	100	68	100	68	100	68	100
325	3.1	68	100	68	100	68	100	68	100	68	100	68	100
300	3.2	66	100	66	100	66	100	66	100	66	100	79	120
280	3.3	64	100	64	100	64	100	64	100	64	100	77	120
265	3.4	62	100	62	100	62	100	62	100	62	100	75	120
250	3.5	60	100	60	100	60	100	60	100	72	120	72	120
235	3.5	60	100	60	100	60	100	60	100	72	120	72	120
220	3.6	59	100	59	100	59	100	59	100	70	120	70	120
205	3.7	57	100	57	100	57	100	57	100	69	120	69	120
190	3.8	56	100	56	100	56	100	67	120	67	120	78	140
175	3.9	54	100	54	100	54	100	65	120	65	120	76	140
160	3.9	54	100	54	100	54	100	65	120	65	120	76	140
145	4.0	53	100	53	100	53	100	63	120	63	120	74	140
130	4.0	53	100	53	100	53	100	63	120	63	120	74	140
⊗127	4.0	53	100	53	100	53	100	63	120	63	120	74	140

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS WITH AN
ABSOLUTE MINIMUM Lr OF 100 FEET.

⊗ MINIMUM ALLOWABLE RADIUS

URBAN LOW SPEED DESIGN TABLE

DV/NC	MAX. f	C	Lr
45	0.161	2.75	140
40	0.178	3.00	120
35	0.197	3.25	120
30	0.221	3.50	100
25	0.252	3.75	90
20	0.300	4.00	90

LEGEND

- C- RATE OF CHANGE OF SIDE FRICTION (f) IN FT./SEC.³
- e- SUPERELEVATION RATE IN PERCENT.
- f- FRICTION FACTOR.
- Lr- LENGTH OF SUPERELEVATION RUNOFF SECTION.
- Lt- LENGTH OF TANGENT RUNOUT SECTION
- R- RADIUS OF CURVE.
- DV- DESIGN VELOCITY UTILIZING SUPERELEVATION.
- NC- MAXIMUM VELOCITY WITH NO SUPERELEVATION (NORMAL CROWN).

FRICTION FACTORS (f) FOR ODD VELOCITIES NOT LISTED SHOULD BE DERIVED BY INTERPOLATION.

FOR Lr LENGTHS FOR INTERMEDIATE VELOCITIES NOT LISTED IN TABLE USE THE Lr FOR NEXT LOWER VELOCITY IN TABLE.

GENERAL DESIGN CONSIDERATIONS

1. WHEN "URBAN LOW SPEED" DESIGNS UTILIZE SUPERELEVATION, THEY WILL BE SUPERELEVATED BY AN AMOUNT EQUAL TO THE NORMAL CROWN (TYPICALLY 2%) AND THE APPROXIMATE MAXIMUM SAFE SPEED (DV) AFFORDED THEREBY.
2. WHEN "URBAN LOW SPEED DESIGN" WITH NO SUPERELEVATION, THE APPROXIMATE MAXIMUM SAFE SPEED (NC) IS CALCULATED USING A NEGATIVE NORMAL CROWN (TYPICALLY -2%).
3. WHEN THE CURVE IS SUPERELEVATED, THE Lr IS APPLIED IN THE SAME MANNER AS IN URBAN CONDITIONS WITH THE TANGENT RUNOUT SECTION (Lt) BEING EQUAL TO THE Lr VALUE. THE CROWN RUNOUT SECTION (Lt) IS ALWAYS ACHIEVED OUTSIDE OF THE TRANSITION (Lr).
4. PLEASE NOTE THAT THE RADIUS VALUES LISTED ON PAGE 801.20 HAVE BEEN ROUNDED UP TO THE NEAREST TWENTY FIVE FOOT INCREMENT.

EXAMPLES

DV = 21 mph

e = +2.1%

f = 300-[1/5(0.300-0.252)]=0.2904 (ROUND TO 0.29)

Lr = 47.2 f DV/C=47.2(0.29)(21)/4=71.862 FT.

= 71.862 <90 THEREFORE Lr=90 FT.

Rmin. = (21)²/15(0.021+0.29)=94.53376206 FT.

NC = 37 mph

e = -2.1%

f = 0.197-[2/5(0.197-0.178)]=0.1894 (ROUND TO 0.189)

Rmin. = (37)²/15(-0.021+0.189)=543.2539683 FT.

METHODOLOGIES FOR CALCULATING TC-5 VALUES FOR URBAN LOW-SPEED STREETS

DESIGN FACTORS FOR A DESIGN SPEED OF 25 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
20000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
15000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
10000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
7000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
5000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
4000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
3000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
2500	2.1	100	100	100	100	100	100	100	100	100	100	100	100
2250	2.1	100	100	100	100	100	100	100	100	100	100	100	100
2000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1750	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1500	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1300	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1150	2.3	92	100	92	100	92	100	92	100	92	100	92	100
1000	2.4	88	100	88	100	88	100	88	100	88	100	88	100
900	2.5	84	100	84	100	84	100	84	100	84	100	84	100
800	2.6	81	100	81	100	81	100	81	100	81	100	81	100
750	2.7	78	100	78	100	78	100	78	100	78	100	78	100
700	2.8	75	100	75	100	75	100	75	100	75	100	75	100
650	2.9	73	100	73	100	73	100	73	100	73	100	73	100
600	2.9	73	100	73	100	73	100	73	100	73	100	73	100
550	3.0	70	100	70	100	70	100	70	100	70	100	84	120
500	3.2	66	100	66	100	66	100	66	100	66	100	79	120
475	3.2	66	100	66	100	66	100	66	100	66	100	79	120
450	3.3	64	100	64	100	64	100	64	100	77	120	77	120
425	3.4	62	100	62	100	62	100	62	100	75	120	75	120
400	3.4	62	100	62	100	62	100	62	100	75	120	75	120
375	3.5	60	100	60	100	60	100	60	100	72	120	72	120
350	3.6	59	100	59	100	59	100	70	120	70	120	82	140
325	3.7	57	100	57	100	57	100	69	120	69	120	80	140
300	3.8	56	100	56	100	56	100	67	120	67	120	78	140
280	3.9	54	100	54	100	54	100	65	120	76	140	76	140
265	3.9	54	100	54	100	54	100	65	120	76	140	76	140
250	4.0	53	100	53	100	63	120	63	120	74	140	74	140
235	4.0	53	100	53	100	63	120	63	120	74	140	74	140
220	4.0	53	100	53	100	63	120	63	120	74	140	74	140
⊕204	4.0	53	100	53	100	63	120	63	120	74	140	74	140

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS WITH AN
ABSOLUTE MINIMUM Lr OF 100 FEET.

⊕MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 30 MPH
(URBAN) USING E=4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
20000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
15300	2.1	100	100	100	100	100	100	100	100	100	100	100	100
10000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
7000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
5300	2.1	100	100	100	100	100	100	100	100	100	100	100	100
4000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
3000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
2530	2.1	100	100	100	100	100	100	100	100	100	100	100	100
2250	2.1	100	100	100	100	100	100	100	100	100	100	100	100
2000	2.1	100	100	100	100	100	100	100	100	100	100	100	100
1750	2.2	96	100	96	100	96	100	96	100	96	100	96	100
1500	2.4	88	100	88	100	88	100	88	100	88	100	88	100
1000	2.5	84	100	84	100	84	100	84	100	84	100	84	100
1150	2.6	81	100	81	100	81	100	81	100	81	100	81	100
1000	2.8	75	100	75	100	75	100	75	100	75	100	90	120
900	2.9	73	100	73	100	73	100	73	100	73	100	87	120
800	3.0	70	100	70	100	70	100	70	100	70	100	84	120
750	3.1	68	100	68	100	68	100	68	100	82	120	82	120
700	3.2	66	100	66	100	66	100	66	100	79	120	79	120
650	3.3	64	100	64	100	64	100	64	100	77	120	77	120
600	3.4	62	100	62	100	62	100	75	120	75	120	87	140
570	3.5	60	100	60	100	60	100	72	120	72	120	84	140
500	3.6	59	100	59	100	59	100	70	120	70	120	82	140
475	3.7	57	100	57	100	57	100	69	120	80	140	80	140
450	3.8	56	100	56	100	67	120	67	120	78	140	78	140
425	3.8	56	100	56	100	67	120	67	120	78	140	78	140
400	3.9	54	100	54	100	65	120	65	120	76	140	76	140
375	3.9	54	100	54	100	65	120	65	120	76	140	76	140
350	4.0	53	100	53	100	63	120	63	120	74	140	84	160
325	4.0	53	100	53	100	63	120	63	120	74	140	84	160
⊗ 300	4.0	53	100	53	100	63	120	63	120	74	140	84	160

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS WITH AN
ABSOLUTE MINIMUM Lr OF 100 FEET.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 35 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
20000	2.1	120	120	120	120	120	120	120	120	120	120	120	120
15000	2.1	120	120	120	120	120	120	120	120	120	120	120	120
10000	2.1	120	120	120	120	120	120	120	120	120	120	120	120
7000	2.1	120	120	120	120	120	120	120	120	120	120	120	120
5000	2.1	120	120	120	120	120	120	120	120	120	120	120	120
4000	2.1	120	120	120	120	120	120	120	120	120	120	120	120
3000	2.1	120	120	120	120	120	120	120	120	120	120	120	120
2500	2.1	120	120	120	120	120	120	120	120	120	120	120	120
2250	2.2	115	120	115	120	115	120	115	120	115	120	115	120
2000	2.4	105	120	105	120	105	120	105	120	105	120	105	120
1750	2.5	101	120	101	120	101	120	101	120	101	120	101	120
1500	2.7	94	120	94	120	94	120	94	120	94	120	94	120
1300	2.8	90	120	90	120	90	120	90	120	90	120	90	120
1150	3.0	84	120	84	120	84	120	84	120	84	120	84	120
1000	3.2	79	120	79	120	79	120	79	120	79	120	92	140
900	3.3	77	120	77	120	77	120	77	120	77	120	90	140
800	3.5	72	120	72	120	72	120	72	120	84	140	84	140
750	3.5	72	120	72	120	72	120	72	120	84	140	84	140
700	3.6	70	120	70	120	70	120	70	120	82	140	82	140
650	3.7	69	120	69	120	69	120	69	120	80	140	91	160
600	3.8	67	120	67	120	67	120	78	140	78	140	89	160
550	3.9	65	120	65	120	65	120	76	140	76	140	87	160
500	4.0	63	120	63	120	63	120	74	140	74	140	84	160
475	4.0	63	120	63	120	63	120	74	140	74	140	84	160
450	4.0	63	120	63	120	63	120	74	140	74	140	84	160
425	4.0	63	120	63	120	63	120	74	140	74	140	84	160
⊕ 420	4.0	63	120	63	120	63	120	74	140	74	140	84	160

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS WITH AN
ABSOLUTE MINIMUM Lr OF 120 FEET.

⊕ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 40 MPH
(URBAN) USING E= 4 % MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr		
20000	2.1	120	120	120	120	120	120	120	120	120	120	120	
15000	2.1	120	120	120	120	120	120	120	120	120	120	120	
10000	2.1	120	120	120	120	120	120	120	120	120	120	120	
7000	2.1	120	120	120	120	120	120	120	40	120	120	120	
5000	2.1	120	120	120	120	120	120	120	120	120	120	120	
4000	2.1	120	120	120	120	120	120	120	120	120	120	120	
3000	2.2	115	120	115	120	115	120	115	120	115	120	115	
2500	2.4	105	120	105	120	105	120	105	120	105	120	105	
2250	2.5	101	120	101	120	101	120	101	120	101	120	101	
2000	2.7	94	120	94	120	94	120	94	120	94	120	94	
1750	2.8	90	120	90	120	90	120	90	120	90	120	90	
1500	3.0	84	120	84	120	84	120	84	120	84	120	98	
1300	3.2	79	120	79	120	79	120	79	120	92	140	92	
1150	3.3	77	120	77	120	77	120	77	120	90	140	90	
1000	3.5	72	120	72	120	72	120	84	140	84	140	96	
900	3.7	69	120	69	120	69	120	80	140	91	160	91	
800	3.8	67	120	67	120	67	120	78	140	89	160	89	
750	3.9	65	120	65	120	76	140	76	140	87	160	97	
700	3.9	65	120	65	120	76	140	76	140	87	160	97	
650	4.0	63	120	63	120	74	140	74	140	84	160	95	
600	4.0	63	120	63	120	74	140	74	140	84	160	95	
⊕563	4.0	63	120	63	120	74	140	74	140	84	160	95	

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS WITH AN
ABSOLUTE MINIMUM Lr OF 120 FEET.

⊕ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 45 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH												
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)												
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'		
Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	
20000	2.1	140	140	140	140	140	140	140	140	140	140	140	140	140
15000	2.1	140	140	140	140	140	140	140	140	140	140	140	140	140
10000	2.1	140	140	140	140	140	140	140	140	140	140	140	140	140
7000	2.1	140	140	140	140	140	140	140	140	140	140	140	140	140
5000	2.1	140	140	140	140	140	140	140	140	140	140	140	140	140
4000	2.1	140	140	140	140	140	140	140	140	140	140	140	140	140
3000	2.5	118	140	118	140	118	140	118	140	118	140	118	140	140
2500	2.7	109	140	109	140	109	140	109	140	109	140	109	140	140
2250	2.8	105	140	105	140	105	140	105	140	105	140	105	140	140
2000	2.9	102	140	102	140	102	140	102	140	102	140	102	140	140
1750	3.1	95	140	95	140	95	140	95	140	95	140	95	140	140
1500	3.3	90	140	90	140	90	140	90	140	90	140	102	160	160
1300	3.5	84	140	84	140	84	140	84	140	96	160	96	160	160
1150	3.7	80	140	80	140	80	140	80	140	91	160	103	180	180
1000	3.9	76	140	76	140	76	140	87	160	87	160	97	180	180
900	4.0	74	140	74	140	74	140	84	160	95	160	95	180	180
800	4.0	74	140	74	140	74	140	84	160	95	180	95	180	180
750	4.0	74	140	74	140	74	140	84	160	95	180	95	180	180
⊗ 732	4.0	74	140	74	140	74	140	84	160	95	180	95	180	180

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS WITH AN
ABSOLUTE MINIMUM Lr OF 140 FEET.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 50 MPH
(URBAN) USING E= 4 % MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
20000	2.1	160	160	160	160	160	160	160	160	160	160	160	160
15000	2.1	160	160	160	160	160	160	160	160	160	160	160	160
10000	2.1	160	160	160	160	160	160	160	160	160	160	160	160
7000	2.1	160	160	160	160	160	160	160	160	160	160	160	160
5000	2.1	160	160	160	160	160	160	160	160	160	160	160	160
4000	2.4	140	160	140	160	140	160	140	160	140	160	140	160
3000	2.7	125	160	125	160	125	160	125	160	125	160	125	160
2500	2.9	116	160	116	160	116	160	116	160	116	160	116	160
2250	3.1	109	160	109	160	109	160	109	160	109	160	109	160
2000	3.2	105	160	105	160	105	160	105	160	105	160	105	160
1750	3.4	99	160	99	160	99	160	99	160	99	160	112	180
1500	3.6	94	160	94	160	94	160	94	160	94	160	105	180
1300	3.8	89	160	89	160	89	160	89	160	100	180	111	200
1150	3.9	87	160	87	160	87	160	87	160	97	180	108	200
1000	4.0	84	160	84	160	84	160	84	160	95	180	105	200
929 ⊗	4.0	84	160	84	160	84	160	84	160	95	180	105	200

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS WITH AN
ABSOLUTE MINIMUM Lr OF 160 FEET.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 55 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
20000	2.1	180	180	180	180	180	180	180	180	180	180	180	180
15000	2.1	180	180	180	180	180	180	180	180	180	180	180	180
10000	2.1	180	180	180	180	180	180	180	180	180	180	180	180
7000	2.1	180	180	180	180	180	180	180	180	180	180	180	180
5000	2.3	165	180	165	180	165	180	165	180	165	180	165	180
4000	2.6	146	180	146	180	146	180	146	180	146	180	146	180
3000	3.0	126	180	126	180	126	180	126	180	126	180	126	180
2500	3.3	115	180	115	180	115	180	115	180	115	180	115	180
2250	3.4	112	180	112	180	112	180	112	180	112	180	112	180
2000	3.6	105	180	105	180	105	180	105	180	105	180	117	200
1750	3.8	100	180	100	180	100	180	100	180	100	180	111	200
1500	3.9	97	180	97	180	97	180	97	180	108	200	108	200
1300	4.0	95	180	95	180	95	180	95	180	105	200	116	220
⊗ 1190	4.0	95	180	95	180	95	180	95	180	105	200	116	220

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS WITH AN
ABSOLUTE MINIMUM Lr OF 180 FEET.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 60 MPH
(URBAN) USING E= 4 % MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr		
20000	2.1	180	180	180	180	180	180	180	180	180	180	180	
15000	2.1	180	180	180	180	180	180	180	180	180	180	180	
10000	2.1	180	180	180	180	180	180	180	180	180	180	180	
7000	2.1	180	180	180	180	180	180	180	180	180	180	180	
5000	2.6	146	180	146	180	146	180	146	180	146	180	146	
4000	2.9	131	180	131	180	131	180	131	180	131	180	131	
3000	3.3	115	180	115	180	115	180	115	180	115	180	115	
2500	3.6	105	180	105	180	105	180	105	180	105	180	117	
2250	3.7	103	180	103	180	103	180	103	180	114	200	114	
2000	3.9	97	180	97	180	97	180	97	180	108	200	119	
1750	4.0	95	180	95	180	95	180	95	180	105	200	116	
⊗1505	4.0	95	180	95	180	95	180	95	180	105	200	116	

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS WITH AN
ABSOLUTE MINIMUM Lr OF 180 FEET.

⊗ MINIMUM ALLOWABLE RADIUS

TC-5		DESIGN FACTORS FOR A DESIGN SPEED OF 20 MPH (RURAL) USING E= 8% MAX.																	
DESIGN VELOCITY=20		WIDTH=16 FT			WIDTH= 18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 8'			1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'		
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
15000	2.1	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
10000	2.1	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
7000	2.1	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
5000	2.1	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
4000	2.1	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
3000	2.1	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
2500	2.1	13	60	3.6	14	60	2.6	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
2250	2.1	13	60	3.7	14	60	2.7	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
2000	2.1	13	60	3.7	14	60	2.7	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
1750	2.1	13	60	3.8	14	60	2.8	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
1500	2.1	13	60	3.9	14	60	2.9	60	60	0.0	60	60	0.0	60	60	0.0	60	60	0.0
1300	2.1	13	60	4.0	14	60	3.0	15	60	2.0	60	60	0.0	60	60	0.0	60	60	0.0
1150	2.1	13	60	4.1	14	60	3.1	15	60	2.0	60	60	0.0	60	60	0.0	60	60	0.0
1000	2.4	13	60	4.2	14	60	3.2	15	60	2.2	53	60	0.0	53	60	0.0	53	60	0.0
900	2.6	13	60	4.3	14	60	3.3	15	60	2.3	49	60	0.0	49	60	0.0	65	80	0.0
800	2.9	13	60	4.4	14	60	3.4	15	60	2.4	44	60	0.0	44	60	0.0	58	80	0.0
750	3.1	13	60	4.4	14	60	3.4	15	60	2.4	41	60	0.0	41	60	0.0	55	80	0.0
700	3.3	13	60	4.5	14	60	3.5	14	60	2.5	39	60	0.0	39	60	0.0	51	80	0.0
650	3.4	13	60	4.6	14	60	3.6	14	60	2.6	38	60	0.0	38	60	0.0	62	100	0.0
600	3.7	13	60	4.7	14	60	3.7	14	60	2.7	35	60	0.0	35	60	0.0	57	100	0.0
550	3.9	13	60	4.8	14	60	3.8	14	60	2.8	33	60	0.0	44	80	0.0	54	100	0.0
500	4.2	13	60	4.9	18	80	3.9	19	80	2.9	40	80	0.0	40	80	0.0	60	120	0.0
475	4.3	16	80	5.0	18	80	4.0	19	80	3.0	20	80	2.0	40	80	0.0	31	120	2.0
450	4.5	16	80	5.1	18	80	4.1	19	80	3.1	20	80	2.0	38	80	0.0	31	120	2.2
425	4.7	16	80	5.2	18	80	4.2	19	80	3.2	20	80	2.2	36	80	0.0	30	120	2.4
400	4.8	16	80	5.3	17	80	4.3	19	80	3.3	20	80	2.3	35	80	0.0	35	140	2.6
375	5.0	16	80	5.4	17	80	4.4	18	80	3.4	24	100	2.4	34	80	0.0	35	140	2.8
350	5.2	16	80	5.5	17	80	4.5	23	100	3.5	24	100	2.5	41	100	0.0	35	140	3.0
325	5.4	16	80	5.7	21	100	4.7	23	100	3.7	24	100	2.7	39	100	0.0	35	140	3.4
300	5.6	20	100	5.8	21	100	4.8	23	100	3.8	24	100	2.8	38	100	0.0	40	160	3.6
280	5.8	20	100	6.0	21	100	5.0	22	100	4.0	24	100	3.0	30	120	2.0	39	160	4.0
265	6.0	20	100	6.1	21	100	5.1	22	100	4.1	28	120	3.1	29	120	2.0	39	160	4.2
250	6.1	19	100	6.3	21	100	5.3	22	100	4.3	28	120	3.3	29	120	2.3	44	180	4.6
235	6.3	19	100	6.4	21	100	5.4	26	120	4.4	28	120	3.4	29	120	2.4	43	180	4.8
220	6.5	19	100	6.6	25	120	5.6	26	120	4.6	28	120	3.6	29	120	2.6	43	180	5.2
205	6.7	23	120	6.8	24	120	5.8	26	120	4.8	27	120	3.8	29	120	2.8	43	180	5.6
190	6.9	22	120	7.1	24	120	6.1	26	120	5.1	31	140	4.1	33	140	3.1	47	200	6.2
175	7.2	22	120	7.4	24	120	6.4	29	120	5.4	31	140	4.4	33	140	3.4	46	200	6.8
160	7.4	22	120	7.7	27	140	6.7	29	140	5.7	31	140	4.7	32	140	3.7	51	220	7.4
145	7.6	25	140	8.1	27	140	7.1	29	140	6.1	30	140	5.1	36	160	4.1	50	220	8.2
130	7.9	24	140	8.6	26	140	7.6	32	160	6.6	34	160	5.6	36	160	4.6	53	240	9.2
115	8.0	24	140	9.2	26	140	8.2	31	160	7.2	33	160	6.2	35	160	5.2	52	240	10.4
107 ⊗	8.0	23	140	9.6	29	160	8.6	31	160	7.6	33	160	6.6	35	160	5.6	52	240	11.2

NOTE:
Lt, Lr & w VALUES IN FEET.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 25 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY=25		WIDTH=16 FT			WIDTH=18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 8'			1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'		
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
15000	2.1	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
10000	2.1	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
7000	2.1	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
5000	2.1	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
4000	2.1	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
3000	2.1	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
2500	2.1	18	80	3.7	19	80	2.7	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
2250	2.1	17	80	3.8	19	80	2.8	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
2000	2.1	17	80	3.9	19	80	2.9	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
1750	2.1	17	80	3.9	19	80	2.9	80	80	0.0	80	80	0.0	80	80	0.0	80	80	0.0
1500	2.4	17	80	4.0	18	80	3.0	20	80	2.0	70	80	0.0	70	80	0.0	70	80	0.0
1300	2.7	17	80	4.1	18	80	3.1	20	80	2.0	63	80	0.0	63	80	0.0	63	80	0.0
1150	2.9	17	80	4.2	18	80	3.2	19	80	2.2	58	80	0.0	58	80	0.0	58	80	0.0
1000	3.3	17	80	4.3	18	80	3.3	19	80	2.3	51	80	0.0	51	80	0.0	64	100	0.0
900	3.6	17	80	4.4	18	80	3.4	19	80	2.4	47	80	0.0	47	80	0.0	59	100	0.0
800	3.9	17	80	4.5	18	80	3.5	19	80	2.5	44	80	0.0	44	80	0.0	54	100	0.0
750	4.1	17	80	4.6	18	80	3.6	19	80	2.6	41	80	0.0	41	80	0.0	62	120	0.0
700	4.3	17	80	4.7	18	80	3.7	19	80	2.7	40	80	0.0	40	80	0.0	59	120	0.0
650	4.6	17	80	4.8	18	80	3.8	19	80	2.8	37	80	0.0	37	80	0.0	55	120	0.0
600	4.8	17	80	4.9	18	80	3.9	19	80	2.9	35	80	0.0	44	100	0.0	62	140	0.0
550	5.1	16	80	5.0	18	80	4.0	23	100	3.0	25	100	2.0	42	100	0.0	36	140	2.0
500	5.3	20	80	5.1	22	100	4.1	23	100	3.1	24	100	2.0	39	100	0.0	41	160	2.2
475	5.5	20	100	5.2	22	100	4.2	23	100	3.2	24	100	2.2	39	100	0.0	40	160	2.4
450	5.7	20	100	5.3	22	100	4.3	23	100	3.3	24	100	2.3	37	100	0.0	40	160	2.6
425	5.8	20	100	5.4	22	100	4.4	23	100	3.4	24	100	2.4	37	100	0.0	40	160	2.8
400	6.0	20	100	5.5	21	100	4.5	23	100	3.5	29	120	2.5	42	120	0.0	45	180	3.0
375	6.2	20	100	5.6	21	100	4.6	27	120	3.6	29	120	2.6	41	120	0.0	45	180	3.2
350	6.4	20	100	5.8	25	120	4.8	27	120	3.8	28	120	2.8	40	120	0.0	44	180	3.6
325	6.7	24	120	5.9	25	120	4.9	27	120	3.9	28	120	2.9	38	120	0.0	49	200	3.8
300	6.9	23	120	6.1	25	120	5.1	27	120	4.1	33	140	3.1	34	140	2.0	49	200	4.2
280	7.1	23	120	6.3	25	120	5.3	31	140	4.3	32	140	3.3	34	140	2.3	48	200	4.6
265	7.3	23	120	6.4	29	140	5.4	31	140	4.4	32	140	3.4	34	140	2.4	53	220	4.8
250	7.4	23	120	6.6	29	140	5.6	30	140	4.6	32	140	3.6	34	140	2.6	53	220	5.2
235	7.6	26	140	6.8	28	140	5.8	30	140	4.8	32	140	3.8	38	160	2.8	52	220	5.6
220	7.7	26	140	7.0	28	140	6.0	30	140	5.0	36	160	4.0	38	160	3.0	52	220	6.0
205	7.9	26	140	7.2	28	140	6.2	34	160	5.2	36	160	4.2	38	160	3.2	56	240	6.4
190	8.0	26	140	7.4	28	140	6.4	34	160	5.4	35	160	4.4	37	160	3.4	56	240	6.8
175	8.0	25	140	7.7	27	140	6.7	33	160	5.7	35	160	4.7	37	160	3.7	55	240	7.4
171 ⊗	8.0	25	140	7.8	27	140	6.8	33	160	5.8	35	160	4.8	37	160	3.8	55	240	7.6

NOTE:
Lt, Lr & w VALUES IN FEET.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 30 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY=30		WIDTH=16 FT			WIDTH=18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 8'			1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'		
RADIUS (FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0
15000	2.1	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0
10000	2.1	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0
7000	2.1	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0
5000	2.1	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0
4000	2.1	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0
3000	2.1	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0
2500	2.1	22	100	3.8	23	100	2.8	100	100	0.0	100	100	0.0	100	100	0.0	100	100	0.0
2250	2.2	22	100	3.9	23	100	2.9	96	100	0.0	96	100	0.0	96	100	0.0	96	100	0.0
2000	2.4	21	100	4.0	23	100	3.0	24	100	2.0	88	100	0.0	88	100	0.0	88	100	0.0
1750	2.7	21	100	4.0	23	100	3.0	24	100	2.0	78	100	0.0	78	100	0.0	78	100	0.0
1500	3.1	21	100	4.1	23	100	3.1	24	100	2.0	68	100	0.0	68	100	0.0	68	100	0.0
1300	3.5	21	100	4.3	23	100	3.3	24	100	2.3	60	100	0.0	60	100	0.0	60	100	0.0
1150	3.8	21	100	4.4	23	100	3.4	24	100	2.4	56	100	0.0	56	100	0.0	67	120	0.0
1000	4.2	21	100	4.5	22	100	3.5	24	100	2.5	50	100	0.0	50	100	0.0	60	120	0.0
900	4.6	21	100	4.6	22	100	3.6	24	100	2.6	46	100	0.0	46	100	0.0	64	140	0.0
800	4.9	21	100	4.7	22	100	3.7	24	100	2.7	43	100	0.0	43	100	0.0	60	140	0.0
750	5.2	21	100	4.8	22	100	3.8	24	100	2.8	41	100	0.0	41	100	0.0	57	140	0.0
700	5.4	21	100	4.9	22	100	3.9	23	100	2.9	39	100	0.0	39	100	0.0	63	160	0.0
650	5.6	20	100	5.0	22	100	4.0	23	100	3.0	29	120	2.0	45	120	0.0	60	160	2.0
600	5.9	20	100	5.1	22	100	4.1	28	120	3.1	29	120	2.0	43	120	0.0	46	180	2.2
550	6.1	20	100	5.2	26	120	4.2	28	120	3.2	29	120	2.2	42	120	0.0	45	180	2.4
500	6.4	24	120	5.4	26	120	4.4	27	120	3.4	29	120	2.4	40	120	0.0	50	200	2.8
475	6.6	24	120	5.5	26	120	4.5	27	120	3.5	33	140	2.5	39	120	0.0	50	200	3.0
450	6.8	24	120	5.5	26	120	4.5	27	120	3.5	33	140	2.5	44	140	0.0	50	200	3.0
425	7.0	24	120	5.7	25	120	4.7	32	140	3.7	33	140	2.7	42	140	0.0	54	220	3.4
400	7.1	24	120	5.8	30	140	4.8	31	140	3.8	33	140	2.8	42	140	0.0	54	220	3.6
375	7.3	24	120	5.9	29	140	4.9	31	140	3.9	33	140	2.9	41	140	0.0	54	220	3.8
350	7.5	27	140	6.0	29	140	5.0	31	140	4.0	33	140	3.0	39	160	2.0	54	220	4.0
325	7.7	27	140	6.2	29	140	5.2	30	140	4.2	37	160	3.2	39	160	2.2	58	240	4.4
300	7.9	27	140	6.4	29	140	5.4	35	160	4.4	37	160	3.4	39	160	2.4	58	240	4.8
280	8.0	27	140	6.6	33	160	5.6	35	160	4.6	37	160	3.6	38	160	2.6	57	240	5.2
265	8.0	26	140	6.7	32	160	5.7	35	160	4.7	36	160	3.7	38	160	2.7	57	240	5.4
⊗ 250	8.0	26	140	6.9	32	160	5.9	34	160	4.9	36	160	3.9	43	180	2.9	61	260	5.8

