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INTRODUCTION

INTRODUCTION

In 1988 Congress enacted the Omnibus Trade and Competitiveness Act which among other things:

1 - Declared the metric system the preferred system of weights and measures for U.S. trade and commerce.

2 - Required each federal agency to convert to the metric system for procurements, grants, and business related activities.

In 1991 President Bush issued an Executive Order which basically directed federal agencies to convert to metric under the leadership of the Secretary of Commerce and they were to do so within a fixed period of time.

As a consequence, the Federal highway Administration developed an implementation plan which was intended to lead to complete metrication by September 30, 1996. Their intent was to have the Plan, Specification and Estimate assemblies for all federal-aid projects in metric units after that date. The September 1996 deadline was extended to September 2000 after the National Highway System (NHS) Designation Act was signed in November 1995.

The Location and Design Division initiated metric survey and plan development in 1993 to meet FHWA's date for advertisement. All projects that have not already been surveyed will be surveyed and designed in metric.

This volume of the Road Design Manual is being distributed to provide guidance in the Department's requirements for metric plan development. The information being provided at this time is not all inclusive and as additional design information is developed it will be distributed for inclusion in this manual.

BASIC METRIC

Base Units

There are seven metric base units of measurement, six of which are used in design and construction. (The seventh, mole, is the amount of molecular substance and is used in physics.)

Quantity	Unit	Symbol
length	meter	m
mass∗	kilogram	kg
time	second	s
electric current	ampere	A
temperature	kelvin	K
luminous intensity	candela	cd

∗ "Weight" in common practice often is used to mean "mass."

Celsius temperature (°C) is more commonly used than kelvin (K), but both have the same temperature gradients. Celsius temperature is simply 273.15 degrees warmer than kelvin, which begins at absolute zero. For instance, water freezes at 273.15 K and at 0 °C; it boils at 373.15 K and at 100 °C. To move between Celsius and kelvin, add or subtract 273.15.

Decimal Prefixes

Only two decimal prefixes are commonly used with the base units in design and construction.

Prefix	Symbol	Order of Magnitude	Expression
kilo	k	10^3	1000 (one thousand)
milli	m	10^{-3}	0.001 (one thousand)

The prefixes mega (M) for one million (10^6), giga (G) for one billion (10^9), micro (μ) for one millionth (10^{-6}), and nano (n) for one billionth (10^{-9}) are used in some engineering calculations.

Plane and Solid Angles

The radian (rad) and steradian (sr) denote plane and solid angles. They are used in lighting work and in various engineering calculations. In surveying, the units degree (°), minute ('), and second (") continue in use.

Derived Units

Fifteen derived units with special names are used in engineering calculations:

Quantity	Name	Symbol	Expression
frequency	hertz	Hz	$Hz = s^{-1}$
force	newton	N	$N = kgm/s^2$
pressure, stress	pascal	Pa	$Pa = N/m^2$
energy, work,quantitiy of heat	joule	J	$J = Nm$
power, radiant flux	watt	W	$W = J/s$
electric charge, quantity	coulonmb	C	$C = As$
electric potential	volt	V	$V = W/A$ or J/C
capacitance	farad	F	$F = C/V$
electric resistance	ohm	Ω	$\Omega = V/A$
electric conductance	siemens	S	$S = A/V$ or Ω^{-1}
magnetic flux	weber	Wb	$Wb = Vs$
magnetic flux density	tesla	T	$T = Wb/m^2$
inductance	henry	H	$H = Wb/A$
luminous flux	lumen	lm	$lm = cdsr$
illunimance	lux	lx	$lx = lm/m^2$

Liter, Hectare, and Metric Ton

The liter (L) is the measurement for liquid volume. The hectare (ha) is a metric measurement used in surveying. The metric ton (t) is used to denote large loads such as those used in excavating.

Pronunciation

candela   Accent the second syllable, can-dell-ah.
hectare   Accent the first syllable: heck-tare. 'Me second syllable rhymes with care.
joule   Rhymes with pool.
kilometer Accent the first syllable: kill-o-meter.
pascal   Rhymes with rascal.
siemens   Sounds like seamen's.

Rules for Writing Metric Symbols and Names

- Print unit symbols in upright type and in lower case except for liter (L) or unless the unit name is derived from a proper name.