NOTE:
Lt, Lr & w VALUES IN FEET.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 35 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY=35		WIDTH=18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT			WIDTH=72 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'		
RADIUS (FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
15000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
10000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
7000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
5000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
4000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
3000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
2500	2.5	28	120	2.9	101	120	0.0	101	120	0.0	101	120	0.0	101	120	0.0	101	120	0.0
2250	2.8	27	120	3.0	29	120	2.0	90	120	0.0	90	120	0.0	90	120	0.0	90	120	0.0
2000	3.0	27	120	3.1	29	120	2.0	84	120	0.0	84	120	0.0	84	120	0.0	84	120	0.0
1750	3.4	27	120	3.2	29	120	2.2	75	120	0.0	75	120	0.0	75	120	0.0	87	140	0.0
1500	3.8	27	120	3.3	29	120	2.3	67	120	0.0	67	120	0.0	67	120	0.0	89	160	0.0
1300	4.3	27	120	3.4	29	120	2.4	59	120	0.0	59	120	0.0	69	140	0.0	88	180	0.0
1150	4.7	27	120	3.5	28	120	2.5	54	120	0.0	54	120	0.0	63	140	0.0	81	180	0.0
1000	5.2	27	120	3.6	28	120	2.6	49	120	0.0	49	120	0.0	65	160	0.0	81	200	0.0
900	5.5	27	120	3.8	28	120	2.8	46	120	0.0	46	120	0.0	62	160	0.0	84	220	0.0
800	5.9	26	120	3.9	28	120	2.9	43	120	0.0	43	120	0.0	65	180	0.0	61	240	2.7
750	6.1	26	120	4.0	28	120	3.0	29	120	2.0	42	120	0.0	51	200	2.0	66	260	3.0
700	6.4	26	120	4.1	28	120	3.1	34	140	2.0	46	140	0.0	51	200	2.2	66	260	3.3
650	6.6	26	120	4.2	32	140	3.2	34	140	2.2	45	140	0.0	50	200	2.4	70	280	3.6
600	6.9	30	140	4.3	32	140	3.3	34	140	2.3	43	140	0.0	55	220	2.6	70	280	3.9
550	7.1	30	140	4.4	32	140	3.4	34	140	2.4	42	140	0.0	55	220	2.8	75	300	4.2
500	7.4	30	140	4.6	32	140	3.6	38	160	2.6	46	160	0.0	60	240	3.2	79	320	4.8
475	7.6	30	140	4.7	36	160	3.7	38	160	2.7	45	160	0.0	59	240	3.4	79	320	5.1
450	7.7	30	140	4.8	36	160	3.8	38	160	2.8	44	160	0.0	59	240	3.6	79	320	5.4
425	7.8	34	160	4.9	36	160	3.9	38	160	2.9	44	160	0.0	64	260	3.8	83	340	5.7
400	7.9	33	160	5.0	35	160	4.0	37	160	3.0	44	180	2.0	63	260	4.0	83	340	6.0
375	8.0	33	160	5.2	35	160	4.2	37	160	3.2	44	180	2.2	63	260	4.4	82	340	6.6
350 ⊗	8.0	33	160	5.3	35	160	4.3	42	180	3.3	44	180	2.3	63	260	4.6	82	340	6.9

NOTE:

Lt, Lr, & w VALUES IN FEET.

FOR PAVEMENT WIDTHS
GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED
BY IGRDS.

⊗ MINIMUM ALLOWABLE RADIUS.

DESIGN FACTORS FOR A DESIGN SPEED OF 40 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY=40		WIDTH=18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT			WIDTH=72 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'		
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
15000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
10000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
7000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
5000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
4000	2.1	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
3000	2.6	97	120	0.0	97	120	0.0	97	120	0.0	97	120	0.0	97	120	0.0	97	120	0.0
2500	3.1	27	120	3.0	29	120	2.0	82	120	0.0	82	120	0.0	82	120	0.0	95	140	0.0
2250	3.4	27	120	3.1	29	120	2.0	75	120	0.0	75	120	0.0	75	120	0.0	99	160	0.0
2000	3.7	27	120	3.2	29	120	2.2	69	120	0.0	69	120	0.0	69	120	0.0	91	160	0.0
1750	4.1	27	120	3.3	29	120	2.3	62	120	0.0	62	120	0.0	72	140	0.0	93	180	0.0
1500	4.6	27	120	3.4	29	120	2.4	55	120	0.0	55	120	0.0	74	160	0.0	92	200	0.0
1300	5.1	27	120	3.5	28	120	2.5	50	120	0.0	50	120	0.0	66	160	0.0	91	220	0.0
1150	5.5	27	120	3.7	28	120	2.7	45	120	0.0	45	120	0.0	68	180	0.0	90	240	0.0
1000	6.0	27	120	3.8	28	120	2.8	42	120	0.0	49	140	0.0	70	200	0.0	91	270	0.0
900	6.4	31	140	3.9	33	140	2.9	46	140	0.0	46	140	0.0	66	200	0.0	92	280	0.0
800	6.8	30	140	4.1	32	140	3.1	39	160	2.0	50	160	0.0	61	240	2.2	76	300	3.3
750	7.0	30	140	4.2	32	140	3.2	39	160	2.2	48	160	0.0	60	240	2.4	80	340	3.6
700	7.3	34	160	4.3	37	160	3.3	39	160	2.3	47	160	0.0	60	240	2.6	80	340	3.9
650	7.5	34	160	4.4	36	160	3.4	38	160	2.4	45	160	0.0	65	270	2.8	85	340	4.2
600	7.7	34	160	4.5	36	160	3.5	43	180	2.5	44	160	0.0	65	270	3.0	84	340	4.5
550	7.9	34	160	4.6	41	180	3.6	43	180	2.6	48	180	0.0	69	280	3.2	89	360	4.8
500	8.0	34	160	4.8	40	180	3.8	42	180	2.8	48	180	0.0	69	280	3.6	88	360	5.4
475	8.0	34	160	4.9	40	180	3.9	42	180	2.9	48	180	0.0	69	280	3.8	88	360	5.7
⊗ 465	8.0	33	160	5.0	40	180	4.0	42	180	3.0	44	180	2.0	68	280	4.0	88	360	6.0

NOTE:

Lt, Lr & w VALUES IN FEET.

⊗ MINIMUM ALLOWABLE RADIUS

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS.

DESIGN FACTORS FOR A DESIGN SPEED OF 45 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY=45		WIDTH=18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT			WIDTH=72 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'		
RADIUS (FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0
15000	2.1	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0
10000	2.1	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0
7000	2.1	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0
5000	2.1	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0	140	140	0.0
4000	2.5	118	140	0.0	118	140	0.0	118	140	0.0	118	140	0.0	118	140	0.0	118	140	0.0
3000	3.2	92	140	0.0	92	140	0.0	92	140	0.0	92	140	0.0	92	140	0.0	105	160	0.0
2500	3.7	32	140	3.1	34	140	2.0	80	140	0.0	80	140	0.0	80	140	0.0	103	180	0.0
2250	4.0	32	140	3.2	34	140	2.2	74	140	0.0	74	140	0.0	74	140	0.0	95	180	0.0
2000	4.4	32	140	3.3	33	140	2.3	67	140	0.0	67	140	0.0	77	160	0.0	96	200	0.0
1750	4.9	31	140	3.4	33	140	2.4	60	140	0.0	60	140	0.0	78	180	0.0	95	220	0.0
1500	5.4	31	140	3.5	33	140	2.5	55	140	0.0	55	140	0.0	70	180	0.0	94	240	0.0
1300	6.0	31	140	3.7	33	140	2.7	49	140	0.0	49	140	0.0	70	200	0.0	98	280	0.0
1150	6.4	31	140	3.8	33	140	2.8	46	140	0.0	53	160	0.0	73	220	0.0	99	300	0.0
1000	6.9	35	160	4.0	37	160	3.0	39	160	2.0	49	160	0.0	74	240	0.0	98	320	0.0
900	7.3	35	160	4.1	37	160	3.1	44	180	2.0	52	160	0.0	75	260	0.0	98	340	0.0
800	7.6	34	160	4.3	41	180	3.3	43	180	2.3	50	180	0.0	70	280	2.6	90	360	3.9
750	7.8	39	180	4.3	41	180	3.3	43	180	2.3	49	180	0.0	70	280	2.6	95	380	3.9
700	7.9	38	180	4.4	41	180	3.4	43	180	2.4	48	180	0.0	70	280	2.8	95	380	4.2
650	8.0	38	180	4.6	41	180	3.6	47	200	2.6	48	180	0.0	74	300	3.2	94	380	4.8
⊗ 602	8.0	38	180	4.7	40	180	3.7	47	200	2.7	48	180	0.0	74	300	3.4	99	400	5.1

NOTE:

Lt, Lr & w VALUES IN FEET.

⊗ MINIMUM ALLOWABLE RADIUS

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS.

DESIGN FACTORS FOR A DESIGN SPEED OF 50 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY=50		WIDTH=18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT			WIDTH=72 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'		
RADIUS (FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0
15000	2.1	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0
10000	2.1	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0
7000	2.1	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0	160	160	0.0
5000	2.4	140	160	0.0	140	160	0.0	140	160	0.0	140	160	0.0	140	160	0.0	140	160	0.0
4000	2.9	116	160	0.0	116	160	0.0	116	160	0.0	116	160	0.0	116	160	0.0	116	160	0.0
3000	3.7	91	160	0.0	91	160	0.0	91	160	0.0	91	160	0.0	91	160	0.0	103	180	0.0
2500	4.3	36	160	3.2	38	160	2.2	79	160	0.0	79	160	0.0	79	160	0.0	108	220	0.0
2250	4.7	36	160	3.3	38	160	2.3	72	160	0.0	72	160	0.0	81	180	0.0	108	240	0.0
2000	5.1	36	160	3.4	38	160	2.4	66	160	0.0	66	160	0.0	83	200	0.0	108	260	0.0
1750	5.6	36	160	3.5	38	160	2.5	60	160	0.0	60	160	0.0	83	220	0.0	105	280	0.0
1500	6.2	35	160	3.7	38	160	2.7	55	160	0.0	55	160	0.0	82	240	0.0	102	300	0.0
1300	6.7	35	160	3.8	37	160	2.8	51	160	0.0	57	180	0.0	82	260	0.0	107	340	0.0
1150	7.2	35	160	3.9	42	180	2.9	47	160	0.0	53	180	0.0	76	260	0.0	105	360	0.0
1000	7.6	39	180	4.1	41	180	3.1	48	200	2.0	56	200	0.0	78	280	0.0	105	380	0.0
900	7.9	39	180	4.3	46	200	3.3	48	200	2.3	54	200	0.0	80	300	0.0	102	380	0.0
800	8.0	38	180	4.4	45	200	3.4	48	200	2.4	53	200	0.0	80	320	2.8	105	420	4.2
⊗ 760	8.0	38	180	4.5	45	200	3.5	48	200	2.5	53	200	0.0	80	320	3.0	104	420	4.5

NOTE:

Lt, Lr & w VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 55 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY=55		WIDTH=18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT			WIDTH=72 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'		
RADIUS (FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0
15000	2.1	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0
10000	2.1	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0
7000	2.1	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0
5000	2.8	135	180	0.0	135	180	0.0	135	180	0.0	135	180	0.0	135	180	0.0	135	180	0.0
4000	3.4	112	180	0.0	112	180	0.0	112	180	0.0	112	180	0.0	112	180	0.0	112	180	0.0
3000	4.4	86	180	0.0	86	180	0.0	86	180	0.0	86	180	0.0	86	180	0.0	115	240	0.0
2500	5.0	40	180	3.3	43	180	2.3	76	180	0.0	76	180	0.0	84	200	0.0	110	260	0.0
2250	5.4	40	180	3.4	43	180	2.4	70	180	0.0	70	180	0.0	86	220	0.0	109	280	0.0
2000	5.9	40	180	3.5	42	180	2.5	65	180	0.0	65	180	0.0	86	240	0.0	114	320	0.0
1750	6.4	40	180	3.6	42	180	2.6	60	180	0.0	60	180	0.0	86	260	0.0	112	340	0.0
1500	7.0	40	180	3.8	42	180	2.8	54	180	0.0	54	180	0.0	84	280	0.0	108	360	0.0
1300	7.5	39	180	4.0	46	200	3.0	49	200	2.0	56	200	0.0	84	300	0.0	112	400	0.0
1150	7.8	43	200	4.1	46	200	3.1	48	200	2.0	54	200	0.0	81	300	0.0	108	400	0.0
1000	8.0	43	200	4.3	46	200	3.3	53	220	2.3	58	220	0.0	84	320	0.0	111	420	0.0
⊗ 964	8.0	43	200	4.3	46	200	3.3	53	220	2.3	58	220	0.0	84	320	0.0	111	420	3.9

NOTE:

Lt, Lr & w VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 60 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY-60		WIDTH-18 FT			WIDTH-20 FT			WIDTH-22 FT			WIDTH-24 FT			WIDTH-48 FT			WIDTH-72 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'		
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0
15000	2.1	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0
10000	2.1	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0	180	180	0.0
7000	2.4	158	180	0.0	158	180	0.0	158	180	0.0	158	180	0.0	158	180	0.0	158	180	0.0
5000	3.3	115	180	0.0	115	180	0.0	115	180	0.0	115	180	0.0	115	180	0.0	115	180	0.0
4000	4.0	95	180	0.0	95	180	0.0	95	180	0.0	95	180	0.0	95	180	0.0	116	220	0.0
3000	5.0	76	180	0.0	76	180	0.0	76	180	0.0	76	180	0.0	84	200	0.0	118	280	0.0
2500	5.8	40	180	3.4	43	180	2.4	66	180	0.0	66	180	0.0	87	240	0.0	116	320	0.0
2250	6.2	40	180	3.5	42	180	2.5	61	180	0.0	61	180	0.0	89	260	0.0	116	340	0.0
2000	6.7	40	180	3.6	42	180	2.6	57	180	0.0	57	180	0.0	88	280	0.0	113	360	0.0
1750	7.2	40	180	3.8	47	200	2.8	53	180	0.0	59	200	0.0	88	300	0.0	117	400	0.0
1500	7.7	44	200	3.9	46	200	2.9	55	200	0.0	60	220	0.0	88	320	0.0	115	420	0.0
1300	8.0	43	200	4.1	50	220	3.1	58	220	2.0	58	220	0.0	84	320	0.0	116	440	0.0
⊗ 1204	8.0	43	200	4.2	50	220	3.2	58	220	2.2	58	220	0.0	84	320	0.0	116	440	0.0

NOTE:

Lt, Lr & w VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 65 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY=65		WIDTH=18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT			WIDTH=72 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'		
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	200	200	0.0	200	200	0.0	200	200	0.0	200	200	0.0	200	200	0.0	200	200	0.0
15000	2.1	200	200	0.0	200	200	0.0	200	200	0.0	200	200	0.0	200	200	0.0	200	200	0.0
10000	2.1	200	200	0.0	200	200	0.0	200	200	0.0	200	200	0.0	200	200	0.0	200	200	0.0
7000	2.7	156	200	0.0	156	200	0.0	156	200	0.0	156	200	0.0	156	200	0.0	156	200	0.0
5000	3.7	114	200	0.0	114	200	0.0	114	200	0.0	114	200	0.0	114	200	0.0	125	220	0.0
4000	4.4	96	200	0.0	96	200	0.0	96	200	0.0	96	200	0.0	96	200	0.0	125	260	0.0
3000	5.6	75	200	0.0	75	200	0.0	75	200	0.0	75	200	0.0	98	260	0.0	128	340	0.0
2500	6.5	44	200	3.5	47	200	2.5	65	200	0.0	65	200	0.0	97	300	0.0	130	400	0.0
2250	6.9	44	200	3.6	47	200	2.6	61	200	0.0	67	220	0.0	98	320	0.0	128	420	0.0
2000	7.4	44	200	3.7	51	220	2.7	57	200	0.0	63	220	0.0	97	340	0.0	125	440	0.0
1750	7.8	48	220	3.9	51	220	2.9	60	220	0.0	65	240	0.0	97	360	0.0	124	460	0.0
1500	8.0	48	220	4.1	55	240	3.1	58	240	2.0	63	240	0.0	95	360	0.0	126	480	0.0
⊗ 1488	8.0	48	220	4.1	55	240	3.1	58	240	2.0	63	240	0.0	95	360	0.0	126	480	0.0

NOTE:

Lt, Lr & w VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS.

⊗ MINIMUM ALLOWABLE RADIUS

DESIGN FACTORS FOR A DESIGN SPEED OF 70 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY-70		WIDTH-18 FT			WIDTH-20 FT			WIDTH-22 FT			WIDTH-24 FT			WIDTH-48 FT			WIDTH-72 FT		
		IGRDS EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)																	
		1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'		
RADIUS (FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
20000	2.1	220	220	0.0	220	220	0.0	220	220	0.0	220	220	0.0	220	220	0.0	220	220	0.0
15000	2.1	220	220	0.0	220	220	0.0	220	220	0.0	220	220	0.0	220	220	0.0	220	220	0.0
10000	2.2	210	220	0.0	210	220	0.0	210	220	0.0	210	220	0.0	210	220	0.0	210	220	0.0
7000	3.0	154	220	0.0	154	220	0.0	154	220	0.0	154	220	0.0	154	220	0.0	154	220	0.0
5000	4.1	113	220	0.0	113	220	0.0	113	220	0.0	113	220	0.0	113	220	0.0	134	260	0.0
4000	5.0	93	220	0.0	93	220	0.0	93	220	0.0	93	220	0.0	101	240	0.0	126	300	0.0
3000	6.3	74	220	0.0	74	220	0.0	74	220	0.0	74	220	0.0	100	300	0.0	127	380	0.0
2500	7.2	49	220	3.6	52	220	2.6	65	220	0.0	65	220	0.0	100	340	0.0	129	440	0.0
2250	7.6	48	220	3.7	51	220	2.7	61	220	0.0	67	240	0.0	100	360	0.0	128	460	0.0
2000	8.0	48	220	3.9	56	240	2.9	58	220	0.0	63	240	0.0	95	360	0.0	126	480	0.0
⊗1821	8.0	45	220	4.0	55	240	3.0	58	240	2.0	63	240	0.0	95	360	0.0	126	480	0.0

NOTE:

Lt, Lr & w VALUES IN FEET.

⊗ MINIMUM ALLOWABLE RADIUS

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET
USE Lr VALUES DEVELOPED BY IGRDS.

STANDARD SYMBOLS

- LOCATION EALIGNMENT ON WHICH THE PROPOSED RIGHT-OF-WAY AND CONSTRUCTION IS BASED.
- STANDARD PAVEMENT.....THE TYPICAL PAVEMENT SECTION TO BE SHOWN ON THE ROAD PLANS.
- P.C.POINT OF BEGINNING OF BASELINE CIRCULAR CURVE.
- P.T.POINT OF ENDING OF BASELINE CIRCULAR CURVE.
- P.C.C.POINT OF BASELINE COMPOUND CURVATURE.
- P.R.C.....POINT OF BASELINE REVERSE CURVE.
- T.S.POINT OF CHANGE FROM TANGENT TO TRANSITION CURVE. (TANGENT TO SPIRAL)
- S.C.POINT OF CHANGE FROM TRANSITION CURVE TO CIRCULAR CURVE. (SPIRAL TO CIRCULAR)
- C.S.POINT OF CHANGE FROM CIRCULAR CURVE TO TRANSITION CURVE. (CIRCULAR TO SPIRAL)
- S.T.POINT OF CHANGE FROM TRANSITION CURVE TO TANGENT. (SPIRAL TO TANGENT)
- RADIUSRADIUS OF BASELINE CIRCULAR CURVE.
- DVAPPROXIMATE MAXIMUM SAFE SPEED IN MILES PER HOUR USING STANDARD RATE OF SUPER-ELEVATION.
- NCAPPROXIMATE MAXIMUM SAFE SPEED IN MILES PER HOUR WITH NO SUPERELEVATION. FACTORS APPLY ONLT TO URBAN LOW SPEED CONDITIONS.
- LrLENGTH OF TRANSITION CURVE MEASURED ALONG BASELINE. WHERE NO TRANSITION CURVE IS APPLIED Lr IS LENGTH OF SUPERELEVATION RUNOFF SECTION.
- W OR PWWIDTH OF STANDARD PAVEMENT.
- ZTDISTANCE FROM TRANSITIONED BASELINE TO EDGES OF TRANSITIONED PAVEMENT
- wMAXIMUM TOTAL PAVEMENT WIDENING.
- ERATE OF SUPERELEVATION.
- FSAFE SIDE FRICTION FACTOR.
- SAMOUNT OF SUPERELEVATION TO BE APPLIED TO THE BASELINE GRADE TO OBTAIN THE ELEVATIONS OF THE EDGES OF TRANSITIONED PAVEMENT.
- CDIFFERENCE IN ELEVATION BETWEEN BASELINE (CENTER) AND EDGE OF PAVEMENT FOR STANDARD PAVEMENT CROWN.
- LtSTANDARD PAVEMENT CROWN TRANSITION OR TANGENT RUNOUT SECTION.
- CPCHORD POINT (1/10 INCREMENTS OF TRANSITION CURVE).
- NPC.....NORMAL PAVEMENT CROWN.

ALL DISTANCES (HORIZONTAL AND VERTICAL) ARE MEASURED IN FEET.

SPECIFICATION REFERENCE

TRANSITION CURVES FOR RURAL AND URBAN HIGHWAYS AND STREET CONDITIONS

VIRGINIA DEPARTMENT OF TRANSPORTATION

URBAN CONDITION

URBAN CONDITIONS APPLY TO URBAN STREET SYSTEMS AND ANY OTHER ROAD WITH PRESENT OR FUTURE URBAN STREET OPERATING CONDITIONS.

THESE TABLES CONTAIN THE MINIMUM SUPERELEVATION RATES AND TRANSITION LENGTHS FOR STANDARD URBAN PAVEMENT WIDTHS THROUGH A RANGE OF DESIGN VELOCITIES CONSIDERED MOST LIKELY TO BE USED IN URBAN ROAD DESIGN.

DEFINITIONS FOR THE STANDARD SYMBOLS USED THROUGHOUT THESE TABLES ARE FOUND ON SHEET 802.01.

A TABLE FOR "LOW SPEED URBAN" DESIGNS IS ON SHEET 802.24 WITH A RANGE OF STANDARD PAVEMENT WIDTHS (W), SUPERELEVATION RUNOFF (L_r), AND RADII OF CURVE WHEN SUPERELEVATED BY AN AMOUNT EQUAL TO THE NORMAL CROWN AND THE APPROXIMATE MAXIMUM SAFE SPEEDS (DV) AFFORDED THEREBY. VALUES IN THIS TABLE CAN BE USED ON STREETS WITH OPERATING SPEEDS LESS THAN OR EQUAL TO 45 MPH. ALSO SHOWN ARE THE APPROXIMATE MAXIMUM SAFE SPEEDS (NC) WITH NO SUPERELEVATION. VALUES FOR (NC) CAN BE USED ON URBAN ARTERIAL, COLLECTOR, AND LOCAL STREETS.

FOR MINIMUM DESIGN FACTORS FOR VARIOUS DESIGN SPEEDS FOR URBAN CONDITIONS SEE SHEETS 802.25 THRU 802.33

WHEN URBAN CONDITIONS APPLY THERE WILL BE NO BASELINE TRANSITION OR PAVEMENT WIDENING. THE LENGTH OF SUPERELEVATION RUNOFF (L_r) DETERMINES THE LENGTH OF SUPERELEVATION TRANSITION THROUGH WHICH THE OUTER EDGE OF PAVEMENT IS RAISED ABOVE THE BASELINE GRADE TO A MAXIMUM OF $E \left(\frac{W}{2} \right)$. SEE SHEET 802.07 FOR A GRAPHICAL ILLUSTRATION OF THE APPLICATION OF THIS CORRECTION.

FOR CURVE RADII NOT LISTED IN TABLES REFER TO SHEET 802.22 TO CALCULATE SUPERELEVATION RUNOFF (L_r).

L_r SHOULD BE SHOWN ON THE PLANS FOR ALL CURVES.

E SHOULD BE SHOWN ON THE PLANS FOR ALL CURVES WITH URBAN STREET CONDITIONS.

FOR GRAPHICAL ILLUSTRATION OF DESIGN SUPERELEVATION RATES FOR URBAN CONDITIONS SEE SHEET 802.19.

FOR ADDITIONAL GENERAL INSTRUCTIONS (BOTH URBAN AND RURAL) SEE SHEET 802.04.

EXPLANATION OF TABLES AND INSTRUCTIONS FOR USE
URBAN CONDITION

RURAL CONDITION

RURAL CONDITIONS APPLY TO INTERSTATE, ARTERIAL, PRIMARY AND SECONDARY SYSTEMS OR TO ANY OTHER ROAD WITH RURAL TYPE DESIGN AND OPERATING CONDITIONS.

THESE TABLES CONTAIN THE MINIMUM ALLOWABLE SUPERELEVATION, TRANSITION LENGTHS, AND WIDENING CORRECTIONS FOR STANDARD RURAL PAVEMENT WIDTHS THROUGH A RANGE OF DESIGN VELOCITIES CONSIDERED MOST LIKELY TO BE USED IN RURAL HIGHWAY DESIGN.

DEFINITIONS FOR THE STANDARD SYMBOLS USED THROUGHOUT THESE TABLES ARE FOUND ON SHEET 802.01.

FOR MINIMUM DESIGN FACTORS FOR VARIOUS DESIGN SPEEDS FOR RURAL CONDITIONS SEE SHEETS 802.34 THRU 802.44.

ON CURVES WITH GREATER THAN 2865 FT RADIUS, THERE WILL BE NO SPIRAL TRANSITION OR PAVEMENT WIDENING. PAVEMENT WILL BE SUPERELEVATED BY AN AMOUNT EQUAL TO THE RATE SHOWN IN THE TABLES. SEE SHEET 802.06 FOR A GRAPHICAL ILLUSTRATION OF THE APPLICATION OF THIS CORRECTION.

ON CURVES WITH PAVEMENT WIDTHS OF 24' OR WIDER AND A RADIUS OF 882 FT. OR GREATER, THERE WILL BE NO SPIRAL TRANSITION OR PAVEMENT WIDENING. PAVEMENT WILL BE SUPERELEVATED BY AN AMOUNT EQUAL TO THE RATE SHOWN IN THESE TABLES.

FOR CURVE RADII NOT LISTED IN TABLES, REFER TO SHEET 802.22 TO CALCULATE SUPERELEVATION RUNOFF LENGTH (L_r) AND PAVEMENT WIDENING (w).

L_r AND E SHOULD BE SHOWN ON THE PLANS FOR ALL CURVES..

FOR GRAPHICAL ILLUSTRATION OF DESIGN SUPERELEVATION RATES FOR RURAL CONDITIONS SEE SHEET 802.20.

FOR ADDITIONAL GENERAL INSTRUCTIONS (BOTH URBAN AND RURAL) SEE SHEET 802.04.

SEE SHEET 802.05 FOR A GRAPHICAL ILLUSTRATION OF SPIRAL TRANSITIONS.

EXPLANATION OF TABLES AND INSTRUCTIONS FOR USE
RURAL CONDITION

VIRGINIA DEPARTMENT OF TRANSPORTATION

GENERAL CONDITION

ALL ORIGINAL CROSS SECTIONS SHALL BE TAKEN FROM THE BASELINE AT STATIONS, PLUS FIFTIES, AND UNUSUAL BREAKS IN THE GROUND AS ON TANGENT ALIGNMENT.

WHERE A PART OR ALL OF A SUPERELEVATION TRANSITION CURVE FALLS ON A VERTICAL CURVE, ELEVATIONS ON THE VERTICAL CURVE SHOULD BE COMPUTED FOR THE POSITIONS GIVEN ON SHEET 802.16 FOR CROWN TRANSITIONS, SHEET 802.17 FOR URBAN PROJECTS AND SHEET 802.18 FOR RURAL PROJECTS. THESE ELEVATIONS AND PLUSES SHOULD BE SHOWN ON THE PLANS FOR THE CONVENIENCE OF THE SURVEY PARTY IN STAKING OUT THE PROJECT. THROUGHOUT THESE SECTIONS OF THE GRADE, ELEVATIONS AT EVEN STATIONS AND PLUS FIFTIES SHOULD BE OMITTED.

SLOPE STAKES SHOULD BE SET AT THE POSITIONS ON THE TRANSITION GIVEN ON SHEETS 802.16, 802.17 AND 802.18 AND GROUND CROSS SECTIONS TAKEN AT THESE POSITIONS OMITTING THE STATIONS AND PLUS FIFTIES THROUGHOUT THE TRANSITION. IF UNUSUAL BREAKS IN THE GROUND OCCUR, ADDITIONAL SECTIONS SHOULD, OF COURSE, BE TAKEN. ADDITIONAL SECTIONS SHOULD ALSO BE TAKEN WHERE LOCATION IS THROUGH ROCK CUT IN ANTICIPATION OF UNUSUAL BREAKAGE WHICH MAY OCCUR DURING CONSTRUCTION.

AFTER ROUGH GRADING HAS BEEN DONE, FINE GRADING (BLUE TOP) AND FORM STAKES SHOULD BE SET AT THE POSITIONS GIVEN ON SHEET 802.16 FOR CROWN TRANSITIONS, SHEET 802.17 FOR URBAN PROJECTS OR AS GIVEN ON SHEET 802.18 FOR RURAL PROJECTS.

FINAL CROSS SECTIONS SHOULD, OF COURSE, BE TAKEN AT THOSE POSITIONS AT WHICH THE SLOPE STAKE SECTIONS WERE TAKEN. WHERE UNUSUAL BREAKAGE IN ROCK OCCURS, AND THIS WAS NOT ANTICIPATED, ADDITIONAL FINAL SECTIONS SHOULD BE TAKEN AND ORIGINAL GROUND SECTIONS INTERPOLATED.

BASELINE STAKES SHOULD BE SET AT ALL P.C.'S, P.T.'S, T.S.'S, S.T.'S, S.C.'S, AND C.S.'S IN STAKING OUT ALIGNMENT BUT SLOPE STAKES NEED NOT BE SET NOR CROSS SECTIONS TAKEN AT P.C.'S OR P.T.'S EXCEPT WHERE CALLED FOR IN THE ACCOMPANYING TABLES. THE TRANSITION WILL TAKE ITS FORM FROM THE POSITIONS GIVEN ON SHEETS 802.17 AND 802.18.

THE RIGHT OF WAY SHALL, IN ALL CASES, BE REFERENCED FROM THE BASELINE.

THE DESIGNER SHOULD EXERCISE CAUTION IN THE USE OF COMPOUND AND REVERSE CURVES UNLESS TOPOGRAPHICAL OR RIGHT OF WAY RESTRICTIONS MAKE THEIR USE APPROPRIATE. THE USE OF BROKEN-BACK CURVES SHOULD BE AVOIDED EXCEPT WHERE VERY UNUSUAL TOPOGRAPHICAL OR RIGHT OF WAY CONDITIONS MAKE OTHER ALTERNATIVES IMPRACTICAL. THE USE OF BROKEN-BACK CURVES MAY REQUIRE A DESIGN EXCEPTION FROM THE STATE LOCATION AND DESIGN ENGINEER. SEE SHEETS 802.11 THRU 802.14 FOR GENERAL INFORMATION ON COMPOUND, REVERSE AND BROKEN-BACK CURVE INFORMATION. REFER TO APPENDIX A OF THE ROAD DESIGN MANUAL FOR SPECIFIC COMPOUND AND REVERSE CURVE DESIGN INFORMATION.

A DESIGN EXCEPTION IS NOT REQUIRED WHEN USING VALUES FROM SHEETS 802.24 THRU 802.44 SINCE THESE TABLES WERE DERIVED WITHIN AASHTO GUIDELINES.

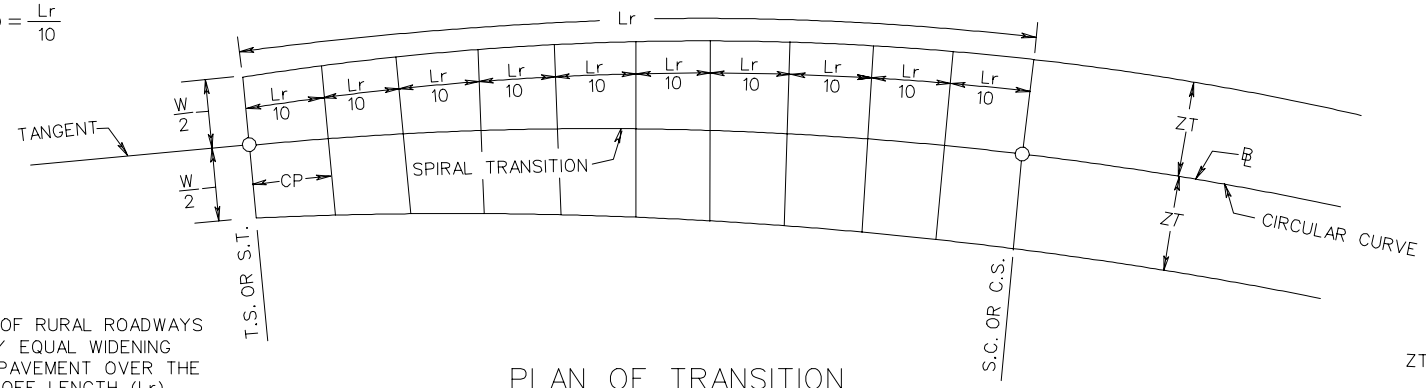
REFER TO CHAPTER 4 OF AASHTO'S A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS FOR INFORMATION ON THE USE OF 18' PAVEMENT WIDTHS (9' LANE WIDTHS).

ALL TANGENT RUNOUT SECTION (L_t) VALUES AND SUPERELEVATION RUNOFF LENGTHS (L_r) LISTED IN THE TABLES HAVE BEEN ROUNDED UP TO THE NEAREST FOOT. ALL L_t VALUES ARE BASED ON A 2% CROWN.

EXPLANATION OF TABLES AND INSTRUCTIONS FOR USE GENERAL CONDITION

VIRGINIA DEPARTMENT OF TRANSPORTATION

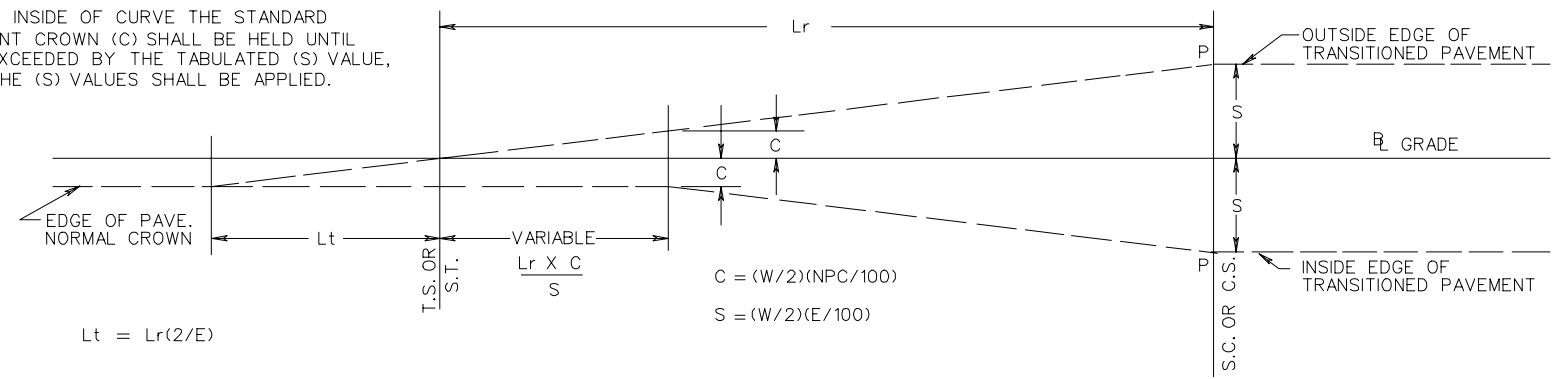
CHORD POINTS (CP) = $\frac{L_r}{10}$



NOTE:
PAVEMENT WIDENING OF RURAL ROADWAYS WILL BE ACHIEVED BY EQUAL WIDENING OF BOTH EDGES OF PAVEMENT OVER THE SUPERELEVATION RUNOFF LENGTH (L_r).

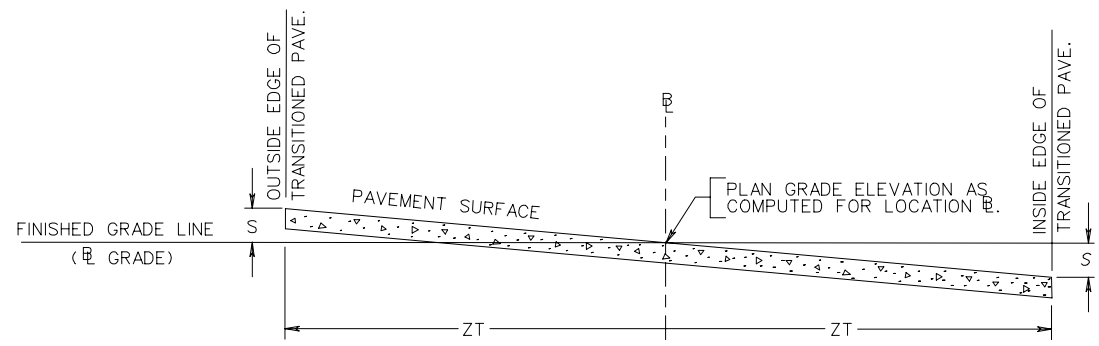
PLAN OF TRANSITION

NOTE:
ON THE INSIDE OF CURVE THE STANDARD PAVEMENT CROWN (C) SHALL BE HELD UNTIL IT IS EXCEEDED BY THE TABULATED (S) VALUE, THEN THE (S) VALUES SHALL BE APPLIED.



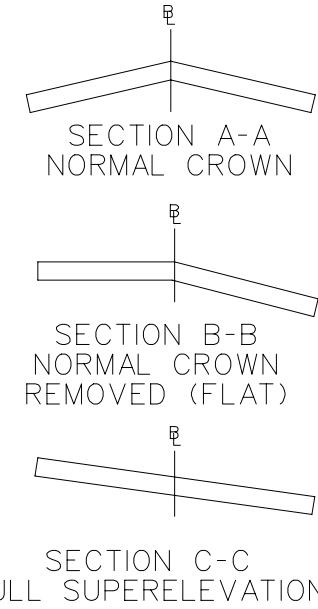
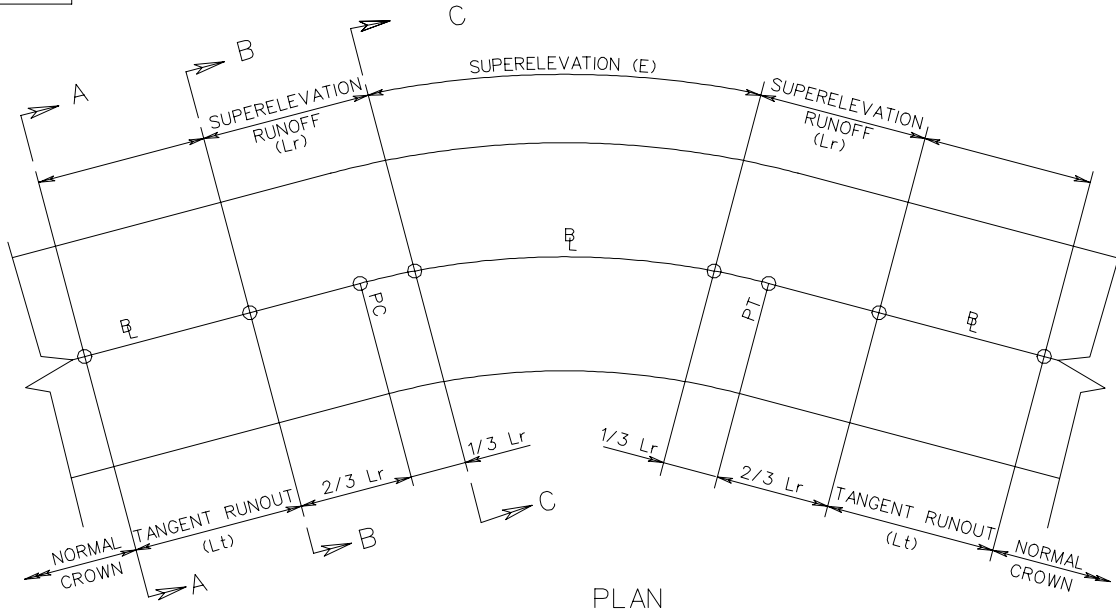
PROFILE OF TRANSITION

NOTE: SHORT VERTICAL CURVES SHOULD BE INSERTED BY EYE AT POINTS (P) IF CONSIDERED NECESSARY.

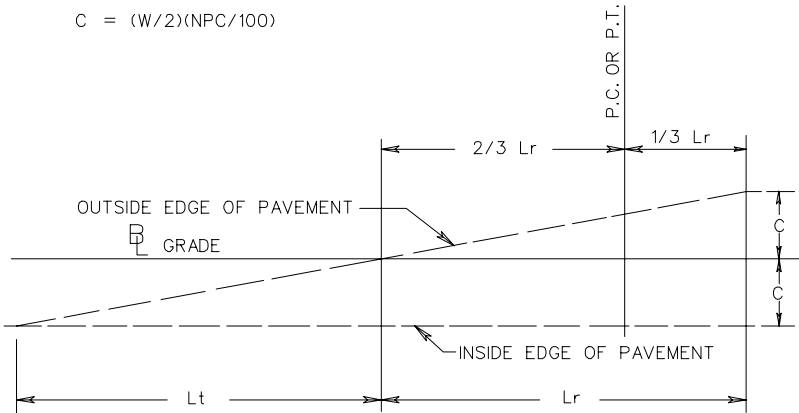


CROSS SECTION THRU TRANSITION

DETAILS FOR TRANSITIONED E
RURAL CONDITION WITH PAVEMENT WIDENING



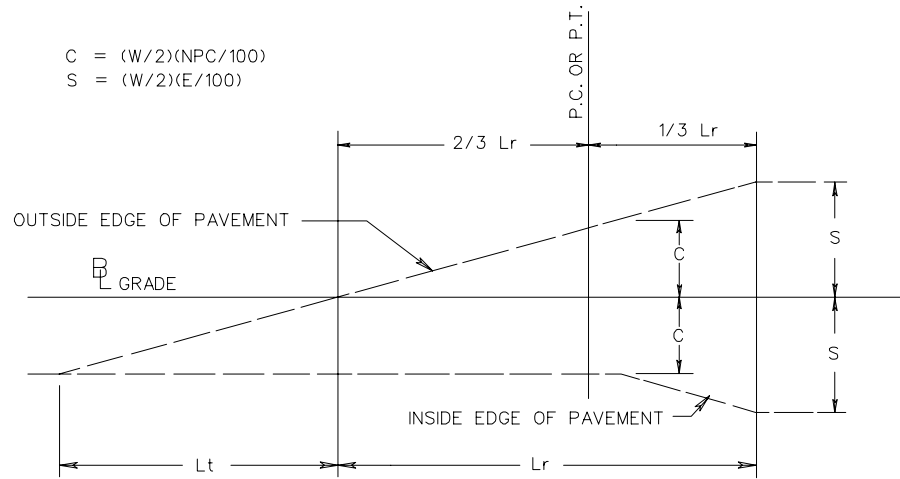
$$C = (W/2)(NPC/100)$$



SUPERELEVATED BY AN AMOUNT EQUAL TO THE STANDARD PAVEMENT CROWN

$$C = (W/2)(NPC/100)$$

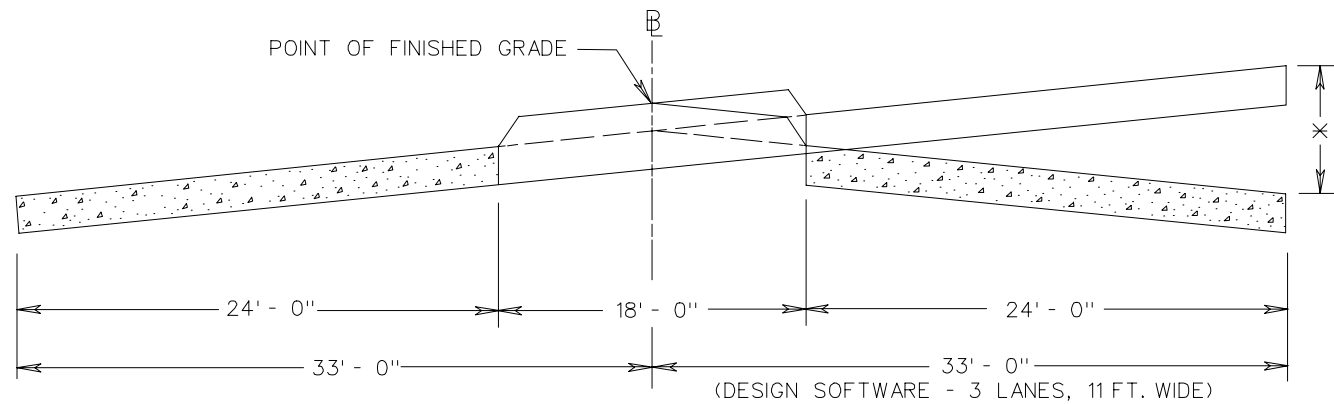
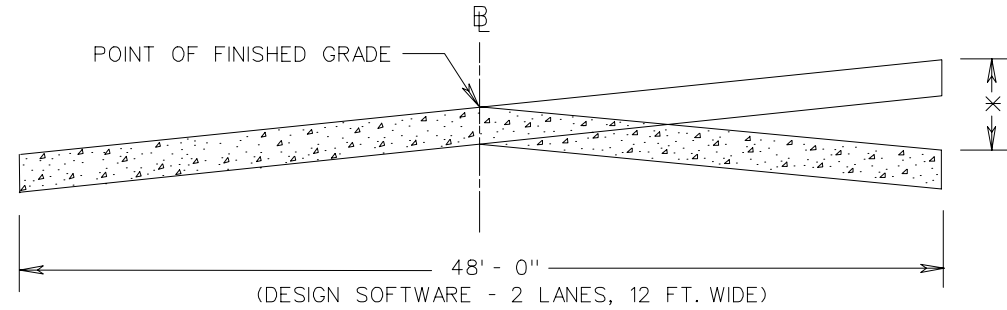
$$S = (W/2)(E/100)$$



NOTE : ON THE INSIDE OF CURVE THE STANDARD PAVEMENT CROWN (C) SHALL BE HELD UNTIL IT IS EXCEEDED BY THE TABULATED RATE OF SUPERELEVATION (E).

SUPERELEVATED BY AN AMOUNT EXCEEDING THE STANDARD PAVEMENT CROWN

DETAILS FOR NON-TRANSITION \mathbb{E}

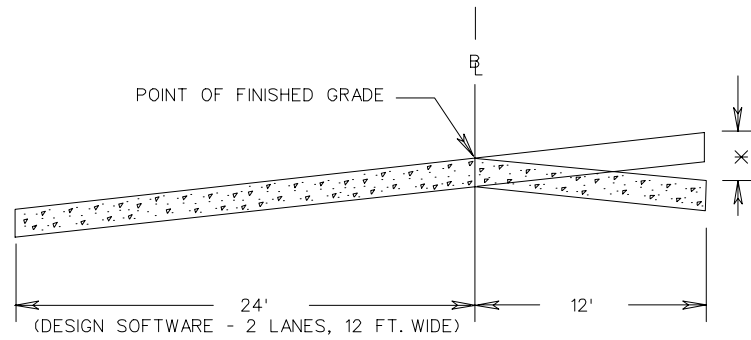


✕ THE ELEVATION DIFFERENTIAL BETWEEN NORMAL CROWN AND MAXIMUM SUPERELEVATION, RELATIVE TO THE BASELINE PROFILE.

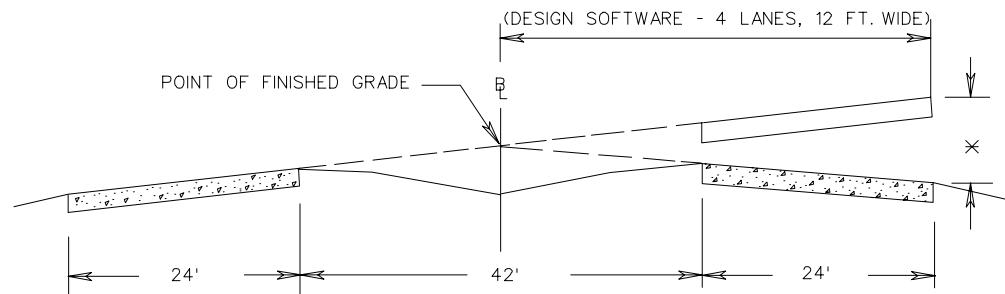
ADDITIONAL INFORMATION MAY BE OBTAINED FROM A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (AASHTO) BOOK, CHAPTER III - ELEMENTS OF DESIGN (SUPERELEVATION RUNOFF).

ON STANDARD TC-5.01ULS, TC-5.01U, AND TC-5.01R (WITHOUT PAVEMENT WIDENING) SUPERELEVATED CURVES, POSITION THE SUPERELEVATION RUNOFF SECTION (L_r) TWO THIRDS ($2/3$) ON THE TANGENT AND ONE THIRD ($1/3$) INTO THE CURVE. STATIONS AND ELEVATIONS FOR THESE TRANSITIONS WILL NEED TO BE COMPUTED FOR ALL CHORD POINTS AND SHOWN ON THE PROFILES.

DETAILS OF SUPERELEVATION ABOUT BASELINE



THE PAVEMENT WIDTHS SHOWN IN THE STANDARD TC-5.01 TABLES ON SHEET 802.25 THROUGH 802.44 REPRESENT TWICE THE DISTANCE FROM THE CROWNLINER TO THE EDGE OF PAVEMENT ON THE HIGH SIDE.

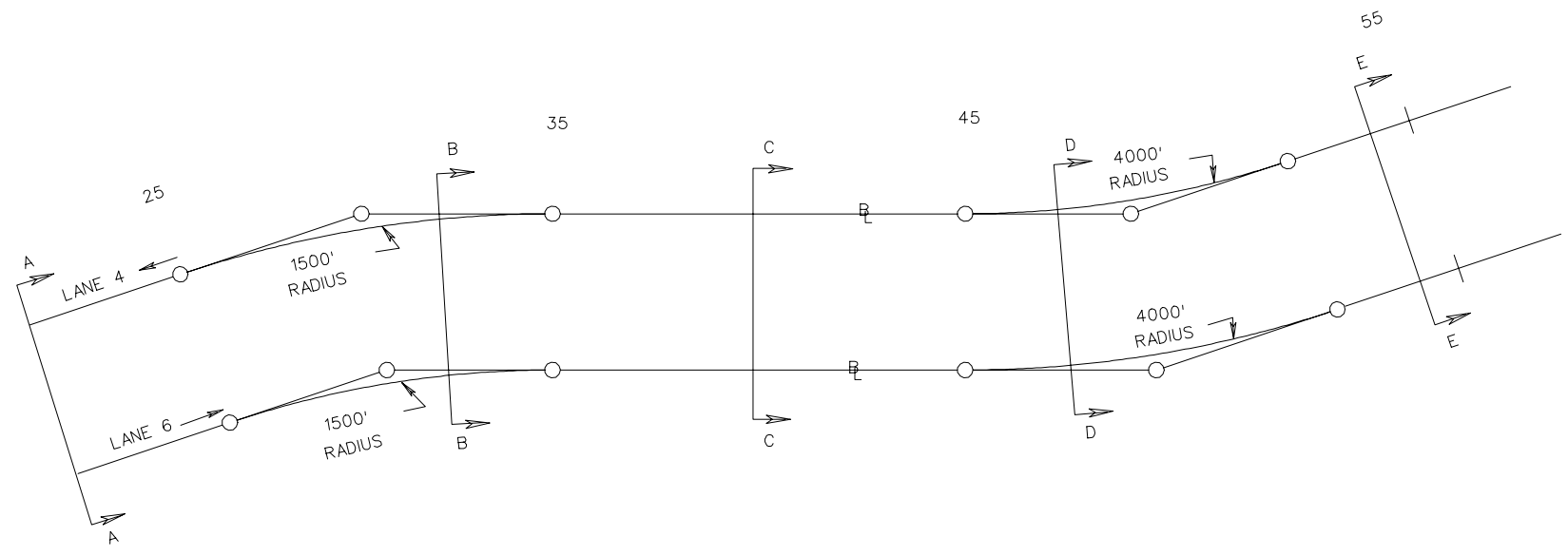


× THE ELEVATION DIFFERENTIAL BETWEEN NORMAL CROWN AND MAXIMUM SUPERELEVATION, RELATIVE TO THE BASELINE PROFILE.

ADDITIONAL INFORMATION MAY BE OBTAINED FROM A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (AASHTO) BOOK, CHAPTER III - ELEMENTS OF DESIGN (SUPERELEVATION RUNOFF).

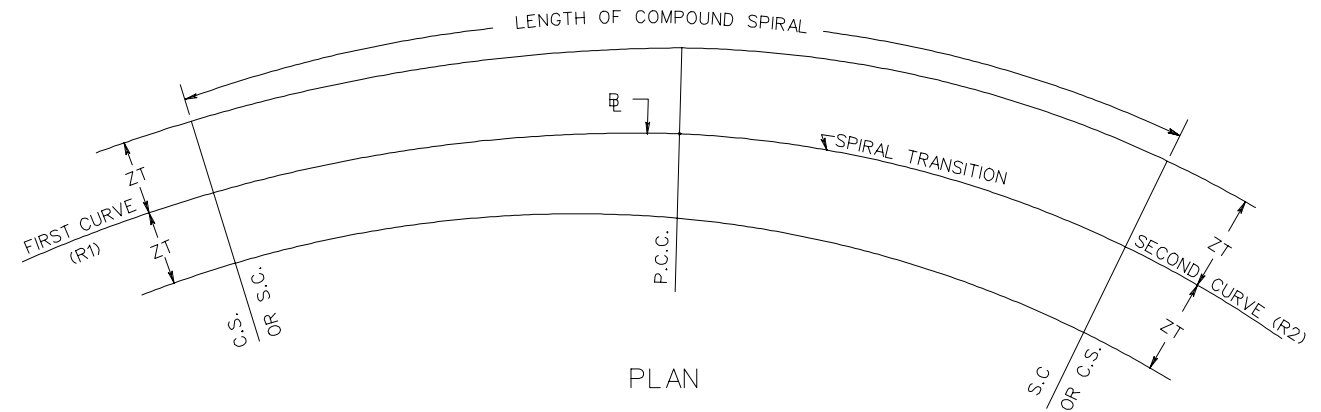
PROJECTS IN WHICH LANES MAY BE ADDED IN THE FUTURE IN THE MEDIAN AREA SHOULD BE DESIGNED WITH THE CONSTRUCTION BASELINE AND POINT OF FINISHED GRADE LOCATED IN THE MIDDLE OF THE MEDIAN. SUPERELEVATION IS TO BE ROTATED FROM THIS BASELINE POINT. THIS WILL PREVENT UNEVEN PAVEMENT PROBLEMS (WHEN ADDITIONAL LANES ARE ADDED IN THE MEDIAN AREA) SUCH AS CROSSOVER GRADES AS WELL AS THE NEED FOR RETAINING WALLS, MEDIAN BARRIERS AND SPECIAL DESIGN DRAINAGE STRUCTURES. ADDITIONAL RIGHT OF WAY OR EASEMENTS, IN MOST SITUATIONS, WILL NOT BE REQUIRED.