- Print unit names in lower case, even those derived from a proper name.

- Print decimal prefixes in lower case for magnitudes 10^3 and lower (that is, k, m, μ, and n) print the prefixes in upper case for magnitudes 10^6 and higher (that is, M and G).

- Leave a space between a numeral and a symbol (write 45 kg or 37° C, not 45 kg or 37°C or 37° C).

- Do not use a degree mark (') with Kelvin temperature (write K, not °K).

- Do not leave a space a unit symbol and its decimal prefix (write kg, not k g.

- Do not use the plural of unit symbols (write 45 kg, not 45 kgs), but do use the plural of written unit names (several kilograms).

- For technical writing, use symbols in conjunction with numerals (the area is 10 m^2); write out unit names if numerals are not used (carpet is measured in square meters) Numerals may be combined with written unit names in nontechnical writing (10 meters).

- Indicate the product of two or more units in symbolic form by using a dot positioned above the line ($kgms^{-2}$).
- Do not mix names and symbols (write Nm or Newton meter, not or Newton).

- Do not use a period after a symbol (write " 12 g", not " 12 g.") except when it occurs at the end of a sentence.

Decimal prefixes to the tertiary power of 10 are preferred. The prefixes deci (d) for one tenth (10^{-1}), centi (c) for one hundredth (10^{-2}), deca (da) for ten (10^1), and hecto (h) for one hundred (10^2) have limited application in construction.

Rules for Writing Numbers

- Always use decimals, not fractions (write 0.75 g not ¾g).

- Use a zero before the decimal marker for values less than one (write 0.45 g, not   .45 g).

Conversion and Rounding

- When converting numbers from inch-pounds to metric, round the metric value to the same number of digits as there were in the inch-pound number (11 miles at 1. 609 km/mi equals 17.699 km, which rounds to 18 km).

- Convert mixed inch-pound units (feet and inches, pounds and ounces) to the smaller inch-pound unit before converting to metric and rounding (10 feet, 3 inches = 123 inches; 123 inches x 25.4 mm = 3124.2 mm; round to 3124 mm).

- In a "soft"conversion, an inch-pound measurement is mathematically converted to its exact (or nearly exact) metric equivalent. With "hard" conversion, a new rounded, rationalized metric number is created that is convenient to work with and remember.

LENGTH, AREA, AND VOLUME

One metric unit is used to measure length, area, and volume in most design and construction work:

- meter (m).

Rules for Linear Measurement (Length)

- Use only the meter and millimeter in building design and construction.

- Use the kilometer for long distances and the micrometer for precision measurements.

- Avoid use of the centimeter.

- For survey measurement, use the meter and the kilometer.

Rules for Area

- The square meter is preferred.

- Very large areas may be expressed in square kilometers and very small areas, in millimeters.

- Use the hectare (10 000 square meters) for land and water measurement only.

   Avoid use of the square centimeter.
- Linear dimensions such as 40 x 90 mm may be used; if so, indicate width first and second.

Rules for Volume and Fluid Capacity

- Cubic meter is preferred for volumes in construction and for large storage tanks-

Use liter (L) and milliliter (ml) for fluid capacity (liquid volume). One liter is 1/1000 of a cubic meter or 1000 cubic centimeters.

Since a cubic meter equals one billion cubic millimeters, the cubic decimeter and cubic centimeter may be used in limited applications, since they are multiples of 1000 in volume measurement.

CONVERSION FACTORS

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Length	mile	km	1.609 344
	yard	m	0.914 4
	foot	m	0.304 8
	foot	mm	304.8
	inch	mm	25.4 00
Area	square mile	km^2	2.590 00
	acre	m^2	4 046.856
		ha (10,000 m^2)	0.404 685 6
	square yard	m^2	0.836 127 36
	square foot	m^2	0.092 903 04
	square inch	mm^2	645.16
Volume	acre foot	m^3	1 233.49
	cubic yard	m^3	0.764 555
	cubic foot	m^3	0.028 316 8
	cubic foot	cm^3	28 316.85
	cubic foot	L (1000 cm^3)	28.316 85
	100 board feet	m^3	0.235 974
	gallon	L (1000 cm^3)	3.785 41
	quart	L (1000 cm^3)	0.946 353
	ounce	ml^3	29.573 5
	cubic inche	cm^3	16.387 064
	cubic inch	mm^3	16 387.064
Mass	pound	kg	0.453 592
	ounce	g	28.349 5
	short ton (2000 lbs.)	metric ton (1000 kg)	0.907 184
Velocity	foot/sec	m/sec	0.304 8
	mile/hour	km/h	1.609 344

NOTE: Underline denotes exact number.