DETAILS OF SUPERELEVATION ABOUT BASELINE

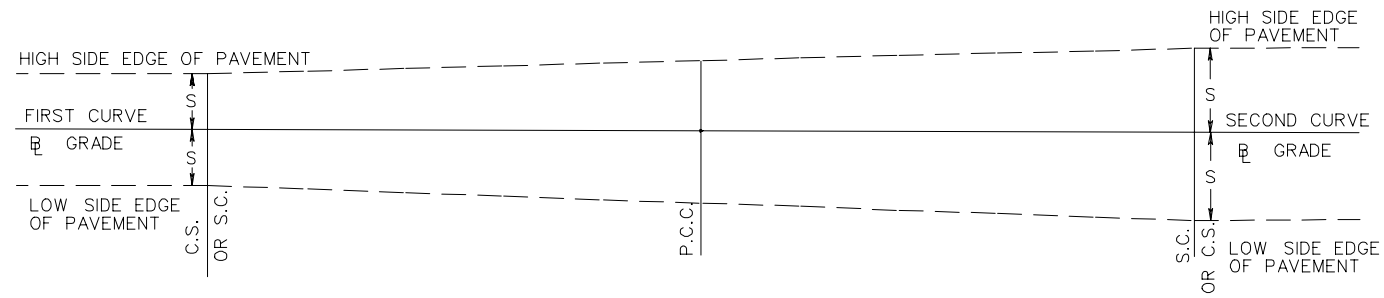


EXAMPLE FOR FOUR LANE ROADWAYS

VIRGINIA DEPARTMENT OF TRANSPORTATION



PLAN



PROFILE

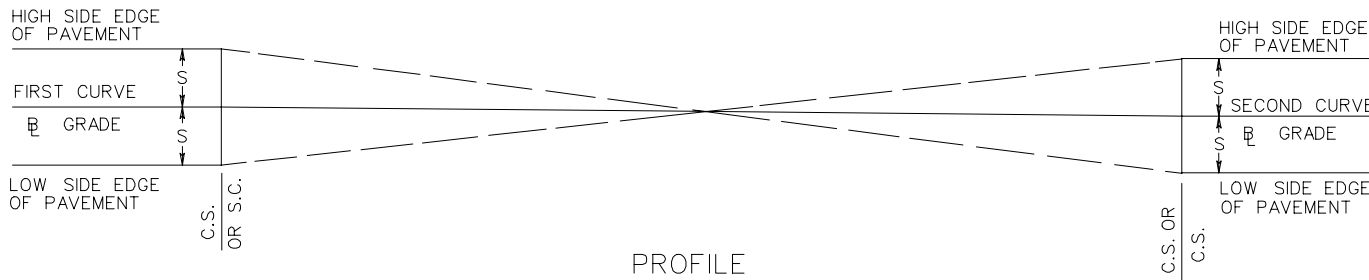
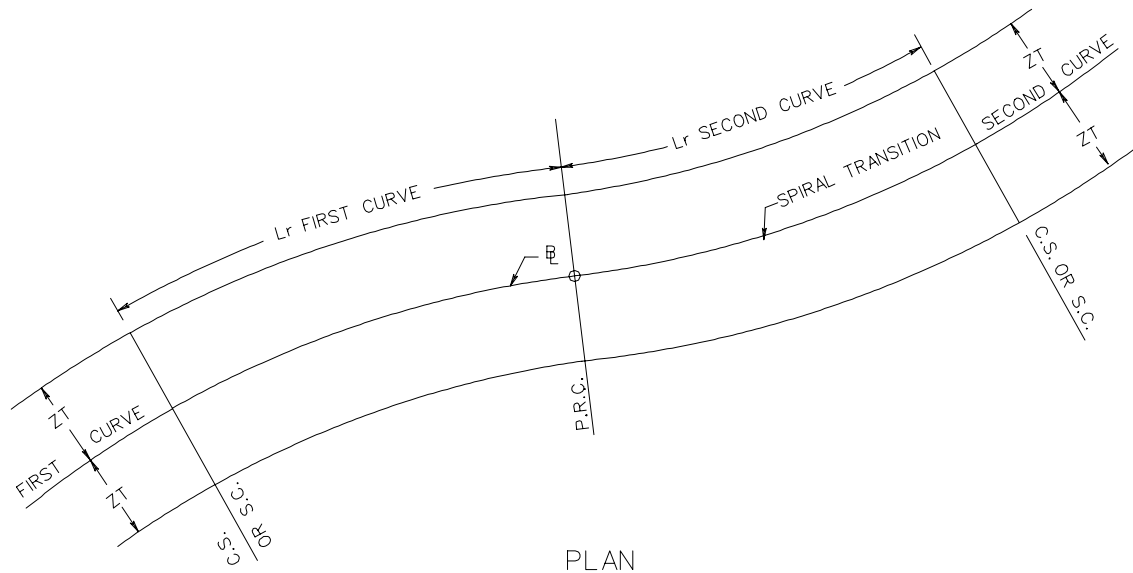
NOTE:

1. FOR COMPOUND CURVES ON OPEN ROADWAYS, THE RATIO OF FLATTER RADIUS (R1) TO THE SHARPER RADIUS (R2) SHALL NOT EXCEED 1.5:1. WHERE PRACTICAL, A DESIRABLE MAXIMUM RATIO OF 1.75:1 SHOULD BE USED.
2. FOR COMPOUND CURVES ON RAMPS AND AT INTERSECTIONS, THE RATIO OF THE FLATTER RADIUS (R1) TO THE SHARPER RADIUS (R2) SHALL NOT EXCEED 2:1.
3. COMPUTE STRAIGHT LINE WIDENING AND SUPERELEVATION TRANSITION FROM MAXIMUM OF FIRST CURVE TO MAXIMUM OF SECOND CURVE.
4. REFER TO CHAPTER 3 OF THE AASHTO GREEN BOOK FOR ADDITIONAL COMPOUND CURVE DESIGN INFORMATION.

SPECIFICATION REFERENCE

METHOD OF APPLYING TC-5.01 ON COMPOUND CURVES
RURAL CONDITIONS WITH PAVEMENT WIDENING

VIRGINIA DEPARTMENT OF TRANSPORTATION

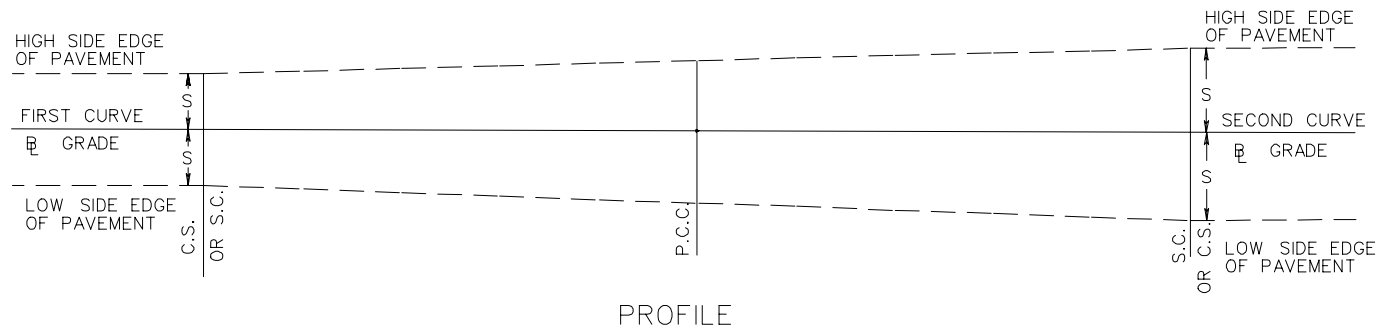
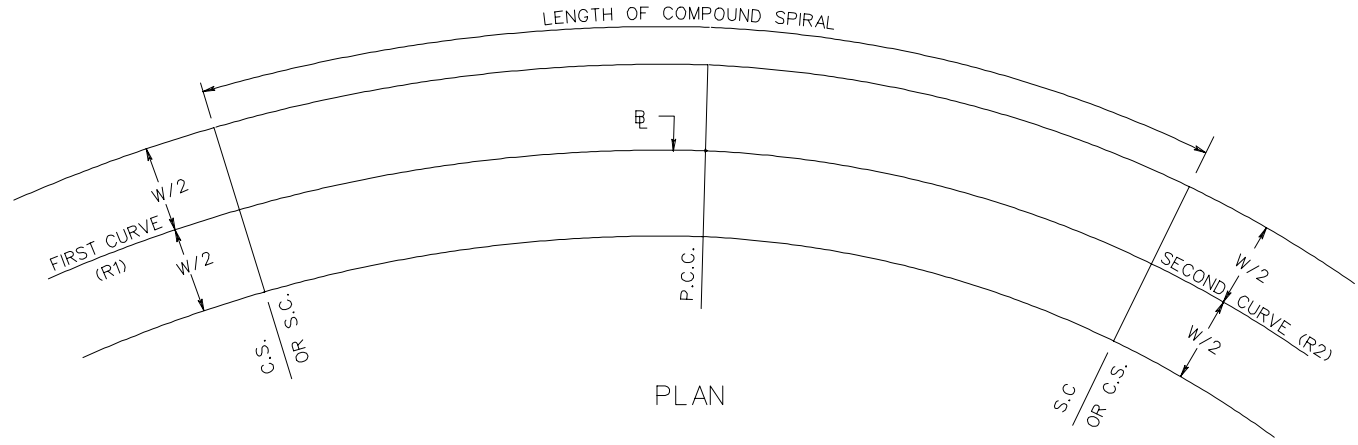


NOTE:

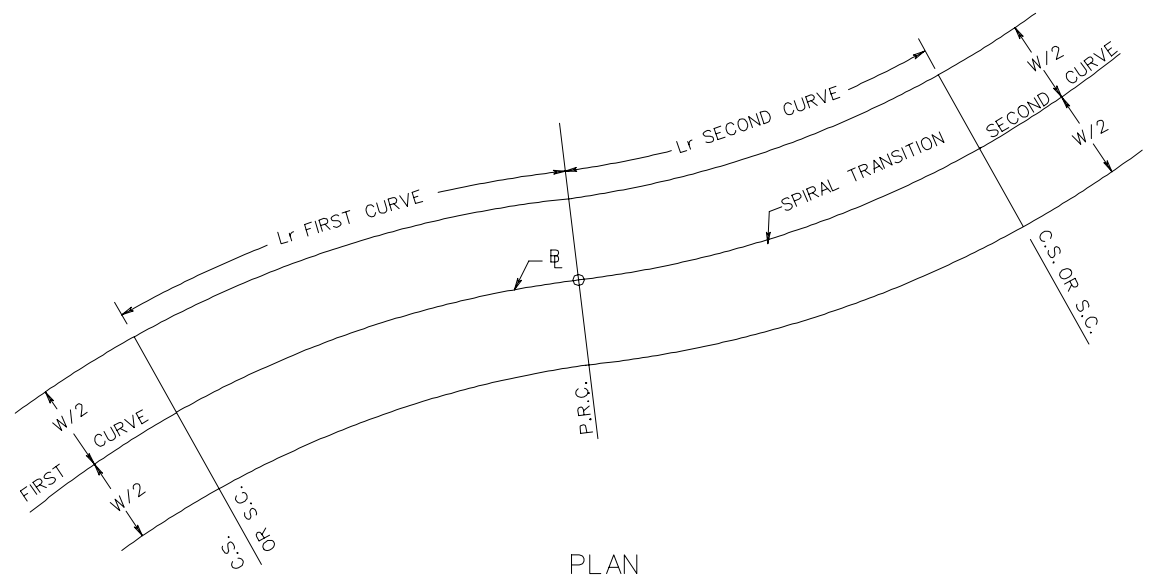
1. COMPUTE STRAIGHT LINE WIDENING AND SUPERELEVATION TRANSITION FROM MAXIMUM OF FIRST CURVE TO MAXIMUM OF SECOND CURVE.
2. REFER TO CHAPTER 3 OF THE AASHTO'S A POLICY ON THE GEOMETRIC DESIGN OF HIGHWAYS AND STREETS FOR ADDITIONAL REVERSE CURVE DESIGN INFORMATION.

METHOD OF APPLYING TC-5.01 ON REVERSE CURVES
RURAL CONDITIONS WITH PAVEMENT WIDENING

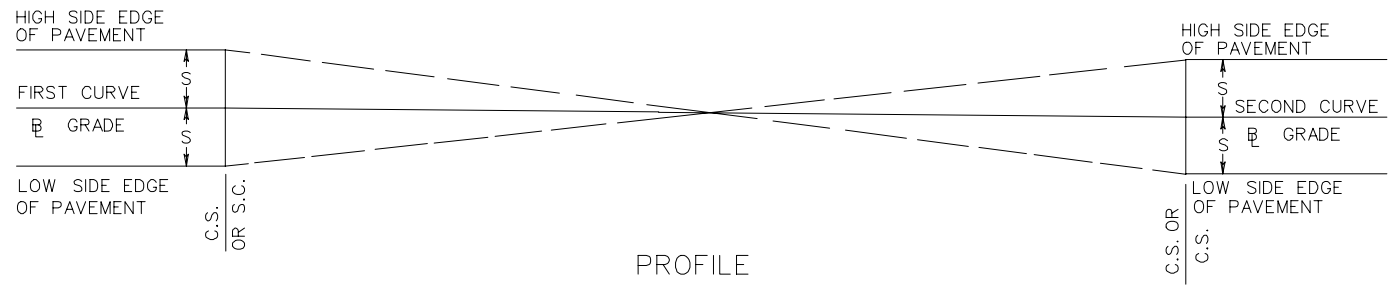
SPECIFICATION
REFERENCE



- NOTE:
1. FOR COMPOUND CURVES ON OPEN ROADWAYS, THE RATIO OF FLATTER RADIUS (R1) TO THE SHARPER RADIUS (R2) SHALL NOT EXCEED 1.5:1. WHERE PRACTICAL, A DESIRABLE MAXIMUM RATIO OF 1.75:1 SHOULD BE USED.
 2. FOR COMPOUND CURVES ON RAMPS AND AT INTERSECTIONS, THE RATIO OF THE FLATTER RADIUS (R1) TO THE SHARPER RADIUS (R2) SHALL NOT EXCEED 2:1.
 3. COMPUTE SUPERELEVATION TRANSITION FROM MAXIMUM OF FIRST CURVE TO MAXIMUM OF SECOND CURVE. LENGTH OF COMPOUND SPIRAL COMPUTED PER PAGE 802.22.
 4. REFER TO CHAPTER 3 OF THE AASHTO GREEN BOOK FOR ADDITIONAL COMPOUND CURVE DESIGN INFORMATION.



PLAN



PROFILE

- NOTE:
1. COMPUTE SUPERELEVATION TRANSITION FROM MAXIMUM OF FIRST CURVE TO MAXIMUM OF SECOND CURVE. LENGTH OF SUPERELEVATION RUNOFF (L_r) COMPUTED PER PAGE 802.22.
 2. REFER TO CHAPTER 3 OF THE AASHTO'S A POLICY ON THE GEOMETRIC DESIGN OF HIGHWAYS AND STREETS FOR ADDITIONAL REVERSE CURVE DESIGN INFORMATION.

METHOD OF APPLYING TC-5.01 ON REVERSE CURVES
 URBAN CONDITIONS & RURAL CONDITIONS WITHOUT PAVEMENT WIDENING

SPECIFICATION
 REFERENCE

TRANSITION TABLE

LENGTH OF TANGENT RUNOUT (Lt)	START/END OF SUPERELEVATION RUNOFF (Lr)	DISTANCE IN FEET FROM START/END OF SUPERELEVATION RUNOFF SECTION (Lr)				NORMAL CROWN
		1	2	3	4	
220	0	44	88	132	176	220
200	0	40	80	120	140	200
180	0	36	72	108	144	180
160	0	32	64	96	128	160
140	0	28	56	84	112	140
120	0	24	48	72	96	120
100	0	20	40	60	80	100
90	0	18	36	54	72	90
80	0	16	32	48	64	80
60	0	15	30	45	———	60
40	0	20	———	———	———	40

NOTE:

TABLE LISTS POSITIONS ON TRANSITIONS AT WHICH SLOPE STAKES SHOULD BE SET,
CONSTRUCTION AND FINAL CROSS-SECTIONS TAKEN, FINE GRADING STAKES (BLUE TOP)
SET, AND FORM STAKES SET (CONCRETE PAVEMENT ONLY).

CROWN TRANSITION / TANGENT RUNOUT (Lt) TABLE

URBAN CONDITIONS

RURAL CONDITIONS WITHOUT PAVEMENT WIDENING

FOR USE WITH FLEXIBLE AND CONCRETE PAVEMENT
(Lr POSITIONED 2/3 ±ON TANGENT, 1/3 ±ON CURVE)

LENGTH OF SUPERELEVATION RUNOFF (Lr)	END/ BEGIN TANGENT RUNOUT (Lt)	DISTANCE IN FEET FROM P.C. OR P.T. ON TANGENT						P.C. OR P.T.	DISTANCE IN FEET FROM P.C. OR P.T. ON CURVE			FULL SUPER ELEVATION (E)
		1	2	3	4	5	6		7	8	9	
480	320	272	224	176	128	80	32	STAKE	16	64	112	160
460	307	261	215	169	123	77	31	STAKE	15	61	107	153
440	293	249	205	161	117	73	29	STAKE	15	59	103	147
420	280	238	196	154	112	70	28	STAKE	14	56	98	140
400	267	227	187	147	107	67	27	STAKE	13	53	93	133
380	253	215	177	139	101	63	25	STAKE	13	51	89	127
360	240	204	168	132	96	60	24	STAKE	12	48	84	120
340	227	193	159	125	91	57	23	STAKE	11	45	79	113
320	213	181	149	117	85	53	21	STAKE	11	43	75	107
300	200	170	140	110	80	50	20	STAKE	10	40	70	100
280	187	159	131	103	75	47	19	STAKE	9	37	65	93
260	173	147 *	121	95 *	69	43 *	17	STAKE *	9	35 *	61	87
240	160	136 *	112	88 *	64	40 *	16	STAKE *	8	32 *	56	80
220	147	125 *	103	81 *	59	37 *	15	STAKE *	7	29 *	51	73
200	133	113 *	93	73 *	53	33 *	13	STAKE *	7	27 *	47	67
180	120	102 *	84	66 *	48	30 *	12	STAKE *	6	24 *	42	60
160	107	91 *	75	59 *	43	27 *	11	STAKE *	5	21 *	37	53

NOTE :

TABLE GIVING POSITIONS ON CURVES AT WHICH SLOPE STAKES SHOULD BE SET,
CONSTRUCTION AND FINAL CROSS-SECTIONS TAKEN, FINE GRADING STAKES (BLUE TOP) SET,
AND FORM STAKES SET (CONCRETE PAVEMENT ONLY).

* DENOTES ADDITIONAL STAKING POSITIONS FOR USE WITH CONCRETE PAVEMENT ONLY.

TABLE I

RURAL CONDITIONS WITH PAVEMENT WIDENING

FOR USE WITH FLEXIBLE AND CONCRETE PAVEMENT

LENGTH OF SUPERELEVATION RUNOFF (Lr)	T.S. OR S.T.	DISTANCE IN FEET FROM T.S. OR S.T. ALONG SPIRAL TRANSITION									S.C. OR C.S.
		1	2	3	4	5	6	7	8	9	
480	0	48	96	144	192	240	288	336	384	432	480
460	0	46	92	138	184	230	276	322	368	414	460
440	0	44	88	132	176	220	264	308	352	396	440
420	0	42	84	126	168	210	252	294	336	378	420
400	0	40	80	120	160	200	240	280	320	360	400
380	0	38	76	114	152	190	228	266	304	342	380
360	0	36	72	108	144	180	216	252	288	324	360
340	0	34	68	102	136	170	204	238	272	306	340
320	0	32	64	96	128	160	192	224	256	288	320
300	0	30	60	90	120	150	180	210	240	270	300
280	0	28	56	84	112	140	168	196	224	252	280
260	0	26 ✕	52	78 ✕	104	130 ✕	156	182 ✕	208	234 ✕	260
240	0	24 ✕	48	72 ✕	96	120 ✕	144	168 ✕	192	216 ✕	240
220	0	22 ✕	44	66 ✕	88	110 ✕	132	154 ✕	176	198 ✕	220
200	0	20 ✕	40	60 ✕	80	100 ✕	120	140 ✕	160	180 ✕	200
180	0	18 ✕	36	54 ✕	72	90 ✕	108	126 ✕	144	162 ✕	180
160	0	16 ✕	32	48 ✕	64	80 ✕	96	112 ✕	128	144 ✕	160

NOTE :

TABLE GIVING POSITIONS ON TRANSITION CURVES AT WHICH SLOPE STAKES SHOULD BE SET,
CONSTRUCTION AND FINAL CROSS-SECTIONS TAKEN, FINE GRADING STAKES (BLUE TOP) SET,
AND FORM STAKES SET (CONCRETE PAVEMENT ONLY).

✕ DENOTES ADDITIONAL STAKING POSITIONS FOR USE WITH CONCRETE PAVEMENT ONLY.

TABLE 2

VIRGINIA DEPARTMENT OF TRANSPORTATION

URBAN LOW SPEED DESIGN TABLE

DV/NC (MPH)	MAX. f	C	MIN. Lr (FEET)
45	0.161	2.75	125
40	0.178	3.00	115
35	0.197	3.25	100
30	0.221	3.50	90
25	0.252	3.75	80
20	0.300	4.00	75

LEGEND

- C- RATE OF CHANGE OF SIDE FRICTION (f) IN FT./SEC.³
- e- SUPERELEVATION RATE.
- f- FRICTION FACTOR.
- Lr- LENGTH OF SUPERELEVATION RUNOFF SECTION.
- Lt- LENGTH OF TANGENT RUNOUT SECTION.
- R- RADIUS OF CURVE.
- DV- DESIGN VELOCITY UTILIZING SUPERELEVATION.
- NC- MAXIMUM VELOCITY WITH NO SUPERELEVATION (NORMAL CROWN).

FRICTION FACTORS (f) FOR ODD VELOCITIES NOT LISTED SHOULD BE DERIVED BY INTERPOLATION.

FOR Lr LENGTHS FOR INTERMEDIATE VELOCITIES NOT LISTED IN TABLE USE THE Lr FOR NEAREST VELOCITY IN TABLE.

GENERAL DESIGN CONSIDERATIONS

1. WHEN "URBAN LOW SPEED" DESIGNS UTILIZE SUPERELEVATION, THEY WILL BE SUPERELEVATED BY AN AMOUNT EQUAL TO THE NORMAL CROWN (TYPICALLY 2.0%) AND THE APPROXIMATE MAXIMUM SAFE SPEED (DV) AFFORDED THEREBY.
2. WHEN "URBAN LOW SPEED" DESIGNS UTILIZE NO SUPERELEVATION, THE APPROXIMATE MAXIMUM SAFE SPEED (NC) IS CALCULATED USING A NEGATIVE NORMAL CROWN (TYPICALLY -2.0 %).
3. WHEN THE CURVE IS SUPERELEVATED, THE Lr IS APPLIED IN THE SAME MANNER AS IN URBAN CONDITIONS WITH THE TANGENT RUNOUT (Lt) BEING EQUAL TO THE Lr VALUE. THE TANGENT RUNOUT (Lt) IS ALWAYS ACHIEVED OUTSIDE OF THE SUPERELEVATION RUNOFF SECTION(Lr).
4. PLEASE NOTE THAT THE RADIUS VALUES LISTED ON PAGE 802.24 HAVE BEEN ROUNDED UP TO THE NEAREST FOOT.

EXAMPLES

DV = 21 mph
e = +2.0 %

f = MAX f ± INTERPOLATED DIFFERENCE BETWEEN LISTED FRICTION FACTORS

$$f = 0.300 - [1/5(0.300 - 0.252)] = 0.2904 \text{ (ROUND TO 0.29)}$$

$$Lr = 47.2 f DV/C$$

$$Lr = 47.2(0.29)(21)/4 = 71.862 \text{ FT.}$$

71.862 < 90 THEREFORE Lr=90 FT.

$$Rmin. = DV^2 / 15(e+f)$$

$$Rmin. = (21) / 15(0.02 + 0.29) = 94.83870968 \text{ FT.}$$

NC = 37 mph

e = -2.0 %

f = MAX f ± INTERPOLATED DIFFERENCE BETWEEN LISTED FRICTION FACTORS

$$f = 0.197 - [2/5(0.197 - 0.178)] = 0.1894 \text{ (ROUND TO 0.189)}$$

$$Rmin. = NC^2 / 15(-e + f)$$

$$Rmin. = (37)^2 / 15(-0.02 + 0.189) = 540.0394477 \text{ FT.}$$

METHODOLOGIES FOR CALCULATING TC-5.01 VALUES FOR URBAN LOW-SPEED STREETS

URBAN LOW SPEED DESIGN TABLE						
DV/NC (MPH)	45	40	35	30	25	20
MAX. f	0.150	0.160	0.180	0.200	0.230	0.270

FRICTION FACTORS (f) FOR ODD VELOCITIES NOT LISTED SHOULD BE DERIVED BY INTERPOLATION.

LEGEND

- e- SUPERELEVATION RATE.
- f- FRICTION FACTOR.
- Lr- LENGTH OF SUPERELEVATION RUNOFF SECTION.
- Lt- LENGTH OF TANGENT RUNOUT SECTION.
- R- RADIUS OF CURVE.
- DV- DESIGN VELOCITY UTILIZING SUPERELEVATION.
- NC- MAXIMUM VELOCITY WITH NO SUPERELEVATION (NORMAL CROWN).

GENERAL DESIGN CONSIDERATIONS

1. WHEN "URBAN LOW SPEED" DESIGNS UTILIZE SUPERELEVATION, THEY WILL BE SUPERELEVATED BY AN AMOUNT EQUAL TO THE NORMAL CROWN (TYPICALLY 2.0%) AND THE APPROXIMATE MAXIMUM SAFE SPEED (DV) AFFORDED THEREBY.
2. WHEN "URBAN LOW SPEED DESIGN" WITH NO SUPERELEVATION, THE APPROXIMATE MAXIMUM SAFE SPEED (NC) IS CALCULATED USING A NEGATIVE NORMAL CROWN (TYPICALLY -2.0 %).
3. WHEN THE CURVE IS SUPERELEVATED, THE Lr IS APPLIED IN THE SAME MANNER AS IN URBAN CONDITIONS WITH THE TANGENT RUNOUT (Lt) BEING EQUAL TO THE Lr VALUE. THE TANGENT RUNOUT (Lt) IS ALWAYS ACHIEVED OUTSIDE OF THE SUPERELEVATION RUNOFF (Lr).
4. PLEASE NOTE THAT THE RADIUS VALUES LISTED ON PAGE 802.24A HAVE BEEN ROUNDED UP TO THE NEAREST FOOT.

EXAMPLES

DV = 21 mph
 e = +2.0 %
 f = MAX f ± INTERPOLATED DIFFERENCE BETWEEN LISTED FRICTION FACTORS
 $f = 0.270 - [1/5(0.270 - 0.230)] = 0.262$
 $R_{min.} = DV^2 / 15(e + f)$
 $R_{min.} = (21)^2 / 15(0.02 + 0.262) = 104.2553191 \text{ FT.}$

NC = 37 mph
 e = -2.0 %
 f = MAX f ± INTERPOLATED DIFFERENCE BETWEEN LISTED FRICTION FACTORS
 $f = 0.18 - [2/5(0.18 - 0.16)] = 0.172$
 $R_{min.} = NC^2 / 15(-e + f)$
 $R_{min.} = (37)^2 / 15(-0.02 + 0.172) = 600.4385965 \text{ FT.}$

METHODOLOGIES FOR CALCULATING TC-5.04 VALUES FOR URBAN LOW-SPEED STREETS

CURVE WIDENING TABLES

SU DESIGN VEHICLE

COMPONENT	SIZE
OVERALL WIDTH (u)	8.0 ft
WHEELBASE (L)	20 ft
FRONT OVERHANG (A)	4 ft

LATERAL CLEARANCE

LANE WIDTH	CLEARANCE (C)
9 ft	1.5 ft
10 ft	2 ft
11 ft	2.5 ft
12 ft	3 ft
16 ft	5 ft

ADJUSTMENT FACTORS

NUMBER OF LANES ROTATED n_1	ADJUSTMENT FACTOR (b_w)
1	1.00
1.5	0.8333
2	0.75
2.5	0.70
3	0.6667
3.5	0.6425

RELATIVE GRADIENTS

DESIGN SPEED V_D MPH	MAXIMUM RELATIVE GRADIENT (rg)	MIN. TRANSITION LENGTH IN FEET RURAL CONDITIONS WITH PAVEMENT WIDENING AND REVERSE CURVES FOR ALL CONDITIONS (2 SECOND RULE)
20	0.74	59
25	0.70	74
30	0.66	88
35	0.62	103
40	0.58	117
45	0.54	132
50	0.50	147
55	0.47	161
60	0.45	176
65	0.43	191
70	0.40	205

- A - FRONT OVERHANG OF DESIGN VEHICLE FROM APPROPRIATE TABLE.
- b_w - ADJUSTMENT FACTOR FROM TABLE.
- C - LATERAL CLEARANCE OF DESIGN VEHICLE FROM APPROPRIATE TABLE.
- E - SUPERELEVATION RATE FROM APPROPRIATE TABLE.
- F_A - CALCULATED WIDTH OF OVERHANG FOR DESIGN VEHICLE.
- L - WHEELBASE OF DESIGN VEHICLE FROM APPROPRIATE TABLE.
- L_r - LENGTH OF SUPERELEVATION RUNOFF SECTION.

DEFINITIONS

- L_t - LENGTH OF TANGENT RUNOUT SECTION
- M - MULTIPLE LANE FACTOR.
- N - NUMBER OF LANES.
- n_1 - NUMBER OF LANES ROTATED (FROM TABLES).
- P_w - PAVEMENT WIDTH.
- R - RADIUS OF CURVE.
- rg - RELATIVE GRADIENT FROM APPROPRIATE TABLE.
- U - CALCULATED TRACK WIDTH OF DESIGN VEHICLE.

- u - TRACK WIDTH OF DESIGN VEHICLE FROM APPROPRIATE TABLE.
- V_D - DESIGN VELOCITY.
- w - CALCULATED WIDENING.
- W - PAVEMENT WIDTH
- W_C - CALCULATED TOTAL CURVE WIDTH.
- W_n - WIDTH OF LANE.
- Z - CALCULATED EXTRA WIDTH ALLOWANCE.

GENERAL DESIGN CONSIDERATIONS

1. WHERE PAVEMENT WIDENING IS REQUIRED, THE APPROPRIATE WIDENING IS ADDED TO THE LANE WIDTH WHEN CALCULATING THE SUPERELEVATION RUNOFF LENGTH (L_r).
2. THE COMPUTED SUPERELEVATION RUNOFF LENGTH (L_r) IS ROUNDED UP TO THE NEAREST FOOT.
3. WHEN THE SUPERELEVATION RUNOFF LENGTH (L_r) IS CALCULATED, IT MUST BE COMPARED WITH THE MINIMUM VALUE LISTED IN THE APPROPRIATE COLUMN ON THE RELATIVE GRADIENT TABLE.
4. TANGENT RUNOUT (L_t) IS ALWAYS ACHIEVED OUTSIDE OF THE SUPERELEVATION RUNOFF SECTION (L_r).
5. NO PAVEMENT WIDENING IS REQUIRED FOR URBAN ROADWAYS.
6. NO PAVEMENT WIDENING IS REQUIRED FOR RURAL ROADWAYS WITH A CURVE RADIUS GREATER THAN 2865 FEET.
7. NO PAVEMENT WIDENING IS REQUIRED FOR RURAL ROADWAYS WITH 12 FOOT WIDE LANES AND A CURVE RADIUS GREATER THAN 881 FEET.
8. PAVEMENT WIDENING IS APPLIED ONLY WHEN CALCULATED WIDENING (w) IS EQUAL TO OR GREATER THAN 2 FEET.
9. WHEN CALCULATING WIDENING (w) FOR MULTI-LANE RURAL ROADWAYS, WIDENING IS FIRST CALCULATED USING THE SINGLE LANE WIDTH FOR "W".
10. AN ALTERNATE METHOD FOR MULTI-LANE UNDIVIDED PAVEMENTS (48'). THE L_r IS 1.5 TIMES (M=1.5) THE CORRESPONDING LENGTH FOR TWO LANE HIGHWAYS; AND FOR SIX LANE UNDIVIDED PAVEMENTS (72'), THE L_r IS TWO TIMES (M=2) THE CORRESPONDING LENGTH FOR TWO LANE HIGHWAYS.
11. CALCULATED WIDENING IS ROUNDED UP TO THE NEAREST 0.1 FOOT.
12. CURVES WITH SPIRAL CURVE TRANSITIONS MUST HAVE A MINIMUM SUPERELEVATION RUNOFF LENGTH (L_r) EQUAL TO 2 SECONDS OF TRAVEL TIME AT THE ROADWAY'S DESIGN SPEED AS NOTED IN THE RELATIVE GRADIENT TABLE.

NO WIDENING REQUIRED FORMULAS USED TO CALCULATE SUPERELEVATION RUNOFF (L_r) AND WIDENING (w)

$L_r = b_w (W_n E / rg)$

$L_r = M(WE / rg)$ (ALT. MULTI-LANE)

WIDENING REQUIRED
 $L_r = b_w [E n_1 (W_n + w / N) / rg]$

$L_r = m [E (W + w / N) / rg]$ (ALT. MULTI-LANE)

$U = u + R - \sqrt{R^2 - L^2}$

$F_A = \sqrt{R^2 + A(2L + A)} - R$

$Z = (V_D / \sqrt{R})$

$W_C = N(U + C) + F_A + Z$

$w = W_C - 2W_n$

FOR SOLVED PROBLEMS USING THIS METHODOLOGY, SEE THE EXAMPLES ON PAGE 802.23

METHODOLOGIES FOR CALCULATING TC-5.01 VALUES

RURAL EXAMPLE
20 FT PAVEMENT WIDTH
(DESIGN SOFTWARE - 1 LANE AT 10 FT)

$V_D = 50$ MPH $R = 1000$ FT
 $W_n = 10$ FT $rg = 0.50$
 $E = 7.6$ (7.6% PER 802.40)

$$U = u + R - \sqrt{R^2 - L^2}$$

$$U = 8.0 + 1000 - \sqrt{(1000)^2 - (20)^2}$$

$$U = 8.20002$$

$$F_A = \sqrt{R^2 + A(2L + A)} - R$$

$$F_A = \sqrt{(1000)^2 + 4[2(20) + 4]} - 1000$$

$$F_A = .087996$$

$$Z = (V_D / \sqrt{R})$$

$$Z = (50 / \sqrt{1000})$$

$$Z = 1.58$$

$$W_C = N(U + C) + F_A + Z$$

$$W_C = 2(8.20002 + 2) + 0.087996 + 1.58$$

$$W_C = 22.0680$$

$$w = W_C - 2W_n = 22.0680 - 2(10) = 2.1$$

($R < 2865$ & $w > 2$ THEREFORE WIDENING IS REQUIRED)
 $L_r = [E n_1 (W_n + w/2) / rg] b_w$
 $L_r = [7.6(1)(10 + 2.1/2) / 0.50] 1$
 $L_r = 7.6 (11.05) / 0.50$
 $L_r = 167.96$

RURAL EXAMPLE
72 FT PAVEMENT WIDTH
(DESIGN SOFTWARE - 3 LANES AT 12 FT)

$V_D = 40$ MPH $R = 500$ FT
 $W_n = 12$ FT $rg = 0.58$
 $E = 8.0$ (8% PER PAGE 802.38)

$$U = u + R - \sqrt{R^2 - L^2}$$

$$U = 8.0 + 500 - \sqrt{(500)^2 - (20)^2}$$

$$U = 8.4002$$

$$F_A = \sqrt{R^2 + A(2L + A)} - R$$

$$F_A = \sqrt{(500)^2 + 4[2(20) + 4]} - 500$$

$$F_A = .1760$$

$$Z = (V_D / \sqrt{R})$$

$$Z = (40 / \sqrt{500})$$

$$Z = 1.7885$$

$$W_C = 2(U + C) + F_A + Z$$

$$W_C = 2(8.4002 + 3.0) + .1760 + 1.7885$$

$$W_C = 24.7651$$

$$w = W_C - 2W_n = 24.7651 - 2(12) = 0.7651(0.8)$$

FOR 72' PAVEMENT WIDTH
 $w = 3(0.8) = 2.4$

($R < 881$ & $w > 2$ THEREFORE WIDENING IS REQUIRED)
 $L_r = [E n_1 (W_n + w/3) / rg] b_w$
 $L_r = [8 (3) (12 + 2.4/3) / 0.58] 0.6667$
 $L_r = (307.2 / 0.58) 0.6667$
 $L_r = 353.1211$
 OR
 $L_r = MCE(W_n + w/N) / rg]$
 $L_r = 2 [8(12 + 4.5/3) / 0.58]$
 $L_r = 2 (102.4 / 0.58)$
 $L_r = 353.1034$

URBAN EXAMPLES

24 FT PAVEMENT WIDTH
(DESIGN SOFTWARE - 1 LANE AT 12 FT)

$V_D = 40$ MPH $R = 600$ FT
 $W_n = 12$ FT $rg = 0.58$
 $E = 4.0$ (4% PER PAGE 802.29)

$$L_r = (W_n n_1 E / rg) b_w$$

$$L_r = [12(1)(4) / 0.58] 1.00$$

$$L_r = (48 / 0.58)$$

$$L_r = 82.7586$$

66 FT PAVEMENT WIDTH
(DESIGN SOFTWARE - 3 LANES AT 11 FT)

$V_D = 40$ MPH $R = 600$ FT
 $W_n = 11$ FT $rg = 0.58$
 $E = 4.0$ (4% PER PAGE 802.29)

$$L_r = b_w (W_n n_1 E / rg)$$

$$L_r = 0.6667 [11(3)(4) / 0.58]$$

$$L_r = 0.6667 (132 / 0.58)$$

$$L_r = 151.7317$$

OR

$$L_r = M (E W_n / rg)$$

$$L_r = 2 [4(11) / 0.58]$$

$$L_r = 2 (44 / 0.58)$$

$$L_r = 151.7241$$

CALCULATED TC-5.01 EXAMPLES

MINIMUM RADII AND SUPERELEVATION RUNOFF SECTION (L_r) LENGTHS FOR 2% SUPERELEVATION

RADIUS (FEET)	E (%)	F	DV (MPH)	L _r (FEET)	
				PAVEMENT WIDTH (W)	
				W ≤ 72 FT.	W > 72 FT
>738	2.0	.163	45	126	NOTE: FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE L _r VALUES DEVELOPED BY THE DESIGN SOFTWARE.
539	2.0	.178	40	113	
377	2.0	.197	35	101	
249	2.0	.221	30	90	
154	2.0	.252	25	80	
84	2.0	.300	20	75	

MINIMUM RADII FOR DESIGNS
UTILIZING NORMAL PAVEMENT CROWN

RADIUS (FEET)	F	NC (MPH)
> 945	.163	45
676	.178	40
462	.197	35
299	.221	30
180	.252	25
96	.300	20

SUMMARY OF STD. TC-5.01 ULS (URBAN-LOW SPEED) DESIGN FACTORS

MINIMUM RADII AND SUPERELEVATION RUNOFF SECTION LENGTHS (Lr) FOR +2% SUPERELEVATION

RADIUS (FEET)	E (%)	f	DV (MPH)	LENGTH OF SUPERELEVATION RUNOFF (Lr) IN FEET						
				PAVEMENT WIDTH (W)						W > 72'
				24' (1@12')	36' (1.5@12')	48' (2@12')	60' (3@10')	66' (3@11')	72' (3@12')	
> 795	2.0	0.150	45	45	56	67	75	82	90	*
593	2.0	0.160	40	42	52	63	70	77	84	*
408	2.0	0.180	35	39	49	59	65	72	78	*
273	2.0	0.200	30	37	46	55	61	67	74	*
167	2.0	0.230	25	35	43	52	58	64	69	*
92	2.0	0.270	20	33	41	49	55	60	66	*

* FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

MINIMUM RADII FOR DESIGNS
UTILIZING -2% SUPERELEVATION NORMAL PAVEMENT CROWN

RADIUS (FEET)	f	NC (MPH)
> 1039	.150	45
762	.160	40
510	.180	35
333	.200	30
198	.230	25
107	.270	20

SUMMARY OF STD. TC-5.04 ULS (URBAN-LOW SPEED) DESIGN FACTORS

DESIGN FACTORS FOR A DESIGN SPEED OF 20 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
1400	NC	0	0	0	0	0	0	0	0	0	0	0	0
961	2.0	33	33	41	41	49	49	55	55	60	60	65	65
884	2.1	33	35	41	43	49	52	55	57	60	63	65	69
810	2.2	33	36	41	45	49	54	55	60	60	66	65	72
735	2.3	33	38	41	47	49	56	55	63	60	69	65	75
653	2.4	33	39	41	49	49	59	55	65	60	72	65	78
578	2.5	33	41	41	51	49	61	55	68	60	75	65	82
516	2.6	33	43	41	53	49	64	55	71	60	78	65	85
464	2.7	33	44	41	55	49	66	55	73	60	81	65	88
421	2.8	33	46	41	57	49	69	55	76	60	84	65	91
383	2.9	33	48	41	59	49	71	55	79	60	87	65	95
351	3.0	33	49	41	61	49	73	55	82	60	90	65	98
322	3.1	33	51	41	63	49	76	55	84	60	93	65	101
296	3.2	33	52	41	65	49	78	55	87	60	96	65	104
273	3.3	33	54	41	67	49	81	55	90	60	99	65	108
252	3.4	33	56	41	69	49	83	55	92	60	102	65	111
232	3.5	33	57	41	71	49	86	55	95	60	105	65	114
214	3.6	33	59	41	73	49	88	55	98	60	108	65	117
196	3.7	33	60	41	75	49	90	55	100	60	110	65	120
179	3.8	33	62	41	77	49	93	55	103	60	113	65	124
160	3.9	33	64	41	79	49	95	55	106	60	116	65	127
127	4.0	33	65	41	81	49	98	55	109	60	119	65	130

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt, AND Lr VALUES.

SPECIFICATION
REFERENCE

TRANSITION CURVES - URBAN
20 MPH DESIGN SPEED

VIRGINIA DEPARTMENT OF TRANSPORTATION

TC-5.01		DESIGN FACTORS FOR A DESIGN SPEED OF 25 MPH (URBAN) USING E= 4% MAX.											
RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
2500	NC	0	0	0	0	0	0	0	0	0	0	0	0
1407	2.0	35	35	43	43	52	52	58	58	63	63	69	69
1299	2.1	35	36	43	45	52	54	58	60	63	66	69	72
1195	2.2	35	38	43	48	52	57	58	63	63	70	69	76
1094	2.3	35	40	43	50	52	60	58	66	63	73	69	79
990	2.4	35	42	43	52	52	62	58	69	63	76	69	83
883	2.5	35	43	43	54	52	65	58	72	63	79	69	86
793	2.6	35	45	43	56	52	67	58	75	63	82	69	90
718	2.7	35	47	43	58	52	70	58	78	63	85	69	93
654	2.8	35	48	43	60	52	72	58	80	63	88	69	96
598	2.9	35	50	43	63	52	75	58	83	63	92	69	100
548	3.0	35	52	43	65	52	78	58	86	63	95	69	103
505	3.1	35	54	43	67	52	80	58	89	63	98	69	107
466	3.2	35	55	43	69	52	83	58	92	63	101	69	110
430	3.3	35	57	43	71	52	85	58	95	63	104	69	114
397	3.4	35	59	43	73	52	88	58	98	63	107	69	117
367	3.5	35	60	43	75	52	90	58	100	63	110	69	120
339	3.6	35	62	43	78	52	93	58	103	63	114	69	124
311	3.7	35	64	43	80	52	96	58	106	63	117	69	127
284	3.8	35	66	43	82	52	98	58	109	63	120	69	131
255	3.9	35	67	43	84	52	101	58	112	63	123	69	134
204	4.0	35	69	43	86	52	103	58	115	63	126	69	138

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt, AND Lr VALUES.

DESIGN FACTORS FOR A DESIGN SPEED OF 30 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
3000	NC	0	0	0	0	0	0	0	0	0	0	0	0
1940	2.0	37	37	46	46	55	55	61	61	67	67	73	73
1795	2.1	37	39	46	48	55	58	61	64	67	70	73	77
1658	2.2	37	40	46	50	55	60	61	67	67	74	73	80
1525	2.3	37	42	46	53	55	63	61	70	67	77	73	84
1393	2.4	37	44	46	55	55	66	61	73	67	80	73	88
1255	2.5	37	46	46	57	55	69	61	76	67	84	73	91
1134	2.6	37	48	46	60	55	71	61	79	67	87	73	95
1030	2.7	37	50	46	62	55	74	61	82	67	90	73	99
941	2.8	37	51	46	64	55	77	61	85	67	94	73	102
863	2.9	37	53	46	66	55	80	61	88	67	97	73	106
794	3.0	37	55	46	69	55	82	61	91	67	100	73	110
732	3.1	37	57	46	71	55	85	61	94	67	104	73	113
677	3.2	37	59	46	73	55	88	61	97	67	107	73	117
627	3.3	37	60	46	75	55	90	61	100	67	110	73	120
580	3.4	37	62	46	78	55	93	61	104	67	114	73	124
537	3.5	37	64	46	80	55	96	61	107	67	117	73	128
496	3.6	37	66	46	82	55	99	61	110	67	120	73	131
457	3.7	37	68	46	85	55	101	61	113	67	124	73	135
417	3.8	37	70	46	87	55	104	61	116	67	127	73	139
375	3.9	37	71	46	89	55	107	61	119	67	130	73	142
300	4.0	37	73	46	91	55	110	61	122	67	134	73	146

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt, AND Lr VALUES.

TRANSITION CURVES - URBAN
30 MPH DESIGN SPEED

VIRGINIA DEPARTMENT OF TRANSPORTATION

TC-5.01		DESIGN FACTORS FOR A DESIGN SPEED OF 35 MPH (URBAN) USING E= 4% MAX.											
RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	CR	Lr
4000	NC	0	0	0	0	0	0	0	0	0	0	0	0
2561	2.0	39	39	49	49	59	59	65	65	71	71	78	78
2374	2.1	39	41	49	51	59	61	65	68	71	75	78	82
2199	2.2	39	43	49	54	59	64	65	71	71	79	78	86
2031	2.3	39	45	49	56	59	67	65	75	71	82	78	90
1866	2.4	39	47	49	59	59	70	65	78	71	86	78	93
1697	2.5	39	49	49	61	59	73	65	81	71	89	78	97
1538	2.6	39	51	49	63	59	76	65	84	71	93	78	101
1403	2.7	39	53	49	66	59	79	65	88	71	96	78	105
1285	2.8	39	55	49	68	59	82	65	91	71	100	78	109
1182	2.9	39	57	49	71	59	85	65	94	71	103	78	113
1090	3.0	39	59	49	73	59	88	65	97	71	107	78	117
1008	3.1	39	60	49	75	59	90	65	100	71	110	78	120
933	3.2	39	62	49	78	59	93	65	104	71	114	78	124
865	3.3	39	64	49	80	59	96	65	107	71	118	78	128
802	3.4	39	66	49	83	59	99	65	110	71	121	78	132
743	3.5	39	68	49	85	59	102	65	113	71	125	78	136
688	3.6	39	70	49	88	59	105	65	117	71	128	78	140
634	3.7	39	72	49	90	59	108	65	120	71	132	78	144
580	3.8	39	74	49	92	59	111	65	123	71	135	78	148
522	3.9	39	76	49	95	59	114	65	126	71	139	78	151
420	4.0	39	78	49	97	59	117	65	130	71	142	78	155

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt, AND Lr VALUES.

TRANSITION CURVES - URBAN
35 MPH DESIGN SPEED

VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATION
REFERENCE

DESIGN FACTORS FOR A DESIGN SPEED OF 40 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
5000	NC	0	0	0	0	0	0	0	0	0	0	0	0
3273	2.0	42	42	52	52	63	63	69	69	76	76	83	83
3039	2.1	42	44	52	55	63	66	69	73	76	80	83	87
2820	2.2	42	46	52	57	63	69	69	76	76	84	83	92
2612	2.3	42	48	52	60	63	72	69	80	76	88	83	96
2411	2.4	42	50	52	63	63	75	69	83	76	92	83	100
2209	2.5	42	52	52	65	63	78	69	87	76	95	83	104
2010	2.6	42	54	52	68	63	81	69	90	76	99	83	108
1839	2.7	42	56	52	70	63	84	69	94	76	103	83	112
1689	2.8	42	58	52	73	63	87	69	97	76	107	83	116
1557	2.9	42	60	52	75	63	90	69	100	76	110	83	120
1439	3.0	42	63	52	78	63	94	69	104	76	114	83	125
1332	3.1	42	65	52	81	63	97	69	107	76	118	83	129
1236	3.2	42	67	52	83	63	100	69	111	76	122	83	133
1148	3.3	42	69	52	86	63	103	69	114	76	126	83	137
1066	3.4	42	71	52	88	63	106	69	118	76	129	83	141
989	3.5	42	73	52	91	63	109	69	121	76	133	83	145
916	3.6	42	75	52	94	63	112	69	125	76	137	83	149
845	3.7	42	77	52	96	63	115	69	128	76	141	83	154
774	3.8	42	79	52	99	63	118	69	132	76	145	83	158
698	3.9	42	81	52	101	63	122	69	135	76	148	83	162
563	4.0	42	83	52	104	63	125	69	138	76	152	83	166

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt, AND Lr VALUES.

TRANSITION CURVES - URBAN
40 MPH DESIGN SPEED

VIRGINIA DEPARTMENT OF TRANSPORTATION

DESIGN FACTORS FOR A DESIGN SPEED OF 45 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
6000	NC	0	0	0	0	0	0	0	0	0	0	0	0
4076	2.0	45	45	56	56	67	67	75	75	82	82	89	89
3790	2.1	45	47	56	59	67	70	75	78	82	86	89	94
3523	2.2	45	49	56	62	67	74	75	82	82	90	89	98
3271	2.3	45	52	56	64	67	77	75	86	82	94	89	103
3029	2.4	45	54	56	67	67	80	75	89	82	98	89	107
2790	2.5	45	56	56	70	67	84	75	93	82	102	89	112
2552	2.6	45	58	56	73	67	87	75	97	82	106	89	116
2341	2.7	45	60	56	75	67	90	75	100	82	110	89	120
2155	2.8	45	63	56	78	67	94	75	104	82	115	89	125
1990	2.9	45	65	56	81	67	97	75	108	82	119	89	129
1843	3.0	45	67	56	84	67	100	75	112	82	123	89	134
1710	3.1	45	69	56	87	67	104	75	115	82	127	89	138
1589	3.2	45	72	56	89	67	107	75	119	82	131	89	143
1477	3.3	45	74	56	92	67	110	75	123	82	135	89	147
1374	3.4	45	76	56	95	67	114	75	126	82	139	89	152
1276	3.5	45	78	56	98	67	117	75	130	82	143	89	156
1184	3.6	45	80	56	100	67	120	75	134	82	147	89	160
1093	3.7	45	83	56	103	67	124	75	138	82	151	89	165
1003	3.8	45	85	56	106	67	127	75	141	82	155	89	169
905	3.9	45	87	56	109	67	130	75	145	82	159	89	174
730	4.0	45	89	56	112	67	134	75	149	82	163	89	178

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt, AND Lr VALUES.

TRANSITION CURVES - URBAN
45 MPH DESIGN SPEED

DESIGN FACTORS FOR A DESIGN SPEED OF 50 MPH
(URBAN) USING E= 4 % MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
8000	NC	0	0	0	0	0	0	0	0	0	0	0	0
4792	2.0	48	48	60	60	72	72	80	80	88	88	96	96
4629	2.1	48	51	60	63	72	76	80	84	88	93	96	101
4310	2.2	48	53	60	66	72	80	80	88	88	97	96	106
4010	2.3	48	56	60	69	72	83	80	92	88	102	96	111
3723	2.4	48	58	60	72	72	87	80	96	88	106	96	116
3444	2.5	48	60	60	75	72	90	80	100	88	110	96	120
3166	2.6	48	63	60	78	72	94	80	104	88	115	96	125
2911	2.7	48	65	60	81	72	98	80	108	88	119	96	130
2686	2.8	48	68	60	84	72	101	80	112	88	124	96	135
2486	2.9	48	70	60	87	72	105	80	116	88	128	96	140
2306	3.0	48	72	60	90	72	108	80	120	88	132	96	144
2143	3.1	48	75	60	93	72	112	80	124	88	137	96	149
1994	3.2	48	77	60	96	72	116	80	128	88	141	96	154
1857	3.3	48	80	60	99	72	119	80	132	88	146	96	159
1729	3.4	48	82	60	102	72	123	80	136	88	150	96	164
1608	3.5	48	84	60	105	72	126	80	140	88	154	96	168
1493	3.6	48	87	60	108	72	130	80	144	88	159	96	173
1381	3.7	48	89	60	111	72	134	80	148	88	163	96	178
1268	3.8	48	92	60	114	72	137	80	152	88	168	96	183
1146	3.9	48	94	60	117	72	141	80	156	88	172	96	188
929	4.0	48	96	60	120	72	144	80	160	88	176	96	192

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt AND Lr VALUES.

TRANSITION CURVES - URBAN
50 MPH DESIGN SPEED

DESIGN FACTORS FOR A DESIGN SPEED OF 55 MPH
(URBAN) USING E= 4% MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
10000	NC	0	0	0	0	0	0	0	0	0	0	0	0
5995	2.0	52	52	64	64	77	77	86	86	94	94	103	103
5592	2.1	52	54	64	68	77	81	86	90	94	99	103	108
5218	2.2	52	57	64	71	77	85	86	94	94	103	103	113
4869	2.3	52	59	64	74	77	89	86	98	94	108	103	118
4538	2.4	52	62	64	77	77	92	86	103	94	113	103	123
4220	2.5	52	64	64	80	77	96	86	107	94	118	103	128
3909	2.6	52	67	64	83	77	100	86	111	94	122	103	133
3610	2.7	52	69	64	87	77	104	86	115	94	127	103	138
3343	2.8	52	72	64	90	77	108	86	120	94	132	103	143
3104	2.9	52	75	64	93	77	112	86	124	94	136	103	149
2888	3.0	52	77	64	96	77	115	86	128	94	141	103	154
2691	3.1	52	80	64	99	77	119	86	132	94	146	103	159
2510	3.2	52	82	64	103	77	123	86	137	94	150	103	164
2343	3.3	52	85	64	106	77	127	86	141	94	155	103	169
2186	3.4	52	87	64	109	77	131	86	145	94	160	103	174
2037	3.5	52	90	64	112	77	135	86	149	94	164	103	179
1895	3.6	52	92	64	115	77	138	86	154	94	169	103	184
1756	3.7	52	95	64	119	77	142	86	158	94	174	103	189
1615	3.8	52	98	64	122	77	146	86	162	94	178	103	195
1462	3.9	52	100	64	125	77	150	86	166	94	183	103	200
1190	4.0	52	103	64	128	77	154	86	171	94	188	103	205

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt, AND Lr VALUES.

TRANSITION CURVES - URBAN
55 MPH DESIGN SPEED

VIRGINIA DEPARTMENT OF TRANSPORTATION

DESIGN FACTORS FOR A DESIGN SPEED OF 60 MPH
(URBAN) USING E= 4 % MAX.

RADIUS (FEET)	E (%)	PAVEMENT WIDTH											
		24 FT		36 FT		48 FT		60 FT		66 FT		72 FT	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
		1 @ 12'		1.5 @ 12'		2 @ 12'		3 @ 10'		3 @ 11'		3 @ 12'	
		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
10000	NC	0	0	0	0	0	0	0	0	0	0	0	0
7131	2.0	54	54	67	67	80	80	89	89	98	98	107	107
6663	2.1	54	56	67	70	80	84	89	94	98	103	107	112
6232	2.2	54	59	67	74	80	88	89	98	98	108	107	118
5829	2.3	54	62	67	77	80	92	89	103	98	113	107	123
5451	2.4	54	64	67	80	80	96	89	107	98	118	107	128
5092	2.5	54	67	67	84	80	100	89	112	98	123	107	134
4746	2.6	54	70	67	87	80	104	89	116	98	128	107	139
4408	2.7	54	72	67	90	80	108	89	120	98	132	107	144
4098	2.8	54	75	67	94	80	112	89	125	98	137	107	150
3818	2.9	54	78	67	97	80	116	89	129	98	142	107	155
3563	3.0	54	80	67	100	80	120	89	134	98	147	107	160
3330	3.1	54	83	67	104	80	124	89	138	98	152	107	166
3114	3.2	54	86	67	107	80	128	89	143	98	157	107	171
2913	3.3	54	88	67	110	80	132	89	147	98	162	107	176
2724	3.4	54	91	67	114	80	136	89	152	98	167	107	182
2544	3.5	54	94	67	117	80	140	89	156	98	172	107	187
2372	3.6	54	96	67	120	80	144	89	160	98	176	107	192
2202	3.7	54	99	67	124	80	148	89	165	98	181	107	198
2030	3.8	54	102	67	127	80	152	89	169	98	186	107	203
1842	3.9	54	104	67	130	80	156	89	174	98	191	107	208
1505	4.0	54	107	67	134	80	160	89	178	98	196	107	214

NOTE:

Lt AND Lr VALUES IN FEET.

FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt, AND Lr VALUES.

TRANSITION CURVES - URBAN
60 MPH DESIGN SPEED

VIRGINIA DEPARTMENT OF TRANSPORTATION

DESIGN FACTORS FOR A DESIGN SPEED OF 20 MPH (RURAL) USING E = 8% MAX.