1. **Tons per Cubic Yard to Metric Tons per Cubic Meter**

$$\frac{1 \text{ Ton}}{\text{C.Y.}} \times \frac{1 \text{ C.Y.}}{.764555 \text{ m}^3} \times \frac{.907184 \text{ metric ton}}{\text{Ton}} = 1.18655 \frac{\text{metric tons}}{\text{m}^3}$$

$$\frac{1 \text{ Ton}}{\text{C.Y.}} = \frac{1.18655 \text{ metric tons}}{\text{m}^3}$$

Example: Convert 2 Tons to $\frac{\text{metric tons}}{\text{m}^3}$
C.Y.

$$2 \times 1.18655 \frac{\text{metric tons}}{\text{m}^3} = 2.373 \frac{\text{metric tons}}{\text{m}^3}$$

* Should be rounded to 2.4 in most cases.

2. **Pounds per Cubic Foot to Kilograms per Cubic Meter**

$$\frac{1 \text{ Lb.}}{\text{C.F.}} \times \frac{1 \text{ C.F}}{0.0283168 \text{ m}^3} \times \frac{0.4353592 \text{ kg}}{\text{Lbs.}} = 16.0185 \frac{\text{kg}}{\text{m}^3}$$

$$\frac{1 \text{ Lb.}}{\text{C.F.}} = 16.0185 \frac{\text{kg}}{\text{m}^3}$$

Example: Convert 150 Lbs. to $\frac{\text{kg}}{\text{m}^3}$ or $\frac{\text{metric tons}}{\text{m}^3}$
C.F.

$$150 \times {}^*16.0185 \frac{\text{kg}}{\text{m}^3} = 2403 \frac{\text{kg}}{\text{m}^3} \text{ or } 2.403 \frac{\text{metric tons}}{\text{m}^3}$$

* Should be rounded to 16 in most cases.

Temperature

base unit = Celsius

To convert from Celsius to Fahrenheit and vice versa the following formulas are used:

$$C = 5/9 \ (F - 32)$$
$$F = 9/5C \ + 32$$

The ice point of water: $0^0C = \ 32^0F$
The steam point of water: $100^0C = 212^0F$
Body temperature: $37^0C = 98.6^0F$

Note:

The Kelvin scale is used by the scientific community. It is based on the temperature where water, ice, and water vapor exist in equilibrium. The ice point on the Kelvin scale is 273K and the steam point is 373 K. Hence one Celsius degree is equal to one Kelvin degree.