DESIGN VELOCITY +20	DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)										INTERCHANGE RAMPS														
	WIDTH= 18 FT					WIDTH=20 FT					WIDTH=22 FT					WIDTH=24 FT					WIDTH=48 FT				
	1 @ 9'		1 @ 10'		1 @ 11'		1 @ 12'		1 @ 12'		2 @ 12'		16 FT		18 FT										
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	
1800	NC	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0	0	0	0
1213	2.0	59	59	2.0	28	28	0.0	30	30	0.0	33	33	0.0	33	33	0.0	49	49	0.0	49	49	0.0	39	39	41
1148	2.1	57	59	2.1	28	29	0.0	30	32	0.0	33	35	0.0	33	35	0.0	49	52	0.0	49	52	0.0	39	40	41
1090	2.2	54	59	2.1	28	30	0.0	30	33	0.0	33	36	0.0	33	36	0.0	49	54	0.0	49	54	0.0	39	42	41
1036	2.3	52	59	2.1	28	32	0.0	30	35	0.0	33	38	0.0	33	38	0.0	49	56	0.0	49	56	0.0	39	44	41
987	2.4	50	59	2.2	28	33	0.0	30	36	0.0	33	39	0.0	33	39	0.0	49	59	0.0	49	59	0.0	39	46	41
941	2.5	48	59	2.2	28	34	0.0	30	38	0.0	33	41	0.0	33	41	0.0	49	61	0.0	49	61	0.0	39	48	41
899	2.6	46	59	2.3	28	36	0.0	30	39	0.0	33	43	0.0	33	43	0.0	49	64	0.0	49	64	0.0	39	50	41
860	2.7	44	59	2.3	28	37	0.0	30	41	0.0	33	44	0.0	33	44	0.0	49	66	0.0	49	66	0.0	39	52	41
824	2.8	43	59	2.3	28	38	0.0	30	42	0.0	33	46	0.0	33	46	0.0	49	69	0.0	49	69	0.0	39	54	41
790	2.9	41	59	2.4	28	40	0.0	30	44	0.0	33	48	0.0	33	48	0.0	49	71	0.0	49	71	0.0	39	56	41
759	3.0	40	59	2.4	28	41	0.0	30	45	0.0	33	49	0.0	33	49	0.0	49	73	0.0	49	73	0.0	39	58	41
729	3.1	39	59	2.5	28	42	0.0	30	47	0.0	33	51	0.0	33	51	0.0	49	76	0.0	49	76	0.0	39	60	41
701	3.2	37	59	2.5	28	44	0.0	30	48	0.0	33	52	0.0	33	52	0.0	49	78	0.0	49	78	0.0	39	61	41
674	3.3	36	59	2.5	28	45	0.0	30	50	0.0	33	54	0.0	33	54	0.0	49	81	0.0	49	81	0.0	39	63	41
650	3.4	35	59	2.6	28	46	0.0	30	51	0.0	33	56	0.0	33	56	0.0	49	83	0.0	49	83	0.0	39	65	41
626	3.5	34	59	2.6	28	48	0.0	30	53	0.0	33	57	0.0	33	57	0.0	49	86	0.0	49	86	0.0	39	67	41
604	3.6	33	59	2.7	28	49	0.0	30	54	0.0	33	59	0.0	33	59	0.0	49	88	0.0	49	88	0.0	39	69	41
582	3.7	32	59	2.7	28	50	0.0	30	55	0.0	33	60	0.0	33	60	0.0	49	90	0.0	49	90	0.0	39	71	41
562	3.8	32	59	2.8	28	52	0.0	30	57	0.0	33	62	0.0	33	62	0.0	49	93	0.0	49	93	0.0	39	73	41
543	3.9	31	59	2.8	28	53	0.0	30	58	0.0	33	64	0.0	33	64	0.0	49	95	0.0	49	95	0.0	39	75	41
524	4.0	30	59	2.9	28	55	0.0	30	60	0.0	33	66	0.0	33	66	0.0	49	98	0.0	49	98	0.0	39	77	41
506	4.1	29	59	2.9	28	56	0.0	30	61	0.0	33	67	0.0	33	67	0.0	49	100	0.0	49	100	0.0	39	79	41
489	4.2	29	60	3.0	30	63	2.0	30	63	0.0	33	69	0.0	33	69	0.0	49	103	0.0	49	103	0.0	39	80	41
473	4.3	29	62	3.0	30	64	2.0	30	64	0.0	33	70	0.0	33	70	0.0	49	105	0.0	49	105	0.0	39	82	41
457	4.4	29	63	3.0	30	66	2.0	30	66	0.0	33	72	0.0	33	72	0.0	49	108	0.0	49	108	0.0	39	84	41
442	4.5	29	65	3.1	31	68	2.1	30	67	0.0	33	73	0.0	33	73	0.0	49	110	0.0	49	110	0.0	39	86	41
427	4.6	29	66	3.2	30	69	2.2	30	69	0.0	33	75	0.0	33	75	0.0	49	112	0.0	49	112	0.0	39	88	41
413	4.7	29	68	3.2	31	71	2.2	30	70	0.0	33	77	0.0	33	77	0.0	49	115	0.0	49	115	0.0	39	90	41
399	4.8	30	70	3.3	31	73	2.3	30	72	0.0	33	78	0.0	33	78	0.0	49	117	0.0	49	117	0.0	39	92	41
385	4.9	29	71	3.3	31	74	2.3	30	73	0.0	33	80	0.0	33	80	0.0	49	120	0.0	49	120	0.0	39	94	41
372	5.0	30	73	3.4	31	76	2.4	30	75	0.0	33	82	0.0	33	82	0.0	49	122	0.0	49	122	0.0	39	96	41
358	5.1	30	75	3.5	31	78	2.5	30	76	0.0	33	83	0.0	33	83	0.0	49	125	0.0	49	125	0.0	39	98	41
345	5.2	30	76	3.5	31	80	2.5	30	78	0.0	33	85	0.0	33	85	0.0	49	127	0.0	49	127	0.0	39	100	41
332	5.3	30	78	3.6	31	81	2.6	30	79	0.0	33	86	0.0	33	86	0.0	49	129	0.0	49	129	0.0	39	101	41
320	5.4	30	80	3.7	31	83	2.7	30	81	0.0	33	88	0.0	33	88	0.0	49	132	0.0	49	132	0.0	39	103	41
308	5.5	30	82	3.8	31	85	2.8	30	82	0.0	33	90	0.0	33	90	0.0	49	134	0.0	49	134	0.0	39	105	41
297	5.6	30	83	3.9	32	87	2.9	30	84	0.0	33	91	0.0	33	91	0.0	49	137	0.0	49	137	0.0	39	107	41
286	5.7	30	85	3.9	32	89	2.9	30	85	0.0	33	93	0.0	33	93	0.0	49	139	0.0	49	139	0.0	39	109	41
276	5.8	30	87	4.0	32	91	3.0	33	95	2.0	33	95	0.0	33	95	0.0	53	153	2.0	39	111	41	118	41	
266	5.9	31	89	4.1	32	93	3.1	33	97	2.1	33	96	0.0	33	96	0.0	54	157	2.2	39	113	41	120	41	
258	6.0	30	90	4.2	32	95	3.2	33	99	2.2	33	98	0.0	33	98	0.0	54	161	2.4	39	115	41	122	41	
248	6.1	31	92	4.3	32	97	3.3	34	101	2.3	33	99	0.0	33	99	0.0	55	165	2.6	39	117	41	124	41	
240	6.2	31	94	4.4	32	99	3.4	34	103	2.4	33	101	0.0	33	101	0.0	55	169	2.8	39	119	41	126	41	
232	6.3	31	96	4.5	33	101	3.5	34	105	2.5	33	103	0.0	33	103	0.0	55	173	3.0	39	120	41	128	41	
225	6.4	31	98	4.6	33	103	3.6	34	107	2.6	33	104	0.0	33	104	0.0	56	177	3.2	39	122	41	130	41	
217	6.5	31	100	4.7	33	105	3.7	34	109	2.7	33	106	0.0	33	106	0.0	56	181	3.4	39	124	41	132	41	
209	6.6	31	102	4.8	33	107	3.8	34	111	2.8	33	108	0.0	33	108	0.0	57	185	3.6	39	126	41	134	41	
202	6.7	32	104	4.9	33	109	3.9	34	113	2.9	33	109	0.0	33	109	0.0	57	189	3.8	39	128	41	136	41	
196	6.8	32	106	5.0	33	111	4.0	34	115	3.0	36	120	2.0	57	193	4.0	39	130	41	138	41	138	41		
189	6.9	32	108	5.1	33	113	4.1	35	118	3.1	36	122	2.1	58	198	4.2	39	132	41	140	41	140	41		
183	7.0	32	110	5.2	33	115	4.2	35	120	3.2	36	124	2.2	58	202	4.4	39	134	41	142	41	142	41		
176	7.1	32	112	5.3	33	117	4.3	35	122	3.3	36	127	2.3	59	206	4.6	39	136	41	144	41	144	41		
170	7.2	32	115	5.5	34	120	4.5	35	125	3.5	36	129	2.5	59	212	5.0	39	138	41	146	41	146	41		
164	7.3	33	117	5.6	34	122	4.6	35	127	3.6	37	132	2.6	60	217	5.2	39	140	41	148	41	148	41		
158	7.4	33	119	5.8	34	124	4.8	35	129	3.8	37	134	2.8	60	222	5.6	39	141	41	150	41	150	41		
152	7.5	33	122	5.9	34	127	4.9	36	132	3.9	37	137	2.9	61	227	5.8	39	143	41	152	41	152	41		
146	7.6	33	124	6.1	34	129	5.1	36	135	4.1	37	140	3.1	62	233	6.2	39	145	41	154	41	154	41		
139	7.7	33	127	6.3	35	132	5.3	36	137	4.3	38	143	3.3	63	239	6.6	39	147	41	156	41	156	41		
132	7.8	34	130	6.5	35	135	5.5	36	140	4.5	38	145	3.5	64	246	7.0	39	149	41	158	41	158	41		
124	7.9	34	133	6.8	35	138	5.8	37	144	4.8	38	149	3.8	65	254	7									

DESIGN FACTORS FOR A DESIGN SPEED OF 25 MPH (RURAL) USING E = 8% MAX.

DESIGN VELOCITY =25	WIDTH= 18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT			INTERCHANGE RAMP										
	DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)									1 @ 11'			1 @ 12'			2 @ 12'			16 FT			18 FT				
	1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			1 @ 12'			2 @ 12'			16 FT			18 FT				
	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr
2500	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
1756	2.0	26	0.0	29	29	0.0	32	32	0.0	35	35	0.0	35	35	0.0	52	52	0.0	52	52	0.0	40	40	43	43	
1664	2.1	74	2.0	29	30	0.0	32	33	0.0	35	36	0.0	35	36	0.0	52	54	0.0	52	54	0.0	40	42	43	45	
1579	2.2	68	74	2.0	29	32	0.0	32	35	0.0	35	38	0.0	35	38	0.0	52	57	0.0	52	57	0.0	40	44	43	48
1502	2.3	65	74	2.0	29	33	0.0	33	37	0.0	35	40	0.0	35	40	0.0	52	60	0.0	52	60	0.0	40	46	43	50
1431	2.4	62	74	2.1	29	35	0.0	32	38	0.0	35	42	0.0	35	42	0.0	52	62	0.0	52	62	0.0	40	48	43	52
1366	2.5	60	74	2.1	29	36	0.0	32	40	0.0	35	43	0.0	35	43	0.0	52	65	0.0	52	65	0.0	40	50	43	54
1306	2.6	57	74	2.1	29	38	0.0	32	41	0.0	35	45	0.0	35	45	0.0	52	67	0.0	52	67	0.0	40	52	43	56
1250	2.7	55	74	2.1	29	39	0.0	32	43	0.0	35	47	0.0	35	47	0.0	52	70	0.0	52	70	0.0	40	54	43	58
1198	2.8	53	74	2.2	29	40	0.0	32	44	0.0	35	48	0.0	35	48	0.0	52	72	0.0	52	72	0.0	40	56	43	60
1149	2.9	52	74	2.2	29	42	0.0	32	46	0.0	35	50	0.0	35	50	0.0	52	75	0.0	52	75	0.0	40	58	43	63
1104	3.0	50	74	2.2	29	43	0.0	32	48	0.0	35	52	0.0	35	52	0.0	52	78	0.0	52	78	0.0	40	60	43	65
1061	3.1	48	74	2.3	29	45	0.0	32	49	0.0	35	54	0.0	35	54	0.0	52	80	0.0	52	80	0.0	40	62	43	67
1021	3.2	47	74	2.3	29	46	0.0	32	51	0.0	35	55	0.0	35	55	0.0	52	83	0.0	52	83	0.0	40	64	43	69
983	3.3	45	74	2.3	29	48	0.0	32	52	0.0	35	57	0.0	35	57	0.0	52	85	0.0	52	85	0.0	40	66	43	71
948	3.4	44	74	2.4	29	49	0.0	32	54	0.0	35	59	0.0	35	59	0.0	52	88	0.0	52	88	0.0	40	68	43	73
914	3.5	43	74	2.4	29	50	0.0	32	55	0.0	35	60	0.0	35	60	0.0	52	90	0.0	52	90	0.0	40	70	43	75
882	3.6	42	74	2.4	29	52	0.0	32	57	0.0	35	62	0.0	35	62	0.0	52	93	0.0	52	93	0.0	40	72	43	78
852	3.7	40	74	2.5	29	53	0.0	32	59	0.0	35	64	0.0	35	64	0.0	52	96	0.0	52	96	0.0	40	74	43	80
823	3.8	39	74	2.5	29	55	0.0	32	60	0.0	35	66	0.0	35	66	0.0	52	98	0.0	52	98	0.0	40	76	43	82
795	3.9	38	74	2.6	29	56	0.0	32	62	0.0	35	67	0.0	35	67	0.0	52	101	0.0	52	101	0.0	40	78	43	84
769	4.0	37	74	2.6	29	58	0.0	32	63	0.0	35	69	0.0	35	69	0.0	52	103	0.0	52	103	0.0	40	80	43	86
744	4.1	37	74	2.6	29	59	0.0	32	65	0.0	35	71	0.0	35	71	0.0	52	106	0.0	52	106	0.0	40	82	43	88
720	4.2	36	74	2.7	29	60	0.0	32	66	0.0	35	72	0.0	35	72	0.0	52	108	0.0	52	108	0.0	40	84	43	90
696	4.3	35	74	2.7	29	62	0.0	32	68	0.0	35	74	0.0	35	74	0.0	52	111	0.0	52	111	0.0	40	86	43	93
674	4.4	34	74	2.7	29	63	0.0	32	70	0.0	35	76	0.0	35	76	0.0	52	114	0.0	52	114	0.0	40	88	43	95
652	4.5	33	74	2.8	29	65	0.0	32	71	0.0	35	78	0.0	35	78	0.0	52	116	0.0	52	116	0.0	40	90	43	97
632	4.6	33	74	2.8	29	66	0.0	32	73	0.0	35	79	0.0	35	79	0.0	52	119	0.0	52	119	0.0	40	92	43	99
612	4.7	32	74	2.9	29	68	0.0	32	74	0.0	35	81	0.0	35	81	0.0	52	121	0.0	52	121	0.0	40	94	43	101
592	4.8	31	74	2.9	29	69	0.0	32	76	0.0	35	83	0.0	35	83	0.0	52	124	0.0	52	124	0.0	40	96	43	103
573	4.9	31	75	2.9	29	70	0.0	32	77	0.0	35	84	0.0	35	84	0.0	52	126	0.0	52	126	0.0	40	98	43	105
555	5.0	30	75	3.0	32	79	2.0	32	79	0.0	35	86	0.0	35	86	0.0	52	129	0.0	52	129	0.0	40	100	43	108
537	5.1	31	77	3.0	32	81	2.0	32	81	0.0	35	88	0.0	35	88	0.0	52	132	0.0	52	132	0.0	40	102	43	110
519	5.2	31	79	3.1	32	83	2.1	32	82	0.0	35	90	0.0	35	90	0.0	52	134	0.0	52	134	0.0	40	104	43	112
502	5.3	31	80	3.1	32	84	2.1	32	84	0.0	35	91	0.0	35	91	0.0	52	137	0.0	52	137	0.0	40	106	43	114
485	5.4	31	82	3.2	32	86	2.2	32	85	0.0	35	93	0.0	35	93	0.0	52	139	0.0	52	139	0.0	40	108	43	116
468	5.5	31	84	3.2	32	88	2.2	32	87	0.0	35	95	0.0	35	95	0.0	52	142	0.0	52	142	0.0	40	110	43	118
452	5.6	31	86	3.3	33	90	2.3	32	88	0.0	35	96	0.0	35	96	0.0	52	144	0.0	52	144	0.0	40	112	43	120
437	5.7	31	88	3.4	33	92	2.4	32	90	0.0	35	98	0.0	35	98	0.0	52	147	0.0	52	147	0.0	40	114	43	123
423	5.8	31	89	3.4	33	93	2.4	32	92	0.0	35	100	0.0	35	100	0.0	52	150	0.0	52	150	0.0	40	116	43	125
409	5.9	31	91	3.5	33	95	2.5	32	93	0.0	35	102	0.0	35	102	0.0	52	152	0.0	52	152	0.0	40	118	43	127
396	6.0	31	93	3.5	33	97	2.5	32	95	0.0	35	103	0.0	35	103	0.0	52	155	0.0	52	155	0.0	40	120	43	129
383	6.1	32	95	3.6	33	99	2.6	32	96	0.0	35	105	0.0	35	105	0.0	52	157	0.0	52	157	0.0	40	122	43	131
371	6.2	32	97	3.7	33	101	2.7	32	98	0.0	35	107	0.0	35	107	0.0	52	160	0.0	52	160	0.0	40	124	43	133
359	6.3	32	98	3.7	33	103	2.7	32	99	0.0	35	108	0.0	35	108	0.0	52	162	0.0	52	162	0.0	40	126	43	135
347	6.4	32	100	3.8	33	105	2.8	32	101	0.0	35	110	0.0	35	110	0.0	52	165	0.0	52	165	0.0	40	128	43	138
336	6.5	32	102	3.8	33	103	2.9	32	103	0.0	35	112	0.0	35	112	0.0	52	168	0.0	52	168	0.0	40	130	43	140
326	6.6	32	104	3.9	33	108	2.9	32	104	0.0	35	114	0.0	35	114	0.0	52	170	0.0	52	170	0.0	40	132	43	142
315	6.7	32	106	4.0	34	111	3.0	35	115	2.0	35	115	0.0	35	115	0.0	56	187	2.0	40	134	43	144	43	144	
305	6.8	32	108	4.1	34	113	3.1	35	118	2.1	35	117	0.0	35	117	0.0	57	191	2.2	40	136	43	146	43	146	
295	6.9	32	110	4.2	34	115	3.2	35	120	2.2	35	119	0.0	35	119	0.0	57	196	2.4	40	138	43	148	43	148	
286	7.0	32	111	4.2	34	116	3.2	35	121	2.2	35	120	0.0	35	120	0.0	57	198	2.4	40	140	43	150	43	150	
276	7.1	33	114	4.3	34	119	3.3	35	124	2.3	35	122	0.0	35	122	0.0	58	203	2.6	40	142	43	153	43	153	
267	7.2	33	116	4.4	34	121	3.4	35	126	2.4	35	124	0.0	35	124	0.0	58	207	2.8	40	144	43	155	43	155	
258	7.3	33	118	4.5	34	123	3.5	36	128	2.5	35	126	0.0	35	126	0.0	59	212	3.0	40	146	43	157	43	157	
248	7.4	33	120	4.6	34	125	3.6	36	131	2.6	35	127	0.0	35	127	0.0	59	216	3.2	40	148	43	159	43	159	
239	7.5	33	122	4.7	34	127	3.7	36	133	2.7	35	129	0.0	35	129	0.0	59	221	3.4	40	150	43	161	43	161	
229	7.6	33	124	4.8	35	130	3.8	36	135	2.8</																

DESIGN FACTORS FOR A DESIGN SPEED OF 30 MPH (RURAL) USING E = 8% MAX.

DESIGN VELOCITY -30	WIDTH= 18 FT						WIDTH=20 FT						WIDTH=22 FT						WIDTH=24 FT						WIDTH=48 FT						INTERCHANGE RAMPS																													
	DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)												DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)												DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)												DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)												DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											
	1 @ 9'		1 @ 10'		1 @ 11'		1 @ 12'		1 @ 12'		2 @ 12'		16 FT		18 FT		16 FT		18 FT		16 FT		18 FT		16 FT		18 FT																																	
RADIUS(FT)	E(V)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr																																	
3500	NC	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																																	
2402	2.0	28	28	0.0	31	31	0.0	34	34	0.0	37	37	0.0	39	39	0.0	41	41	0.0	43	43	0.0	45	45	0.0	47	47																																	
2276	2.1	28	29	0.0	31	32	0.0	34	35	0.0	37	39	0.0	40	42	0.0	43	45	0.0	46	48	0.0	49	51	0.0	52	54																																	
2161	2.2	28	30	0.0	31	34	0.0	34	37	0.0	37	40	0.0	40	43	0.0	43	46	0.0	46	49	0.0	50	53	0.0	55	58																																	
2056	2.3	28	32	0.0	31	35	0.0	34	39	0.0	37	42	0.0	41	45	0.0	44	48	0.0	47	51	0.0	54	58	0.0	61	65																																	
1960	2.4	74	88	2.0	31	37	0.0	34	40	0.0	37	44	0.0	41	48	0.0	45	53	0.0	50	59	0.0	64	74	0.0	80	92																																	
1871	2.5	71	88	2.0	31	38	0.0	34	42	0.0	37	46	0.0	43	51	0.0	48	57	0.0	54	64	0.0	70	81	0.0	88	100																																	
1789	2.6	68	88	2.0	31	40	0.0	34	44	0.0	37	48	0.0	45	54	0.0	51	60	0.0	57	67	0.0	74	85	0.0	92	104																																	
1713	2.7	66	88	2.1	31	41	0.0	34	45	0.0	37	50	0.0	47	56	0.0	54	63	0.0	60	70	0.0	77	88	0.0	96	108																																	
1643	2.8	63	88	2.1	31	43	0.0	34	47	0.0	37	51	0.0	48	57	0.0	55	64	0.0	62	72	0.0	79	90	0.0	98	110																																	
1577	2.9	61	88	2.1	31	44	0.0	34	49	0.0	37	53	0.0	50	59	0.0	57	66	0.0	64	74	0.0	81	92	0.0	100	112																																	
1515	3.0	59	88	2.1	31	46	0.0	34	50	0.0	37	55	0.0	52	61	0.0	59	68	0.0	66	76	0.0	83	94	0.0	102	114																																	
1457	3.1	57	88	2.2	31	47	0.0	34	52	0.0	37	57	0.0	54	63	0.0	61	70	0.0	68	78	0.0	95	106	0.0	114	126																																	
1403	3.2	55	88	2.2	31	49	0.0	34	54	0.0	37	59	0.0	56	65	0.0	63	72	0.0	70	80	0.0	97	108	0.0	116	128																																	
1352	3.3	54	88	2.2	31	50	0.0	34	55	0.0	37	60	0.0	57	66	0.0	64	73	0.0	71	81	0.0	98	109	0.0	117	130																																	
1303	3.4	52	88	2.3	31	52	0.0	34	57	0.0	37	62	0.0	59	68	0.0	66	75	0.0	73	83	0.0	100	111	0.0	118	132																																	
1258	3.5	51	88	2.3	31	54	0.0	34	59	0.0	37	64	0.0	61	70	0.0	68	77	0.0	75	85	0.0	102	113	0.0	120	134																																	
1214	3.6	49	88	2.3	31	55	0.0	34	60	0.0	37	66	0.0	62	71	0.0	70	79	0.0	77	87	0.0	104	115	0.0	122	136																																	
1173	3.7	48	88	2.3	31	57	0.0	34	62	0.0	37	68	0.0	64	73	0.0	72	81	0.0	79	89	0.0	106	117	0.0	124	138																																	
1134	3.8	47	88	2.4	31	58	0.0	34	64	0.0	37	70	0.0	66	75	0.0	74	83	0.0	81	91	0.0	108	119	0.0	126	140																																	
1097	3.9	46	88	2.4	31	60	0.0	34	65	0.0	37	71	0.0	68	77	0.0	76	85	0.0	83	93	0.0	110	121	0.0	128	142																																	
1061	4.0	44	88	2.4	31	61	0.0	34	67	0.0	37	73	0.0	69	78	0.0	77	86	0.0	84	94	0.0	112	123	0.0	130	144																																	
1028	4.1	43	88	2.5	31	63	0.0	34	69	0.0	37	75	0.0	71	80	0.0	79	88	0.0	86	96	0.0	114	125	0.0	132	146																																	
995	4.2	42	88	2.5	31	64	0.0	34	70	0.0	37	77	0.0	72	81	0.0	80	89	0.0	87	97	0.0	116	127	0.0	134	148																																	
964	4.3	41	88	2.5	31	66	0.0	34	72	0.0	37	79	0.0	74	83	0.0	82	91	0.0	89	99	0.0	118	129	0.0	136	150																																	
934	4.4	40	88	2.6	31	67	0.0	34	74	0.0	37	80	0.0	75	84	0.0	83	92	0.0	90	100	0.0	120	131	0.0	138	152																																	
905	4.5	40	88	2.6	31	69	0.0	34	75	0.0	37	82	0.0	77	86	0.0	85	94	0.0	92	102	0.0	122	133	0.0	140	154																																	
877	4.6	39	88	2.6	31	70	0.0	34	77	0.0	37	84	0.0	78	87	0.0	86	95	0.0	93	103	0.0	124	135	0.0	142	156																																	
851	4.7	38	88	2.7	31	72	0.0	34	79	0.0	37	86	0.0	80	89	0.0	88	97	0.0	95	105	0.0	126	137	0.0	144	158																																	
825	4.8	37	88	2.7	31	73	0.0	34	80	0.0	37	88	0.0	81	90	0.0	89	98	0.0	96	106	0.0	128	139	0.0	146	160																																	
800	4.9	36	88	2.7	31	75	0.0	34	82	0.0	37	90	0.0	83	92	0.0	91	100	0.0	97	107	0.0	130	141	0.0	148	162																																	
775	5.0	36	88	2.8	31	76	0.0	34	84	0.0	37	91	0.0	84	93	0.0	92	101	0.0	98	108	0.0	132	143	0.0	150	164																																	
752	5.1	35	88	2.8	31	78	0.0	34	85	0.0	37	93	0.0	86	95	0.0	94	103	0.0	100	110	0.0	134	145	0.0	152	166																																	
729	5.2	34	88	2.8	31	79	0.0	34	87	0.0	37	95	0.0	87	96	0.0	95	104	0.0	102	112	0.0	136	147	0.0	154	168																																	
706	5.3	34	88	2.9	31	81	0.0	34	89	0.0	37	97	0.0	89	98	0.0	97	106	0.0	104	114	0.0	138	149	0.0	156	170																																	
684	5.4	33	88	2.9	31	82	0.0	34	90	0.0	37	99	0.0	90	99	0.0	98	107	0.0	106	116	0.0	140	151	0.0	158	172																																	
663	5.5	32	88	3.0	34	92	0.0	34	92	0.0	37	100	0.0	92	101	0.0	100	109	0.0	108	118	0.0	142	153	0.0	160	174																																	
641	5.6	33	90	3.0	34	94	2.0	34	94	0.0	37	102	0.0	94	103	0.0	102	111	0.0	110	120	0.0	144	155	0.0	162	176																																	
621	5.7	32	91	3.0	34	95	2.0	34	95	0.0	37	104	0.0	95	104	0.0	103	112	0.0	111	121	0.0	146	157	0.0	164	178																																	
602	5.8	33	93	3.1	34	98	2.1	34	99	0.0	37	106	0.0	97	105	0.0	105	114	0.0	112	122	0.0	148	159	0.0	166	180																																	
583	5.9	33	95	3.1	34	99	2.1	34	101	2.2	34	108	0.0	99	107	0.0	107	116	0.0	114	124	0.0	150	161	0.0	168	182																																	
565	6.0	33	97	3.2	34	101	2.2	34	102	2.2	34	110	0.0	100	109	0.0	108	117	0.0	115	125	0.0	152	163	0.0	170	184																																	
548	6.1	33	98	3.2	34	103	2.2	34	103	2.2	34	111	0.0	102	110	0.0	110	119	0.0	117	127	0.0	154	165	0.0	172	186																																	
531	6.2	33	101	3.3	34	105	2.3	34	104	2.3	34	113	0.0	104	112	0.0	111	120	0.0	118	128	0.0	156	167	0.0	174	188																																	
515	6.3	33	102	3.3	34	107	2.3	34	105	2.3	34	115	0.0	105	113	0.0	112	121	0.0	120	130	0.0	158	169	0.0	176	190																																	
499	6.4	33	104	3.4	35	109	2.4	34	107	2.4	34	117	0.0	107	115	0.0	114	123	0.0	122	132	0.0	160	171	0.0	178	192																																	
484	6.5	33	106	3.4	35	111	2.4	34	109	0.0	37	119	0.0	109	117	0.0	116	125	0.0	124	134	0.0	162	173	0.0	180	194																																	
469	6.6	33	108	3.5	35	113	2.5	34	110	0.0	37	120	0.0	110	118	0.0	117	126	0.0	125	135	0.0	164	175	0.0	182	196																																	
455	6.7	33	110	3.5	35	115	2.5	34	112	0.0	37	122	0.0	112	120	0.0	119	128	0.0	127	137	0.0	166	177	0.0	184	198																																	
441	6.8	33	112	3.6	35	117	2.6	34	114	0.0	37	124	0.0	114	122	0.0	121	130	0.0	129	139	0.0	168	179	0.0	186	200																																	
427	6.9	33	113	3.6	35	119	2.6	34	115	0.0	37	126	0.0	115	123	0.0	122	131	0.0	130	140	0.0	170	181	0.0	188	202																																	
414	7.0	34	116	3.7	35	121	2.7	34	117	0.0	37	128	0.0	116	124	0.0	123	132	0.0	131	141	0.0	172	183	0.0	190	204																																	
400	7.1	34	118	3.8	35	123	2.8	34	119	0.0	37	130	0.0	117	125	0.0	124	133	0.0	132	142	0.0	174	185	0.0	192	206																																	
387	7.2	34	119	3.8	35	125	2.8	34	120	0.0	37</																																																	