Temperature Conversion Chart
°F = Fahrenheit   °C = Celsius
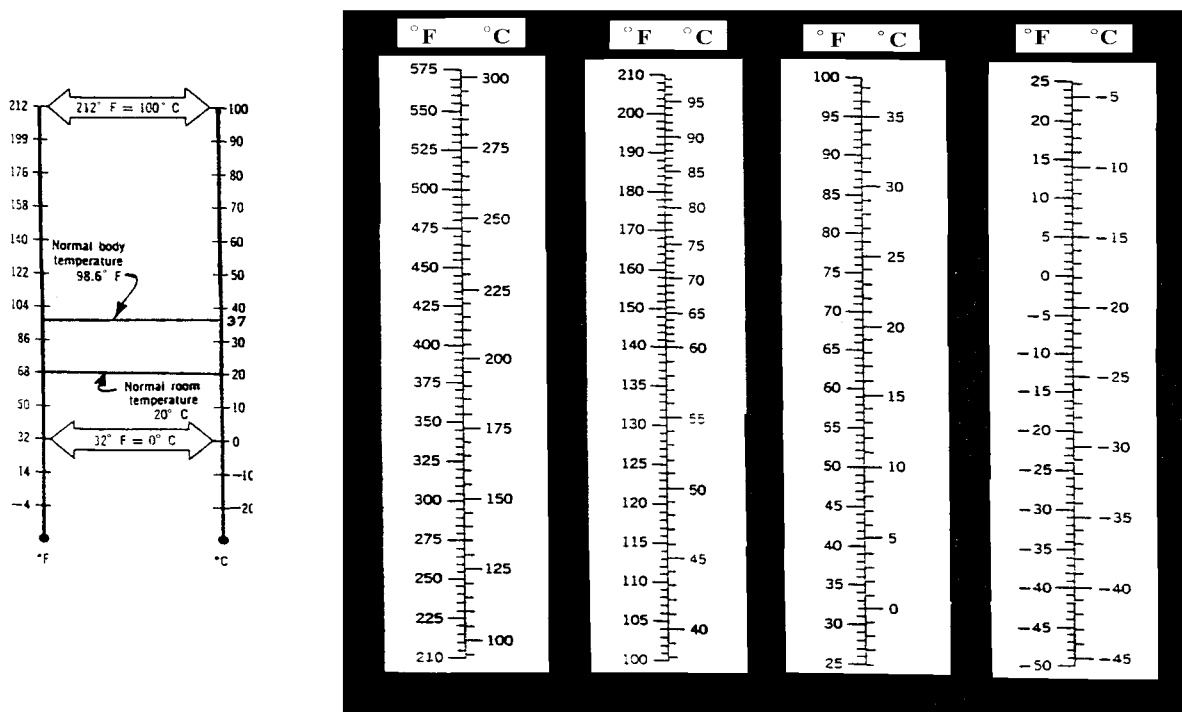
CONVERSION CHARTS

DECIMAL Inches	(in) Inches	(cm) Centimeters	(ft) Feet	(cm) Centimeters	(m) Meters	(km) Kilometer
0.0313	1/32	0.079	1	30.48	0.3048	0.000304
0.0625	1/16	0.159	2	40.96	0.4096	0.000409
0.0938	3/32	0.238	3	91.44	0.9144	0.000914
0.1250	1/8	0.318	4	121.92	1.2192	0.001219
0.1563	5/32	0.397	5	152.40	1.5240	0.001524
0.1875	3/16	0.476	6	182.88	1.8288	0.001828
0.2188	7/32	0.556	7	213.36	2.1336	0.002133
0.2500	1/4	0.635	8	243.84	2.4384	0.00.2438
0.2813	9/32	0.714	9	274.32	2.7432	0.002743
0.3125	5/16	0.794	10	304.80	3.0480	0.003048
0.3438	11/3	0.873	20	609.60	6.0960	0.00609b
0.3750	3/8	0.953	30	914.40	9.1440	0.009144
0.4063	13/32	1.032	40	1219.20	12.1920	0.012192
0.4375	7/16	1.111	50	1524.00	15.2400	0.01524
0.4688	15/32	1.191	60	1828.80	18.2880	0.018288
0.5000	1/2	1.270	70	2133.60	21.3360	0.021336
0.5313	17/32	1.349	80	2438.40	24.3840	0.024384
0.5625	9/16	1.429	90	2743.20	27.4320	0.027432
0.5938	19/32	1.508	100	3048.00	30.4800	0.03048
0.6250	5/8	1.588	200	6096.00	60.9600	0.06096
0.6563	21/32	1.667	300	9144.00	91.4400	0.09144
0.6875	11/16	1.746	400	12192.00	121.9200	0.12192
0.7188	23/32	1.826	500	15240.00	152.4000	0.1524
0.7500	3/4	1.905	600	18288.00	182.8800	0.18288
0.7813	25/32	1.984	700	21336.00	213.3600	0.21336
0.8125	13/16	2.064	800	24384.00	243.8400	0.24384
0.8438	17/32	2.143	900	27432.00	274.3200	0.27432
0.8750	718	2.223	1000	30480.00	304.8000	0.3048
0.9063	29/32	2.302	2000	60960.00	1609.6000	0.6096
0.9375	15/16	2.381	3000	91440.00	914.4000	0.9144
0.9688	31/32	2.461	4000	121920.00	1219.20	1.2192
1.0000	I	2.540	5000	152400.00	1524.00	1.524
2.0000	2	5.080	6000	182880.00	1828.80	1.8288
3.0000	3	7.620	7000	213360.00	2133.60	2.1336
4.0000	4	10.160	8000	243840.00	2438.40	2.4384
5.0000	5	12.700	9000	274320.00	2743.20	2.7432
6.0000	6	15.240	10000	304800.00	3048.00	3.048
7.0000	7	17.780				
8.0000	8	20.320				
9.0000	9	22.860				
10.0000	10	25.400				
11.0000	11	27.940				
12.0000	12	30.480				