SPECIFICATION REFERENCE		DESIGN FACTORS FOR A DESIGN SPEED OF 35 MPH (RURAL) USING E = 8% MAX.																									
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)												WIDTH=72 FT						INTERCHANGE RAMPS							
		WIDTH=18 FT				WIDTH=20 FT				WIDTH=22 FT				WIDTH=24 FT				WIDTH=48 FT		WIDTH=72 FT		16 FT		18 FT			
DESIGN VELOCITY =35	RADIUS(FT)	1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'		3 @ 12'		Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr	Lt	Lr
		E(%)	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
5000	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3149	2.0	30	30	0	33	33	0	36	36	0	39	39	0	42	42	0	45	45	0	48	48	0	51	51	0	54	54
2866	2.1	30	31	0	33	34	0	36	38	0	39	41	0	42	44	0	45	47	0	48	50	0	51	53	0	54	56
2865	2.2	30	32	0	33	36	0	36	40	0	39	43	0	42	46	0	45	49	0	48	52	0	51	55	0	54	58
2835	2.2	30	32	0	33	36	0	36	40	0	39	43	0	42	46	0	45	49	0	48	52	0	51	55	0	54	58
2698	2.3	30	34	0	33	38	0	36	41	0	39	45	0	42	47	0	45	50	0	48	53	0	51	56	0	54	59
2573	2.4	30	35	0	33	39	0	36	43	0	39	47	0	42	49	0	45	52	0	48	55	0	51	58	0	54	60
2457	2.5	83	103	2.0	33	41	0	36	45	0	39	49	0	42	51	0	45	54	0	48	57	0	51	60	0	54	63
2350	2.6	80	103	2.0	33	42	0	36	47	0	39	51	0	42	52	0	45	55	0	48	59	0	51	61	0	54	65
2251	2.7	77	103	2.0	33	44	0	36	48	0	39	53	0	42	54	0	45	57	0	48	61	0	51	63	0	54	68
2159	2.8	74	103	2.0	33	46	0	36	50	0	39	55	0	42	56	0	45	60	0	48	64	0	51	66	0	54	70
2073	2.9	72	103	2.1	33	47	0	36	52	0	39	57	0	42	58	0	45	62	0	48	66	0	51	68	0	54	72
1993	3.0	69	103	2.1	33	49	0	36	54	0	39	59	0	42	60	0	45	64	0	48	68	0	51	70	0	54	75
1917	3.1	67	103	2.1	33	50	0	36	55	0	39	60	0	42	61	0	45	65	0	48	70	0	51	71	0	54	77
1847	3.2	65	103	2.1	33	52	0	36	57	0	39	62	0	42	63	0	45	67	0	48	72	0	51	73	0	54	80
1780	3.3	63	103	2.2	33	54	0	36	59	0	39	64	0	42	65	0	45	69	0	48	74	0	51	75	0	54	82
1717	3.4	61	103	2.2	33	55	0	36	61	0	39	66	0	42	66	0	45	70	0	48	75	0	51	76	0	54	84
1658	3.5	59	103	2.2	33	57	0	36	63	0	39	68	0	42	68	0	45	72	0	48	77	0	51	78	0	54	87
1602	3.6	58	103	2.2	33	59	0	36	64	0	39	70	0	42	70	0	45	74	0	48	79	0	51	80	0	54	89
1548	3.7	56	103	2.3	33	60	0	36	66	0	39	72	0	42	72	0	45	76	0	48	80	0	51	82	0	54	92
1497	3.8	55	103	2.3	33	62	0	36	68	0	39	74	0	42	74	0	45	78	0	48	82	0	51	84	0	54	94
1449	3.9	53	103	2.3	33	63	0	36	70	0	39	76	0	42	75	0	45	80	0	48	84	0	51	86	0	54	96
1403	4.0	52	103	2.3	33	65	0	36	71	0	39	78	0	42	77	0	45	81	0	48	85	0	51	88	0	54	99
1359	4.1	51	103	2.4	33	67	0	36	73	0	39	80	0	42	79	0	45	83	0	48	87	0	51	90	0	54	101
1317	4.2	50	103	2.4	33	68	0	36	75	0	39	82	0	42	80	0	45	85	0	48	89	0	51	92	0	54	104
1277	4.3	48	103	2.4	33	70	0	36	77	0	39	84	0	42	82	0	45	87	0	48	91	0	51	94	0	54	106
1238	4.4	47	103	2.4	33	71	0	36	79	0	39	86	0	42	83	0	45	89	0	48	92	0	51	95	0	54	108
1201	4.5	46	103	2.5	33	73	0	36	80	0	39	88	0	42	85	0	45	91	0	48	94	0	51	96	0	54	111
1165	4.6	45	103	2.5	33	75	0	36	82	0	39	90	0	42	87	0	45	93	0	48	96	0	51	98	0	54	113
1131	4.7	44	103	2.5	33	76	0	36	84	0	39	91	0	42	88	0	45	94	0	48	97	0	51	99	0	54	116
1097	4.8	43	103	2.6	33	78	0	36	86	0	39	93	0	42	90	0	45	96	0	48	98	0	51	100	0	54	118
1065	4.9	43	103	2.6	33	80	0	36	87	0	39	95	0	42	92	0	45	98	0	48	100	0	51	102	0	54	120
1034	5.0	42	103	2.6	33	81	0	36	89	0	39	97	0	42	94	0	45	100	0	48	102	0	51	104	0	54	123
1004	5.1	41	103	2.6	33	83	0	36	91	0	39	99	0	42	96	0	45	102	0	48	104	0	51	106	0	54	125
975	5.2	40	103	2.7	33	84	0	36	93	0	39	101	0	42	98	0	45	104	0	48	106	0	51	108	0	54	128
946	5.3	39	103	2.7	33	86	0	36	95	0	39	103	0	42	100	0	45	106	0	48	108	0	51	110	0	54	130
918	5.4	39	103	2.7	33	88	0	36	96	0	39	105	0	42	102	0	45	108	0	48	110	0	51	112	0	54	132
891	5.5	38	103	2.8	33	89	0	36	98	0	39	107	0	42	104	0	45	110	0	48	112	0	51	114	0	54	135
864	5.6	37	103	2.8	33	91	0	36	100	0	39	109	0	42	106	0	45	112	0	48	114	0	51	116	0	54	137
838	5.7	37	103	2.8	33	92	0	36	102	0	39	111	0	42	108	0	45	114	0	48	116	0	51	118	0	54	140
813	5.8	36	103	2.9	33	94	0	36	103	0	39	113	0	42	110	0	45	116	0	48	118	0	51	120	0	54	142
789	5.9	35	103	2.9	33	96	0	36	105	0	39	115	0	42	112	0	45	118	0	48	120	0	51	122	0	54	144
766	6.0	35	103	3.0	36	107	2.0	36	107	0	39	117	0	42	114	0	45	120	0	48	122	0	51	124	0	54	147
743	6.1	35	104	3.0	36	109	2.0	36	109	0	39	119	0	42	116	0	45	122	0	48	124	0	51	126	0	54	149
722	6.2	34	105	3.0	36	110	2.0	36	110	0	39	120	0	42	117	0	45	123	0	48	126	0	51	127	0	54	152
701	6.3	35	108	3.1	36	113	2.1	36	112	0	39	122	0	42	119	0	45	125	0	48	128	0	51	129	0	54	154
680	6.4	35	109	3.1	36	115	2.1	36	114	0	39	124	0	42	121	0	45	127	0	48	130	0	51	131	0	54	156
660	6.5	35	112	3.2	36	117	2.2	36	116	0	39	126	0	42	123	0	45	129	0	48	132	0	51	133	0	54	159
641	6.6	35	113	3.2	36	119	2.2	36	118	0	39	128	0	42	125	0	45	131	0	48	134	0	51	135	0	54	161
622	6.7	35	115	3.2	36	120	2.2	36	119	0	39	130	0	42	127	0	45	133	0	48	136	0	51	137	0	54	164
603	6.8	35	117	3.3	37	123	2.3	36	121	0	39	132	0	42	129	0	45	135	0	48	138	0	51	139	0	54	166
585	6.9	35	119	3.3	37	125	2.3	36	123	0	39	134	0	42	131	0	45	137	0	48	140	0	51	141	0	54	168
567	7.0	35	121	3.4	37	127	2.4	36	125	0	39	136	0	42	133	0	45	139	0	48	142	0	51	143	0	54	171
550	7.1	35	123	3.4	37	129	2.4	36	126	0	39	138	0	42	135	0	45	141	0	48	144	0	51	145	0	54	173
532	7.2	35	125	3.5	37	131	2.5	36	128	0	39	140	0	42	137	0	45	143	0	48	146	0	51	147	0	54	176
515	7.3	35	127	3.5	37	133	2.5	36	130	0	39	142	0	42	139	0	45	145	0	48	148	0	51	149	0	54	178
497	7.4	35	129	3.6	37	135	2.6	36	132	0	39	144	0	42	141	0	45	147	0	48	150	0	51	151	0	54	180
480	7.5	35	132	3.7	37	138	2.7	36	134	0	39	146	0	42	143	0	45	149	0	48	152	0	51	153	0	54	183
461																											

DESIGN FACTORS FOR A DESIGN SPEED OF 40 MPH (RURAL) USING E = 8% MAX.

DESIGN VELOCITY -40	DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)										INTERCHANGE RAMPS																	
	WIDTH-18 FT			WIDTH-20 FT			WIDTH-22 FT			WIDTH-24 FT			WIDTH-48 FT			WIDTH-72 FT												
	1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'			16 FT			18 FT						
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
6000	NC	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4000	2.0	32	32	0.0	35	35	0.0	38	38	0.0	42	42	0.0	46	46	0.0	50	50	0.0	54	54	0.0	63	63	0.0	83	83	0.0
3792	2.1	32	33	0.0	35	37	0.0	38	40	0.0	42	44	0.0	46	48	0.0	50	52	0.0	54	56	0.0	63	66	0.0	83	87	0.0
3603	2.2	32	35	0.0	35	38	0.0	38	42	0.0	42	46	0.0	46	50	0.0	50	54	0.0	58	62	0.0	63	69	0.0	83	92	0.0
3430	2.3	32	36	0.0	35	40	0.0	38	44	0.0	42	48	0.0	46	52	0.0	50	56	0.0	60	66	0.0	63	72	0.0	83	96	0.0
3271	2.4	32	38	0.0	35	42	0.0	38	46	0.0	42	50	0.0	46	54	0.0	50	60	0.0	63	75	0.0	63	78	0.0	83	100	0.0
3125	2.5	32	39	0.0	35	44	0.0	38	48	0.0	42	52	0.0	46	56	0.0	50	63	0.0	63	78	0.0	63	81	0.0	83	104	0.0
2990	2.6	32	41	0.0	35	45	0.0	38	50	0.0	42	54	0.0	46	58	0.0	50	63	0.0	63	81	0.0	63	84	0.0	83	108	0.0
2866	2.7	32	42	0.0	35	47	0.0	38	52	0.0	42	56	0.0	46	60	0.0	50	63	0.0	63	84	0.0	63	88	0.0	83	112	0.0
2865	2.7	87	117	2.0	35	47	0.0	38	52	0.0	42	56	0.0	46	60	0.0	50	63	0.0	63	84	0.0	63	84	0.0	83	112	0.0
2748	2.8	84	117	2.0	35	49	0.0	38	54	0.0	42	58	0.0	46	62	0.0	50	63	0.0	63	87	0.0	63	87	0.0	83	116	0.0
2640	2.9	81	117	2.0	35	50	0.0	38	55	0.0	42	60	0.0	46	63	0.0	50	63	0.0	63	90	0.0	63	90	0.0	83	120	0.0
2538	3.0	78	117	2.0	35	52	0.0	38	57	0.0	42	63	0.0	46	66	0.0	50	63	0.0	63	94	0.0	63	94	0.0	83	125	0.0
2443	3.1	76	117	2.1	35	54	0.0	38	59	0.0	42	65	0.0	46	69	0.0	50	63	0.0	63	97	0.0	63	97	0.0	83	129	0.0
2354	3.2	74	117	2.1	35	56	0.0	38	61	0.0	42	67	0.0	46	71	0.0	50	63	0.0	63	100	0.0	63	100	0.0	83	133	0.0
2269	3.3	71	117	2.1	35	57	0.0	38	63	0.0	42	69	0.0	46	73	0.0	50	63	0.0	63	103	0.0	63	103	0.0	83	137	0.0
2190	3.4	69	117	2.1	35	59	0.0	38	65	0.0	42	71	0.0	46	75	0.0	50	63	0.0	63	106	0.0	63	106	0.0	83	141	0.0
2115	3.5	67	117	2.2	35	61	0.0	38	67	0.0	42	73	0.0	46	77	0.0	50	63	0.0	63	109	0.0	63	109	0.0	83	145	0.0
2044	3.6	65	117	2.2	35	63	0.0	38	69	0.0	42	75	0.0	46	79	0.0	50	63	0.0	63	112	0.0	63	112	0.0	83	149	0.0
1977	3.7	64	117	2.2	35	64	0.0	38	71	0.0	42	77	0.0	46	81	0.0	50	63	0.0	63	115	0.0	63	115	0.0	83	154	0.0
1913	3.8	62	117	2.2	35	66	0.0	38	73	0.0	42	79	0.0	46	83	0.0	50	63	0.0	63	118	0.0	63	118	0.0	83	158	0.0
1852	3.9	60	117	2.2	35	68	0.0	38	74	0.0	42	81	0.0	46	85	0.0	50	63	0.0	63	122	0.0	63	122	0.0	83	162	0.0
1794	4.0	59	117	2.3	35	69	0.0	38	76	0.0	42	83	0.0	46	87	0.0	50	63	0.0	63	125	0.0	63	125	0.0	83	166	0.0
1739	4.1	58	117	2.3	35	71	0.0	38	78	0.0	42	85	0.0	46	89	0.0	50	63	0.0	63	128	0.0	63	128	0.0	83	170	0.0
1686	4.2	56	117	2.3	35	73	0.0	38	80	0.0	42	87	0.0	46	91	0.0	50	63	0.0	63	131	0.0	63	131	0.0	83	174	0.0
1635	4.3	55	117	2.3	35	75	0.0	38	82	0.0	42	89	0.0	46	93	0.0	50	63	0.0	63	134	0.0	63	134	0.0	83	178	0.0
1587	4.4	54	117	2.4	35	76	0.0	38	84	0.0	42	92	0.0	46	95	0.0	50	63	0.0	63	137	0.0	63	137	0.0	83	183	0.0
1540	4.5	52	117	2.4	35	78	0.0	38	86	0.0	42	94	0.0	46	97	0.0	50	63	0.0	63	140	0.0	63	140	0.0	83	187	0.0
1495	4.6	51	117	2.4	35	80	0.0	38	88	0.0	42	96	0.0	46	99	0.0	50	63	0.0	63	143	0.0	63	143	0.0	83	191	0.0
1452	4.7	50	117	2.4	35	82	0.0	38	90	0.0	42	98	0.0	46	101	0.0	50	63	0.0	63	146	0.0	63	146	0.0	83	195	0.0
1411	4.8	49	117	2.5	35	83	0.0	38	92	0.0	42	100	0.0	46	103	0.0	50	63	0.0	63	149	0.0	63	149	0.0	83	199	0.0
1370	4.9	48	117	2.5	35	85	0.0	38	93	0.0	42	102	0.0	46	105	0.0	50	63	0.0	63	153	0.0	63	153	0.0	83	203	0.0
1332	5.0	47	117	2.5	35	87	0.0	38	95	0.0	42	104	0.0	46	107	0.0	50	63	0.0	63	156	0.0	63	156	0.0	83	207	0.0
1294	5.1	46	117	2.5	35	88	0.0	38	97	0.0	42	106	0.0	46	109	0.0	50	63	0.0	63	159	0.0	63	159	0.0	83	212	0.0
1258	5.2	45	117	2.6	35	90	0.0	38	99	0.0	42	108	0.0	46	111	0.0	50	63	0.0	63	162	0.0	63	162	0.0	83	216	0.0
1222	5.3	45	117	2.6	35	92	0.0	38	101	0.0	42	110	0.0	46	113	0.0	50	63	0.0	63	165	0.0	63	165	0.0	83	220	0.0
1188	5.4	44	117	2.6	35	94	0.0	38	103	0.0	42	112	0.0	46	115	0.0	50	63	0.0	63	168	0.0	63	168	0.0	83	224	0.0
1154	5.5	43	117	2.7	35	95	0.0	38	105	0.0	42	114	0.0	46	117	0.0	50	63	0.0	63	171	0.0	63	171	0.0	83	228	0.0
1122	5.6	42	117	2.7	35	97	0.0	38	107	0.0	42	116	0.0	46	119	0.0	50	63	0.0	63	174	0.0	63	174	0.0	83	232	0.0
1090	5.7	42	117	2.7	35	99	0.0	38	109	0.0	42	118	0.0	46	121	0.0	50	63	0.0	63	177	0.0	63	177	0.0	83	236	0.0
1058	5.8	41	117	2.7	35	100	0.0	38	110	0.0	42	120	0.0	46	123	0.0	50	63	0.0	63	180	0.0	63	180	0.0	83	240	0.0
1028	5.9	40	117	2.8	35	102	0.0	38	112	0.0	42	123	0.0	46	125	0.0	50	63	0.0	63	184	0.0	63	184	0.0	83	245	0.0
999	6.0	39	117	2.8	35	104	0.0	38	114	0.0	42	125	0.0	46	127	0.0	50	63	0.0	63	187	0.0	63	187	0.0	83	249	0.0
971	6.1	39	117	2.8	35	106	0.0	38	116	0.0	42	127	0.0	46	129	0.0	50	63	0.0	63	190	0.0	63	190	0.0	83	253	0.0
944	6.2	38	117	2.9	35	107	0.0	38	118	0.0	42	129	0.0	46	131	0.0	50	63	0.0	63	193	0.0	63	193	0.0	83	257	0.0
917	6.3	38	117	2.9	35	109	0.0	38	120	0.0	42	131	0.0	46	133	0.0	50	63	0.0	63	196	0.0	63	196	0.0	83	261	0.0
891	6.4	37	117	2.9	35	111	0.0	38	122	0.0	42	133	0.0	46	135	0.0	50	63	0.0	63	199	0.0	63	199	0.0	83	265	0.0
866	6.5	37	118	3.0	39	124	2.0	38	124	0.0	42	135	0.0	46	137	0.0	50	63	0.0	63	202	0.0	63	202	0.0	83	269	0.0
842	6.6	37	120	3.0	39	126	2.0	38	126	0.0	42	137	0.0	46	139	0.0	50	63	0.0	63	205	0.0	63	205	0.0	83	274	0.0
818	6.7	37	122	3.0	39	128	2.0	38	128	0.0	42	139	0.0	46	141	0.0	50	63	0.0	63	208	0.0	63	208	0.0	83	278	0.0
794	6.8	37	124	3.1	39	130	2.1	38	129	0.0	42	141	0.0	46	143	0.0	50	63	0.0	63	212	0.0	63	212	0.0	83	282	0.0
771	6.9	37	126	3.1	39	132	2.1	38	131	0.0	42	143	0.0	46	145	0.0	50	63	0.0	63	215	0.0	63	215	0.0	83	286	0.0
748	7.0	37	128	3.2	39	134																						

DESIGN FACTORS FOR A DESIGN SPEED OF 45 MPH (RURAL) USING E = 8% MAX.

DESIGN VELOCITY =45	DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)												INTERCHANGE RAMPS										
	WIDTH= 18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT			WIDTH=72 FT			WIDTH				
	1 @ 9'		1 @ 10'		1 @ 11'		1 @ 12'		2 @ 12'		3 @ 12'		16 FT		18 FT								
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	
8000	NC	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0	0	0	0	0
4957	2.0	34	34	0.0	38	38	0.0	41	41	0.0	45	45	0.0	47	47	0.0	49	49	0.0	53	53	56	56
4702	2.1	34	35	0.0	38	39	0.0	41	43	0.0	45	47	0.0	47	70	0.0	49	84	0.0	53	56	56	59
4467	2.2	34	37	0.0	38	41	0.0	41	45	0.0	45	49	0.0	47	74	0.0	49	98	0.0	53	58	56	61
4254	2.3	34	39	0.0	38	43	0.0	41	47	0.0	45	52	0.0	47	77	0.0	49	103	0.0	53	61	56	64
4057	2.4	34	40	0.0	38	45	0.0	41	49	0.0	45	54	0.0	47	80	0.0	49	107	0.0	53	63	56	67
3876	2.5	34	42	0.0	38	47	0.0	41	51	0.0	45	56	0.0	47	84	0.0	49	112	0.0	53	66	56	70
3710	2.6	34	44	0.0	38	49	0.0	41	53	0.0	45	58	0.0	47	87	0.0	49	116	0.0	53	69	56	72
3554	2.7	34	45	0.0	38	50	0.0	41	55	0.0	45	60	0.0	47	90	0.0	49	120	0.0	53	71	56	75
3412	2.8	34	47	0.0	38	52	0.0	41	58	0.0	45	63	0.0	47	94	0.0	49	125	0.0	53	74	56	78
3278	2.9	34	49	0.0	38	54	0.0	41	60	0.0	45	65	0.0	47	97	0.0	49	129	0.0	53	77	56	81
3152	3.0	34	50	0.0	38	56	0.0	41	62	0.0	45	67	0.0	47	100	0.0	49	134	0.0	53	79	56	84
3035	3.1	34	52	0.0	38	58	0.0	41	64	0.0	45	69	0.0	47	104	0.0	49	138	0.0	53	82	56	86
2925	3.2	34	54	0.0	38	60	0.0	41	66	0.0	45	72	0.0	47	107	0.0	49	143	0.0	53	84	56	89
2866	3.3	34	55	0.0	38	62	0.0	41	68	0.0	45	74	0.0	47	110	0.0	49	147	0.0	53	87	56	92
2865	3.3	80	132	2.1	38	62	0.0	41	68	0.0	45	74	0.0	47	110	0.0	49	147	0.0	53	87	56	92
2822	3.3	80	132	2.1	38	62	0.0	41	68	0.0	45	74	0.0	47	110	0.0	49	147	0.0	53	87	56	92
2724	3.4	78	132	2.1	38	63	0.0	41	70	0.0	45	76	0.0	47	114	0.0	49	152	0.0	53	90	56	95
2631	3.5	76	132	2.1	38	65	0.0	41	72	0.0	45	78	0.0	47	117	0.0	49	156	0.0	53	92	56	97
2544	3.6	74	132	2.1	38	67	0.0	41	74	0.0	45	80	0.0	47	120	0.0	49	160	0.0	53	95	56	100
2461	3.7	72	132	2.2	38	69	0.0	41	76	0.0	45	83	0.0	47	124	0.0	49	165	0.0	53	98	56	103
2383	3.8	70	132	2.2	38	71	0.0	41	78	0.0	45	85	0.0	47	127	0.0	49	169	0.0	53	100	56	106
2308	3.9	68	132	2.2	38	73	0.0	41	80	0.0	45	87	0.0	47	130	0.0	49	174	0.0	53	103	56	108
2237	4.0	66	132	2.2	38	75	0.0	41	82	0.0	45	89	0.0	47	134	0.0	49	178	0.0	53	105	56	111
2169	4.1	65	132	2.2	38	76	0.0	41	84	0.0	45	92	0.0	47	137	0.0	49	183	0.0	53	108	56	114
2104	4.2	63	132	2.3	38	78	0.0	41	86	0.0	45	94	0.0	47	140	0.0	49	187	0.0	53	111	56	117
2041	4.3	62	132	2.3	38	80	0.0	41	88	0.0	45	96	0.0	47	144	0.0	49	192	0.0	53	113	56	120
1982	4.4	60	132	2.3	38	82	0.0	41	90	0.0	45	98	0.0	47	147	0.0	49	196	0.0	53	116	56	122
1924	4.5	59	132	2.3	38	84	0.0	41	92	0.0	45	100	0.0	47	150	0.0	49	200	0.0	53	119	56	125
1870	4.6	58	132	2.4	38	86	0.0	41	94	0.0	45	103	0.0	47	154	0.0	49	205	0.0	53	121	56	128
1817	4.7	57	132	2.4	38	88	0.0	41	96	0.0	45	105	0.0	47	157	0.0	49	209	0.0	53	124	56	131
1766	4.8	55	132	2.4	38	89	0.0	41	98	0.0	45	107	0.0	47	160	0.0	49	214	0.0	53	126	56	133
1717	4.9	54	132	2.4	38	91	0.0	41	100	0.0	45	109	0.0	47	164	0.0	49	218	0.0	53	129	56	136
1669	5.0	53	132	2.4	38	93	0.0	41	102	0.0	45	112	0.0	47	167	0.0	49	223	0.0	53	132	56	139
1624	5.1	52	132	2.5	38	95	0.0	41	104	0.0	45	114	0.0	47	170	0.0	49	227	0.0	53	134	56	142
1579	5.2	51	132	2.5	38	97	0.0	41	106	0.0	45	116	0.0	47	174	0.0	49	232	0.0	53	137	56	144
1536	5.3	50	132	2.5	38	99	0.0	41	108	0.0	45	118	0.0	47	177	0.0	49	236	0.0	53	140	56	147
1495	5.4	49	132	2.5	38	100	0.0	41	110	0.0	45	120	0.0	47	180	0.0	49	240	0.0	53	142	56	150
1454	5.5	48	132	2.6	38	102	0.0	41	113	0.0	45	123	0.0	47	184	0.0	49	245	0.0	53	145	56	153
1415	5.6	48	132	2.6	38	104	0.0	41	115	0.0	45	125	0.0	47	187	0.0	49	249	0.0	53	147	56	156
1376	5.7	47	132	2.6	38	106	0.0	41	117	0.0	45	127	0.0	47	190	0.0	49	254	0.0	53	150	56	158
1339	5.8	46	132	2.6	38	108	0.0	41	119	0.0	45	129	0.0	47	194	0.0	49	258	0.0	53	153	56	161
1302	5.9	45	132	2.7	38	110	0.0	41	121	0.0	45	132	0.0	47	197	0.0	49	263	0.0	53	155	56	164
1266	6.0	44	132	2.7	38	112	0.0	41	123	0.0	45	134	0.0	47	200	0.0	49	267	0.0	53	158	56	167
1232	6.1	44	132	2.7	38	113	0.0	41	125	0.0	45	136	0.0	47	204	0.0	49	272	0.0	53	160	56	169
1199	6.2	43	132	2.8	38	115	0.0	41	127	0.0	45	138	0.0	47	207	0.0	49	276	0.0	53	163	56	172
1166	6.3	42	132	2.8	38	117	0.0	41	129	0.0	45	140	0.0	47	210	0.0	49	280	0.0	53	166	56	175
1135	6.4	42	132	2.8	38	119	0.0	41	131	0.0	45	143	0.0	47	214	0.0	49	285	0.0	53	168	56	178
1104	6.5	41	132	2.8	38	121	0.0	41	133	0.0	45	145	0.0	47	217	0.0	49	289	0.0	53	171	56	180
1073	6.6	40	132	2.9	38	123	0.0	41	135	0.0	45	147	0.0	47	220	0.0	49	294	0.0	53	174	56	183
1044	6.7	40	132	2.9	38	125	0.0	41	137	0.0	45	149	0.0	47	224	0.0	49	298	0.0	53	176	56	186
1015	6.8	39	132	2.9	38	126	0.0	41	139	0.0	45	152	0.0	47	227	0.0	49	303	0.0	53	179	56	189
986	6.9	40	135	3.0	41	141	2.0	41	141	0.0	45	154	0.0	47	230	0.0	49	307	0.0	53	181	56	192
957	7.0	40	137	3.0	41	143	2.0	41	143	0.0	45	156	0.0	47	234	0.0	49	312	0.0	53	184	56	194
929	7.1	40	139	3.1	42	146	2.1	41	145	0.0	45	158	0.0	47	237	0.0	49	316	0.0	53	187	56	197
902	7.2	40	141	3.1	42	148	2.1	41	147	0.0	45	160	0.0	47	240	0.0	49	320	0.0	53	189	56	200
874	7.3	40	143	3.1	42	150	2.1	41	149	0.0	45	163	0.0	47	244	0.0	49	325	0.0	53	192	56	203
845	7.4	40	146	3.2	42	153	2.2	41	151	0.0	45	165	0.0	47	247	0.0	49	329	0.0	53	195	56	205
817	7.5	40	148	3.2	42	155	2.2	41	153	0.0	45	167	0.0	47	250	0.0	49	334	0.0	53	197	56	208
787	7.6	40	150	3.3	42	157	2.3	41	155	0.0	45	169	0.0	47	254	0.0	49	338	0.0	53	200	56	211
756	7.7	40	152	3.3	42	159	2.3	41	157	0.0	45	172	0.0	47	257	0.0	49	343	0.0	53	202	56	214
723	7.8	40	155	3.4	42	162	2.4	41	159	0.0	45	174	0.0	47	260	0.0	49	347	0.0	53	205	56	216
683	7.9	40	158	3.5	42	165	2.5	41	161	0.0	45	176	0.0	47	264	0.0	49	352	0.0	53	208	56	219
602	8.0	41	161	3.7	43	169	2																