VOLUME CONVERSION CHART

LITERS	GALIONS	QUARTS	LITERS
0.00	0.0	0.1	0.095
0.38	0.1	0.2	0.189
0.76	0.2	0.3	0.284
1.14	0.3	0.4.	0.379
1.51	0.4	0.5	0.473
1.89	0.5	0.6	0.568
2.27	0.6	0.7	0.662
2.65	0.7	0.8	0.757
3.03	0.8	0.9	0.352
3.41	0.9	1.0	0.94.6
3.79	1.0	2.0	1.893
7.57	2.0	3.0	2.839
11.36	3.0	4.0	3.785
15.14	4.0	5.0	4.732
18.93	5.0	6.0	5.678
22.71	6.0	7.0	6.624.
26.50	7.0	8.0	7.571
30.28	8.0	9.0	8.517
34.07	9.0	10.0	9.464
37.85	10.0	11.0	10.410
75.71	20.0	12.0	11.356
113.56	30.0	13.0	12.303
151.42	40.0	14.0	13.249
189.27	50.0	15.0	14.195
227.12	60.0	16.0	15.142
264.98	70.0	17.0	16.088
302.83	80.0	18.0	17.034
340.69	90.0	19.0	17.981
378.54	100.0	20.0	18.927
		21.0	19.873
		22.0	20.820
		23.0	21.766
		24.0	22.712
		25.0	23.659
		26.0	24.605
		27.0	25.552
		28.0	26.498
		29.0	27.444
		30.0	28.391

CIVIL AND STRUCTURAL ENGINEERING

The metric units used in civil and structural engineering are:

* meter (m)
* kilogram (kg)
* second (s)
* Newton (N)
* Pascal (pa)

Rules for Civil and Structural Engineering

* There are separate for mass and force.

* The kilogram (kg) is the base unit for mass, which is the unit quantity of MM independent of gravity.

* The Newton (N) is the derived unit for force (mass times acceleration, or kgm/s^2). It replaces the unit kilogram-force (kgf), which should not be used.

* Do not use the joule to designate torque, which is always designated Newton (Nm).

* The Pascal (Pa) is the unit for pressure and (Pa = N/m@. The term 'bar' is not a metric unit and should not be used.

* Structural calculations should be shown in MPa or kPa.

* Plane angles in surveying (cartography) will continue to be measured in degrees (either decimal degree or degrees, minutes, and rather dm the metric radian.

Civil and Structural Engineering Conversion Factors

Quantity	From Inch-Pound Units	To Metric Units	Multiply by
Mass	lb.	kg	0.453 592
	kip (1000 lb.)	metric ton (1000 kg)	0.453 592
Mass/unit length	plf	kg/m	1.488 16
Mass/unit area	psf	kg/M^2	4.882 43
Mass density	pcf	kg/M^3	16.018 5
Force	lb.	N	4.448 22
	kip	kN	4.448 22
Force/unit length	plf	N/m	14.593 9
	klf	kN/m	14.593 9
Pressure, stress, modulus of elasticity	psf	Pa	47.880 3
	ksf	kPa	47.880 3
	psi	kPa	6.894 76
	ksi	MPa	6.894 76
Bending moment, torque, moment of force	ft-lb.	N-m	1.355 82
	ft-kip	kN-m	1.355 82
Moment of mass	lbrft	kam	0.138 255
Moment of inertia	$lbft^2$	kgm^2	0.042 140 1
Second moment of area	in	mm.	416.231
Section modulus	in^2	mm^3	<u>16387.064</u>

NOTE: Underline denotes exact number.

PLAN ELEMENT INFORMATION
PRESENTLY RECOMMENDED BY VDOT

1 -   Sheet size will remain the same.