DESIGN VELOCITY -50		DESIGN FACTORS FOR A DESIGN SPEED OF 50 MPH (RURAL) USING E= 8% MAX.																	
		DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)						INTERCHANGE RAMPS						WIDTH					
		1 @ 9'		1 @ 10'		1 @ 11'		1 @ 12'		2 @ 12'		3 @ 12'		16 FT		18 FT			
		Lt	w	Lt	w	Lt	w	Lt	w	Lt	w	Lt	w	Lt	w	Lt	w		
RADIUS(FT)	E(%)	Lt	w	Lt	w	Lt	w	Lt	w	Lt	w	Lt	w	Lt	w	Lt	w		
8000	NC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
6013	2.0	36	36	40	40	44	44	48	48	48	48	48	48	96	96	0	0		
5703	2.1	36	38	40	42	44	47	48	51	0.0	72	76	0.0	96	101	0.0	57		
5420	2.2	36	40	40	44	44	49	48	53	0.0	72	80	0.0	96	106	0.0	57		
5162	2.3	36	42	40	46	44	51	48	56	0.0	72	83	0.0	96	111	0.0	57		
4926	2.4	36	44	40	48	44	53	48	58	0.0	72	87	0.0	96	116	0.0	57		
4708	2.5	36	45	40	50	44	55	48	60	0.0	72	90	0.0	96	120	0.0	57		
4507	2.6	36	47	40	52	44	58	48	63	0.0	72	94	0.0	96	125	0.0	57		
4320	2.7	36	49	40	54	44	60	48	65	0.0	72	98	0.0	96	130	0.0	57		
4146	2.8	36	51	40	56	44	62	48	68	0.0	72	101	0.0	96	135	0.0	57		
3985	2.9	36	53	40	58	44	64	48	70	0.0	72	105	0.0	96	140	0.0	57		
3834	3.0	36	54	40	60	44	66	48	72	0.0	72	108	0.0	96	144	0.0	57		
3692	3.1	36	56	40	62	44	69	48	75	0.0	72	112	0.0	96	149	0.0	57		
3560	3.2	36	58	40	64	44	71	48	77	0.0	72	116	0.0	96	154	0.0	57		
3434	3.3	36	60	40	66	44	73	48	80	0.0	72	119	0.0	96	159	0.0	57		
3316	3.4	36	62	40	68	44	75	48	82	0.0	72	123	0.0	96	164	0.0	57		
3205	3.5	36	63	40	70	44	77	48	84	0.0	72	126	0.0	96	168	0.0	57		
3099	3.6	36	65	40	72	44	80	48	87	0.0	72	130	0.0	96	173	0.0	57		
2999	3.7	36	67	40	74	44	82	48	89	0.0	72	134	0.0	96	178	0.0	57		
2904	3.8	36	69	40	76	44	84	48	92	0.0	72	137	0.0	96	183	0.0	57		
2866	3.9	36	71	40	78	44	86	48	94	0.0	72	141	0.0	96	188	0.0	57		
2865	3.9	76	147	2.2	40	78	0.0	44	86	0.0	44	86	0.0	44	86	0.0	57		
2814	3.9	76	147	2.2	40	78	0.0	44	86	0.0	44	86	0.0	44	86	0.0	57		
2728	4.0	74	147	2.2	40	80	0.0	44	88	0.0	44	88	0.0	44	88	0.0	57		
2646	4.1	72	147	2.2	40	82	0.0	44	91	0.0	44	91	0.0	44	91	0.0	57		
2568	4.2	70	147	2.2	40	84	0.0	44	93	0.0	44	93	0.0	44	93	0.0	57		
2493	4.3	69	147	2.2	40	86	0.0	44	95	0.0	44	95	0.0	44	95	0.0	57		
2422	4.4	67	147	2.3	40	88	0.0	44	97	0.0	44	97	0.0	44	97	0.0	57		
2353	4.5	66	147	2.3	40	90	0.0	44	99	0.0	44	99	0.0	44	99	0.0	57		
2287	4.6	64	147	2.3	40	92	0.0	44	102	0.0	44	102	0.0	44	102	0.0	57		
2224	4.7	63	147	2.3	40	94	0.0	44	104	0.0	44	104	0.0	44	104	0.0	57		
2163	4.8	62	147	2.4	40	96	0.0	44	106	0.0	44	106	0.0	44	106	0.0	57		
2104	4.9	60	147	2.4	40	98	0.0	44	108	0.0	44	108	0.0	44	108	0.0	57		
2047	5.0	59	147	2.4	40	100	0.0	44	110	0.0	44	110	0.0	44	110	0.0	57		
1992	5.1	58	147	2.4	40	102	0.0	44	113	0.0	44	113	0.0	44	113	0.0	57		
1939	5.2	57	147	2.4	40	104	0.0	44	115	0.0	44	115	0.0	44	115	0.0	57		
1888	5.3	56	147	2.5	40	106	0.0	44	117	0.0	44	117	0.0	44	117	0.0	57		
1838	5.4	55	147	2.5	40	108	0.0	44	119	0.0	44	119	0.0	44	119	0.0	57		
1790	5.5	54	147	2.5	40	110	0.0	44	121	0.0	44	121	0.0	44	121	0.0	57		
1743	5.6	53	147	2.5	40	112	0.0	44	124	0.0	44	124	0.0	44	124	0.0	57		
1698	5.7	52	147	2.6	40	114	0.0	44	126	0.0	44	126	0.0	44	126	0.0	57		
1653	5.8	51	147	2.6	40	116	0.0	44	128	0.0	44	128	0.0	44	128	0.0	57		
1610	5.9	50	147	2.6	40	118	0.0	44	130	0.0	44	130	0.0	44	130	0.0	57		
1568	6.0	49	147	2.6	40	120	0.0	44	132	0.0	44	132	0.0	44	132	0.0	57		
1527	6.1	49	147	2.6	40	122	0.0	44	135	0.0	44	135	0.0	44	135	0.0	57		
1487	6.2	48	147	2.7	40	124	0.0	44	137	0.0	44	137	0.0	44	137	0.0	57		
1448	6.3	47	147	2.7	40	126	0.0	44	139	0.0	44	139	0.0	44	139	0.0	57		
1410	6.4	46	147	2.7	40	128	0.0	44	141	0.0	44	141	0.0	44	141	0.0	57		
1372	6.5	46	147	2.8	40	130	0.0	44	143	0.0	44	143	0.0	44	143	0.0	57		
1336	6.6	45	147	2.8	40	132	0.0	44	146	0.0	44	146	0.0	44	146	0.0	57		
1300	6.7	44	147	2.8	40	134	0.0	44	148	0.0	44	148	0.0	44	148	0.0	57		
1265	6.8	44	147	2.8	40	136	0.0	44	150	0.0	44	150	0.0	44	150	0.0	57		
1230	6.9	43	147	2.9	40	138	0.0	44	152	0.0	44	152	0.0	44	152	0.0	57		
1196	7.0	42	147	2.9	40	140	0.0	44	154	0.0	44	154	0.0	44	154	0.0	57		
1162	7.1	42	149	2.9	40	142	0.0	44	157	0.0	44	157	0.0	44	157	0.0	57		
1128	7.2	43	152	3.0	45	159	2.0	44	159	0.0	44	159	0.0	44	159	0.0	57		
1094	7.3	43	154	3.0	45	161	2.0	44	161	0.0	44	161	0.0	44	161	0.0	57		
1059	7.4	43	156	3.0	45	163	2.0	44	163	0.0	44	163	0.0	44	163	0.0	57		
1024	7.5	43	159	3.1	45	166	2.1	44	165	0.0	44	165	0.0	44	165	0.0	57		
988	7.6	43	161	3.1	45	168	2.1	44	168	0.0	44	168	0.0	44	168	0.0	57		
950	7.7	43	164	3.2	45	171	2.2	44	170	0.0	44	170	0.0	44	170	0.0	57		
908	7.8	43	166	3.2	45	174	2.2	44	172	0.0	44	172	0.0	44	172	0.0	57		
860	7.9	43	169	3.3	45	177	2.3	44	174	0.0	44	174	0.0	44	174	0.0	57		
760	8.0	43	172	3.5	45	180	2.5	44	176	0.0	44	176	0.0	44	176	0.0	57		

NOTE: Lt, Lr & w VALUES IN FEET. LISTED RADIUS IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Lt, Lr, AND w VALUES.

TRANSITION CURVES - RURAL
50 MPH DESIGN SPEED
VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATION REFERENCE

DESIGN FACTORS FOR A DESIGN SPEED OF 55 MPH (RURAL) USING E = 8% MAX.

DESIGN VELOCITY =55	DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)												INTERCHANGE RAMPS																		
	WIDTH= 18 FT				WIDTH=20 FT				WIDTH=22 FT				WIDTH=24 FT				WIDTH=48 FT				WIDTH=72 FT				WIDTH						
	1 @ 9'		1 @ 10'		1 @ 11'		1 @ 12'		1 @ 12'		2 @ 12'		2 @ 12'		3 @ 12'		3 @ 12'		16 FT		18 FT		16 FT		18 FT						
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
10000	NC	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
7190	2.0	39	39	0.0	43	43	0.0	47	47	0.0	52	52	0.0	57	57	0.0	62	62	0.0	67	67	0.0	72	72	0.0	77	77	0.0	81	81	0.0
6821	2.1	39	41	0.0	43	45	0.0	47	50	0.0	52	54	0.0	57	60	0.0	62	65	0.0	67	71	0.0	72	76	0.0	77	81	0.0	81	85	0.0
6485	2.2	39	43	0.0	43	47	0.0	47	52	0.0	52	57	0.0	57	62	0.0	62	67	0.0	67	72	0.0	72	77	0.0	77	82	0.0	81	86	0.0
6179	2.3	39	45	0.0	43	49	0.0	47	54	0.0	52	59	0.0	57	64	0.0	62	69	0.0	67	74	0.0	72	79	0.0	77	84	0.0	81	89	0.0
5897	2.4	39	46	0.0	43	52	0.0	47	57	0.0	52	62	0.0	57	68	0.0	62	73	0.0	67	79	0.0	72	84	0.0	77	91	0.0	81	94	0.0
5638	2.5	39	48	0.0	43	54	0.0	47	59	0.0	52	64	0.0	57	70	0.0	62	74	0.0	67	80	0.0	72	84	0.0	77	93	0.0	81	96	0.0
5399	2.6	39	50	0.0	43	56	0.0	47	61	0.0	52	67	0.0	57	73	0.0	62	75	0.0	67	81	0.0	72	84	0.0	77	95	0.0	81	99	0.0
5177	2.7	39	52	0.0	43	58	0.0	47	64	0.0	52	69	0.0	57	75	0.0	62	76	0.0	67	82	0.0	72	84	0.0	77	97	0.0	81	101	0.0
4972	2.8	39	54	0.0	43	60	0.0	47	66	0.0	52	72	0.0	57	78	0.0	62	78	0.0	67	84	0.0	72	84	0.0	77	99	0.0	81	103	0.0
4779	2.9	39	56	0.0	43	62	0.0	47	68	0.0	52	75	0.0	57	80	0.0	62	80	0.0	67	86	0.0	72	84	0.0	77	101	0.0	81	105	0.0
4600	3.0	39	58	0.0	43	64	0.0	47	71	0.0	52	77	0.0	57	82	0.0	62	82	0.0	67	88	0.0	72	84	0.0	77	103	0.0	81	107	0.0
4432	3.1	39	60	0.0	43	66	0.0	47	73	0.0	52	80	0.0	57	84	0.0	62	84	0.0	67	90	0.0	72	84	0.0	77	105	0.0	81	109	0.0
4274	3.2	39	62	0.0	43	69	0.0	47	75	0.0	52	82	0.0	57	86	0.0	62	86	0.0	67	92	0.0	72	84	0.0	77	107	0.0	81	111	0.0
4125	3.3	39	64	0.0	43	71	0.0	47	77	0.0	52	84	0.0	57	88	0.0	62	88	0.0	67	94	0.0	72	84	0.0	77	109	0.0	81	113	0.0
3986	3.4	39	66	0.0	43	73	0.0	47	80	0.0	52	87	0.0	57	90	0.0	62	90	0.0	67	96	0.0	72	84	0.0	77	111	0.0	81	115	0.0
3853	3.5	39	68	0.0	43	75	0.0	47	82	0.0	52	90	0.0	57	92	0.0	62	92	0.0	67	98	0.0	72	84	0.0	77	113	0.0	81	117	0.0
3728	3.6	39	69	0.0	43	77	0.0	47	85	0.0	52	92	0.0	57	94	0.0	62	94	0.0	67	100	0.0	72	84	0.0	77	115	0.0	81	119	0.0
3610	3.7	39	71	0.0	43	79	0.0	47	87	0.0	52	95	0.0	57	96	0.0	62	96	0.0	67	102	0.0	72	84	0.0	77	117	0.0	81	121	0.0
3498	3.8	39	73	0.0	43	81	0.0	47	89	0.0	52	98	0.0	57	98	0.0	62	98	0.0	67	104	0.0	72	84	0.0	77	119	0.0	81	123	0.0
3391	3.9	39	75	0.0	43	83	0.0	47	92	0.0	52	100	0.0	57	100	0.0	62	100	0.0	67	106	0.0	72	84	0.0	77	121	0.0	81	125	0.0
3289	4.0	39	77	0.0	43	86	0.0	47	94	0.0	52	103	0.0	57	103	0.0	62	103	0.0	67	108	0.0	72	84	0.0	77	123	0.0	81	127	0.0
3192	4.1	39	79	0.0	43	88	0.0	47	96	0.0	52	105	0.0	57	105	0.0	62	105	0.0	67	110	0.0	72	84	0.0	77	125	0.0	81	129	0.0
3100	4.2	39	81	0.0	43	90	0.0	47	99	0.0	52	108	0.0	57	108	0.0	62	108	0.0	67	112	0.0	72	84	0.0	77	127	0.0	81	131	0.0
3011	4.3	39	83	0.0	43	92	0.0	47	101	0.0	52	110	0.0	57	110	0.0	62	110	0.0	67	114	0.0	72	84	0.0	77	129	0.0	81	133	0.0
2927	4.4	39	85	0.0	43	94	0.0	47	103	0.0	52	113	0.0	57	113	0.0	62	113	0.0	67	116	0.0	72	84	0.0	77	131	0.0	81	135	0.0
2866	4.5	39	87	0.0	43	96	0.0	47	106	0.0	52	115	0.0	57	115	0.0	62	115	0.0	67	118	0.0	72	84	0.0	77	133	0.0	81	137	0.0
2846	4.5	72	161	2.3	43	96	0.0	47	106	0.0	52	115	0.0	57	115	0.0	62	115	0.0	67	118	0.0	72	84	0.0	77	133	0.0	81	137	0.0
2768	4.6	70	161	2.3	43	98	0.0	47	108	0.0	52	118	0.0	57	118	0.0	62	118	0.0	67	120	0.0	72	84	0.0	77	135	0.0	81	139	0.0
2693	4.7	69	161	2.3	43	100	0.0	47	110	0.0	52	120	0.0	57	120	0.0	62	120	0.0	67	122	0.0	72	84	0.0	77	137	0.0	81	141	0.0
2621	4.8	68	161	2.3	43	103	0.0	47	113	0.0	52	123	0.0	57	123	0.0	62	123	0.0	67	124	0.0	72	84	0.0	77	139	0.0	81	143	0.0
2552	4.9	66	161	2.3	43	105	0.0	47	115	0.0	52	126	0.0	57	126	0.0	62	126	0.0	67	126	0.0	72	84	0.0	77	141	0.0	81	145	0.0
2486	5.0	65	161	2.3	43	107	0.0	47	118	0.0	52	128	0.0	57	128	0.0	62	128	0.0	67	128	0.0	72	84	0.0	77	143	0.0	81	147	0.0
2421	5.1	64	161	2.4	43	109	0.0	47	120	0.0	52	131	0.0	57	131	0.0	62	131	0.0	67	130	0.0	72	84	0.0	77	145	0.0	81	149	0.0
2359	5.2	62	161	2.4	43	111	0.0	47	122	0.0	52	133	0.0	57	133	0.0	62	133	0.0	67	132	0.0	72	84	0.0	77	147	0.0	81	151	0.0
2299	5.3	61	161	2.4	43	113	0.0	47	125	0.0	52	136	0.0	57	136	0.0	62	136	0.0	67	134	0.0	72	84	0.0	77	149	0.0	81	153	0.0
2241	5.4	60	161	2.4	43	115	0.0	47	127	0.0	52	138	0.0	57	138	0.0	62	138	0.0	67	136	0.0	72	84	0.0	77	151	0.0	81	155	0.0
2185	5.5	59	161	2.5	43	118	0.0	47	129	0.0	52	141	0.0	57	141	0.0	62	141	0.0	67	138	0.0	72	84	0.0	77	153	0.0	81	157	0.0
2130	5.6	58	161	2.5	43	120	0.0	47	132	0.0	52	143	0.0	57	143	0.0	62	143	0.0	67	140	0.0	72	84	0.0	77	155	0.0	81	159	0.0
2077	5.7	57	161	2.5	43	122	0.0	47	134	0.0	52	146	0.0	57	146	0.0	62	146	0.0	67	142	0.0	72	84	0.0	77	157	0.0	81	161	0.0
2026	5.8	56	161	2.5	43	124	0.0	47	136	0.0	52	149	0.0	57	149	0.0	62	149	0.0	67	144	0.0	72	84	0.0	77	159	0.0	81	163	0.0
1976	5.9	55	161	2.5	43	126	0.0	47	139	0.0	52	151	0.0	57	151	0.0	62	151	0.0	67	146	0.0	72	84	0.0	77	161	0.0	81	165	0.0
1927	6.0	54	161	2.6	43	128	0.0	47	141	0.0	52	154	0.0	57	154	0.0	62	154	0.0	67	148	0.0	72	84	0.0	77	163	0.0	81	167	0.0
1880	6.1	53	161	2.6	43	130	0.0	47	143	0.0	52	156	0.0	57	156	0.0	62	156	0.0	67	150	0.0	72	84	0.0	77	165	0.0	81	169	0.0
1833	6.2	52	161	2.6	43	132	0.0	47	146	0.0	52	159	0.0	57	159	0.0	62	159	0.0	67	152	0.0	72	84	0.0	77	167	0.0	81	171	0.0
1788	6.3	52	161	2.6	43	135	0.0	47	148	0.0	52	161	0.0	57	161	0.0	62	161	0.0	67	154	0.0	72	84	0.0	77	169	0.0	81	173	0.0
1743	6.4	51	161	2.6	43	137	0.0	47	150	0.0	52	164	0.0	57	164	0.0	62	164	0.0	67	156	0.0	72	84	0.0	77	171	0.0	81	175	0.0
1700	6.5	50	161	2.7	43	139	0.0	47	153	0.0	52	166	0.0	57	166																

DESIGN FACTORS FOR A DESIGN SPEED OF 70 MPH (RURAL) USING E= 8% MAX.

DESIGN VELOCITY =70	DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)											INTERCHANGE RAMP																
	WIDTH= 18 FT			WIDTH=20 FT			WIDTH=22 FT			WIDTH=24 FT			WIDTH=48 FT			WIDTH=72 FT			WIDTH									
	DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)			DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)			DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)			DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)			DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)			DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)			DESIGN SOFTWARE EQUIVALENTS (NUMBER OF LANES AT LANE WIDTH)									
	1 @ 9'			1 @ 10'			1 @ 11'			1 @ 12'			2 @ 12'			3 @ 12'			16 FT			18 FT						
RADIUS(FT)	E(%)	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w	Lt	Lr	w
17000	NC	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0	0	0	0
10731	2.0	45	45	0	50	50	0.0	55	55	0.0	60	60	0.0	90	90	0.0	120	120	0.0	120	120	0.0	120	120	0.0	120	120	0.0
10194	2.1	45	48	0.0	50	53	0.0	55	58	0.0	60	63	0.0	90	95	0.0	120	126	0.0	120	126	0.0	120	126	0.0	120	126	0.0
9706	2.2	45	50	0.0	50	55	0.0	55	61	0.0	60	66	0.0	90	99	0.0	120	132	0.0	120	132	0.0	120	132	0.0	120	132	0.0
9260	2.3	45	52	0.0	50	58	0.0	55	64	0.0	60	69	0.0	90	104	0.0	120	138	0.0	120	138	0.0	120	138	0.0	120	138	0.0
8851	2.4	45	54	0.0	50	60	0.0	55	66	0.0	60	72	0.0	90	108	0.0	120	144	0.0	120	144	0.0	120	144	0.0	120	144	0.0
8474	2.5	45	57	0.0	50	63	0.0	55	69	0.0	60	75	0.0	90	113	0.0	120	150	0.0	120	150	0.0	120	150	0.0	120	150	0.0
8127	2.6	45	59	0.0	50	65	0.0	55	72	0.0	60	78	0.0	90	117	0.0	120	156	0.0	120	156	0.0	120	156	0.0	120	156	0.0
7805	2.7	45	61	0.0	50	68	0.0	55	75	0.0	60	81	0.0	90	122	0.0	120	162	0.0	120	162	0.0	120	162	0.0	120	162	0.0
7506	2.8	45	63	0.0	50	70	0.0	55	77	0.0	60	84	0.0	90	126	0.0	120	168	0.0	120	168	0.0	120	168	0.0	120	168	0.0
7227	2.9	45	66	0.0	50	73	0.0	55	80	0.0	60	87	0.0	90	131	0.0	120	174	0.0	120	174	0.0	120	174	0.0	120	174	0.0
6967	3.0	45	68	0.0	50	75	0.0	55	83	0.0	60	90	0.0	90	135	0.0	120	180	0.0	120	180	0.0	120	180	0.0	120	180	0.0
6724	3.1	45	70	0.0	50	78	0.0	55	86	0.0	60	93	0.0	90	140	0.0	120	186	0.0	120	186	0.0	120	186	0.0	120	186	0.0
6495	3.2	45	72	0.0	50	80	0.0	55	88	0.0	60	96	0.0	90	144	0.0	120	192	0.0	120	192	0.0	120	192	0.0	120	192	0.0
6281	3.3	45	75	0.0	50	83	0.0	55	91	0.0	60	99	0.0	90	149	0.0	120	198	0.0	120	198	0.0	120	198	0.0	120	198	0.0
6079	3.4	45	77	0.0	50	85	0.0	55	94	0.0	60	102	0.0	90	153	0.0	120	204	0.0	120	204	0.0	120	204	0.0	120	204	0.0
5888	3.5	45	79	0.0	50	88	0.0	55	97	0.0	60	105	0.0	90	158	0.0	120	210	0.0	120	210	0.0	120	210	0.0	120	210	0.0
5708	3.6	45	81	0.0	50	90	0.0	55	99	0.0	60	108	0.0	90	162	0.0	120	216	0.0	120	216	0.0	120	216	0.0	120	216	0.0
5537	3.7	45	84	0.0	50	93	0.0	55	102	0.0	60	111	0.0	90	167	0.0	120	222	0.0	120	222	0.0	120	222	0.0	120	222	0.0
5376	3.8	45	86	0.0	50	95	0.0	55	105	0.0	60	114	0.0	90	171	0.0	120	228	0.0	120	228	0.0	120	228	0.0	120	228	0.0
5222	3.9	45	88	0.0	50	98	0.0	55	108	0.0	60	117	0.0	90	176	0.0	120	234	0.0	120	234	0.0	120	234	0.0	120	234	0.0
5076	4.0	45	90	0.0	50	100	0.0	55	110	0.0	60	120	0.0	90	180	0.0	120	240	0.0	120	240	0.0	120	240	0.0	120	240	0.0
4937	4.1	45	93	0.0	50	103	0.0	55	113	0.0	60	123	0.0	90	185	0.0	120	246	0.0	120	246	0.0	120	246	0.0	120	246	0.0
4805	4.2	45	95	0.0	50	105	0.0	55	116	0.0	60	126	0.0	90	189	0.0	120	252	0.0	120	252	0.0	120	252	0.0	120	252	0.0
4679	4.3	45	97	0.0	50	108	0.0	55	119	0.0	60	129	0.0	90	194	0.0	120	258	0.0	120	258	0.0	120	258	0.0	120	258	0.0
4558	4.4	45	99	0.0	50	110	0.0	55	121	0.0	60	132	0.0	90	198	0.0	120	264	0.0	120	264	0.0	120	264	0.0	120	264	0.0
4443	4.5	45	102	0.0	50	113	0.0	55	124	0.0	60	135	0.0	90	203	0.0	120	270	0.0	120	270	0.0	120	270	0.0	120	270	0.0
4332	4.6	45	104	0.0	50	115	0.0	55	127	0.0	60	138	0.0	90	207	0.0	120	276	0.0	120	276	0.0	120	276	0.0	120	276	0.0
4226	4.7	45	106	0.0	50	118	0.0	55	130	0.0	60	141	0.0	90	212	0.0	120	282	0.0	120	282	0.0	120	282	0.0	120	282	0.0
4125	4.8	45	108	0.0	50	120	0.0	55	132	0.0	60	144	0.0	90	216	0.0	120	288	0.0	120	288	0.0	120	288	0.0	120	288	0.0
4027	4.9	45	111	0.0	50	123	0.0	55	135	0.0	60	147	0.0	90	221	0.0	120	294	0.0	120	294	0.0	120	294	0.0	120	294	0.0
3933	5.0	45	113	0.0	50	125	0.0	55	138	0.0	60	150	0.0	90	225	0.0	120	300	0.0	120	300	0.0	120	300	0.0	120	300	0.0
3843	5.1	45	115	0.0	50	128	0.0	55	141	0.0	60	153	0.0	90	230	0.0	120	306	0.0	120	306	0.0	120	306	0.0	120	306	0.0
3756	5.2	45	117	0.0	50	130	0.0	55	143	0.0	60	156	0.0	90	234	0.0	120	312	0.0	120	312	0.0	120	312	0.0	120	312	0.0
3673	5.3	45	120	0.0	50	133	0.0	55	146	0.0	60	159	0.0	90	239	0.0	120	318	0.0	120	318	0.0	120	318	0.0	120	318	0.0
3592	5.4	45	122	0.0	50	135	0.0	55	149	0.0	60	162	0.0	90	243	0.0	120	324	0.0	120	324	0.0	120	324	0.0	120	324	0.0
3514	5.5	45	124	0.0	50	138	0.0	55	152	0.0	60	165	0.0	90	248	0.0	120	330	0.0	120	330	0.0	120	330	0.0	120	330	0.0
3439	5.6	45	126	0.0	50	140	0.0	55	154	0.0	60	168	0.0	90	252	0.0	120	336	0.0	120	336	0.0	120	336	0.0	120	336	0.0
3366	5.7	45	129	0.0	50	143	0.0	55	157	0.0	60	171	0.0	90	257	0.0	120	342	0.0	120	342	0.0	120	342	0.0	120	342	0.0
3296	5.8	45	131	0.0	50	145	0.0	55	160	0.0	60	174	0.0	90	261	0.0	120	348	0.0	120	348	0.0	120	348	0.0	120	348	0.0
3228	5.9	45	133	0.0	50	148	0.0	55	163	0.0	60	177	0.0	90	266	0.0	120	354	0.0	120	354	0.0	120	354	0.0	120	354	0.0
3163	6.0	45	135	0.0	50	150	0.0	55	165	0.0	60	180	0.0	90	270	0.0	120	360	0.0	120	360	0.0	120	360	0.0	120	360	0.0
3099	6.1	45	138	0.0	50	153	0.0	55	168	0.0	60	183	0.0	90	275	0.0	120	366	0.0	120	366	0.0	120	366	0.0	120	366	0.0
3037	6.2	45	140	0.0	50	155	0.0	55	171	0.0	60	186	0.0	90	279	0.0	120	372	0.0	120	372	0.0	120	372	0.0	120	372	0.0
2977	6.3	45	142	0.0	50	158	0.0	55	174	0.0	60	189	0.0	90	284	0.0	120	378	0.0	120	378	0.0	120	378	0.0	120	378	0.0
2919	6.4	45	144	0.0	50	160	0.0	55	176	0.0	60	192	0.0	90	288	0.0	120	384	0.0	120	384	0.0	120	384	0.0	120	384	0.0
2866	6.5	45	147	0.0	50	163	0.0	55	179	0.0	60	195	0.0	90	293	0.0	120	390	0.0	120	390	0.0	120	390	0.0	120	390	0.0
2865	6.5	64	205	2.5	50	163	0.0	55	179	0.0	60	195	0.0	90	293	0.0	120	390	0.0	120	390	0.0	120	390	0.0	120	390	0.0
2862	6.5	64	205	2.5	50	163	0.0	55	179	0.0	60	195	0.0	90	293	0.0	120	390	0.0	120	390	0.0	120	390	0.0	120	390	0.0
2807	6.6	63	205	2.5	50	165	0.0	55	182	0.0	60	198	0.0	90	297	0.0	120	396	0.0	120	396	0.0	120	396	0.0	120	396	0.0
2753	6.7	62																										