2 -   Stationing - 100 meter method

3 -   Scales:

      Plan Sheets
      a) Rural - 1:500 (Plan sheet covers 400 m± along centerline)
      b) Urban - 1:250 (Plan sheet covers 200 m± along centerline)

      Profile Sheets
      a) Rural - 1:500 Horizontal; 1:100 Vertical
      b) Urban - 1:250 Horizontal; 1:50 Vertical

      Cross-sections
      a) Rural - 1:100   b) Urban - 1:50

4 -   Pavement cross-slope - 2%
      Shoulder cross-slope - 5% Paved; 6% Unpaved; 8% unpaved Local

5 -   Degree of curve will no longer be used. All horizontal curve data will be based on the radius in meters.

6 -   Degree-Minute-Second will be retained for angular measurement.

7 -   Computed spiral transitions will be used for Rural curves with radius less than or equal to 850 meters.

8 -   Cross-section/tick mark interval - 20 meters (Rural)   10 meters (Urban)

9 -   All survey information will be expressed in meters except property data. Only property which is surveyed will be expressed in meters - other property data will be shown in units recorded in court records.

10 -   Until computer software and other hydraulic design aids are available in metric, hydraulic design will continue to be performed in English units with descriptions of proposed structures converted to metric after computations are complete.

11 -   Dual units will not be shown on plans with the probable exception of the R/W Data Sheet.

12 -   Chords rather than concentric curves will be used to describe proposed R/W where a spiral curve transition is used.

13 - When converting meters to feet and extreme accuracy is needed, use the conversion factor for U.S. Survey Feet rather than the slightly different factor for the International Foot. The factors are as follows:

<u>U.S. Survey Feet</u>

For conversion of meters to U.S. Survey Feet, multiply the meters by 39.37 12.0 which is 3.28083333333 to <u>12</u> significant figures.

<u>International Feet</u>

For conversion of meters to International Feet, multiply the meters by 100.0 30.48 which is 3.28083989501 to <u>12</u> significant figures.

14 - The required accuracy for metric projects is as follows:

- All metric survey (horizontal and vertical) information will be obtained and processed to the nearest 0.001 m (1 mm).
- All proposed horizontal alignment information on the plans will be shown to the nearest 0.001 m.
- All proposed elevations will be shown to the nearest 0.005 m (5 mm).
- Most horizontal offset and dimension information such as R/W monuments or locations of concrete items should be shown to the nearest meter or 0.1 meter. An exception to this is R/W monuments located at curve points such as PC's, PT's, etc. where the station of the R/W monument will be shown to the same accuracy as the curve point (0.001 m).

15 - Descriptions for hydraulic items shall be shown in accordance with the following:

<u>Pipe Culverts</u>
1 - Length of culverts shall be shown to the nearest 0.5 m.
2 - Invert elevations shall be shown to the nearest 0.1 m. In some cases elevations may need to be shown to the nearest 0.01 m.

<u>Storm Sewer</u>
1 - Length of culverts shall be shown to the nearest 0.5 m.
2 - Invert elevations shall be shown to the nearest 0.01 m.
3 - Heights of manholes and drop inlets shall be shown to nearest 0.05 m.

<u>Channels & Ditches</u>
1 - Show width and depth to the nearest 0.1 m.

<u>Pipe Cover</u>
1 - Pipe Cover shall be shown to the nearest 0.1 m.

16 - 1 - The VDOT "Metric Logo" is to be shown on all sheets in the plan assembly. This logo appears on the base sheets in the CADD cells.

DRAINAGE INFORMATION

In metric drainage design:

Discharge (Q) will be measured in cubic meters per second.
Velocity (V) will be measured in meters per second.
Small drainage areas will be measured in hectares.
Large drainage areas will be measured in square kilometers.

Millimeters (mm) will be used on Intensity-Duration-Frequency(IDF)
Curves instead of inches.

PIPE CONVERSION CHART

English Circular Size (in)	Metric Circular Size (mm)	Concrete Elliptical			
		Horizontal installation		Vertical Installation	
		Span X Rise (in X in)	Span X Rise (mm x mm)	Span X Rise (in x in)	Span X Rise (mm x mm)
6	150				
8	200				
12	300				
15	375				
18	450	23 X 14	575 X 365		
21	525				
24	600	30 x 19	770 X 490		
27	675	34 X 22	865 X 550		
30	750	38 X 24	960 X 610		
33	825	42 X 27	1055 X 670		
36	900	45 X 29	1150 X 730	29 X 45	730 X 1150
39		49 X 32	1250 X 795	32 X 49	795 X 1250
42	1050	53 X 34	1345 X 855	34 X 53	855 X 1345
48	1200	60 X 38	1535 X 975	38 X 60	975 X 1535
54	1350	68 X 43	1730 X 1095	43-X 68	1095 X 1730
60	1500	76 X 48	1920 X 1220	48 X 76	1220 X 1920
66	1650	83 X 53	2110 X 1340	53 X 83	1340 X 2110
72	1800	91 X 58	2305 X 1465	58 X 91	1465 X 2305
78	1950	98 X 63	2495 X 1585	63 X 98	1585 X 2495
84	2100	106 X 68	2690 X 1705	68 X 106	1705 X 2690
90	2250				
96	2400				
102	2550				
108	2700				
114	2850				
120	3000				

Drop Inlet Slot Lengths For	
English (ft)	Metric (m)
2.5	0.75
3	0.9
4	1.2
6	1.8
8	2.4
10	3.0
12	3.6
14	4.2
16	4.8
18	5.4
20	6.0

At the present time box culverts will be described using a soft conversion of Imperial dimensions. Size dimensions shall be shown to the nearest 0.01 m. Length of culverts shall be shown to the nearest 0.5 m. Example: 8 x 4 BCS-30 shall be described as 2.44 m x 1.22 m BCS-30.16
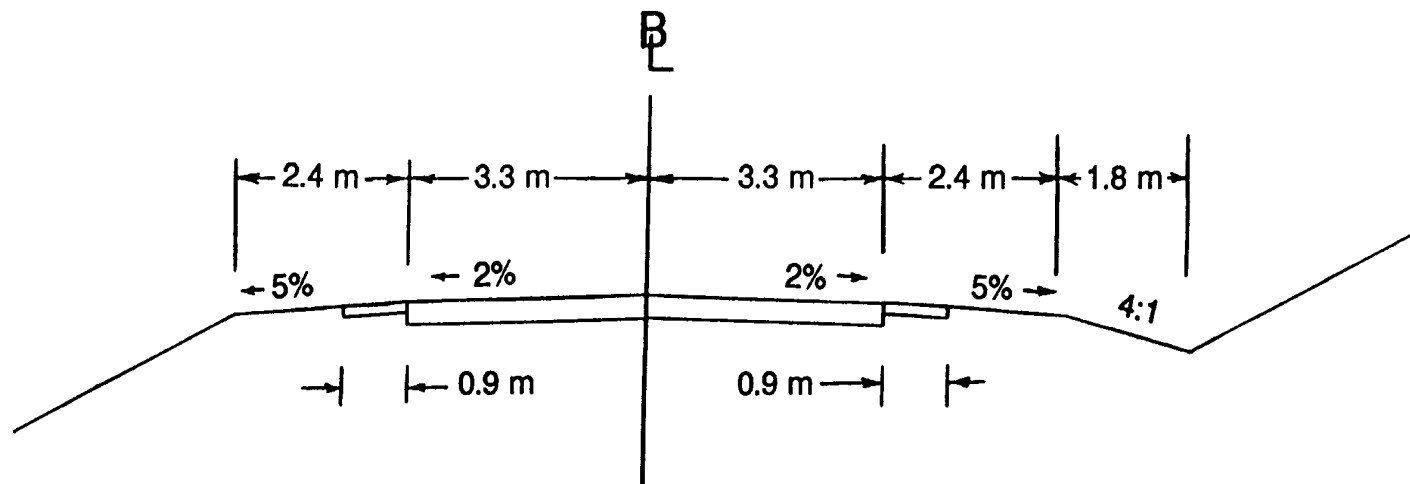
TYPICAL METRIC RURAL SECTION

R/W

R/W

26 m

CL

13 m

13 m

0.25 m

0.25 m

0.6 m

0.75 m

0.75 m

0.6 m

1.5 m

7.5 m

2.4 m

2.4 m

7.5 m

1.5 m

2%

2%

2%

2%

2%

2%

2%

2%

0.15 m

4.8 m

0.3 m

0.3 m

Left Turn lane

1.2 m

3.6 m

Typical Metric Urban Section

100 mm

50 mm R

150 mm

12:1

325 mm

175 mm

150 mm

600 mm
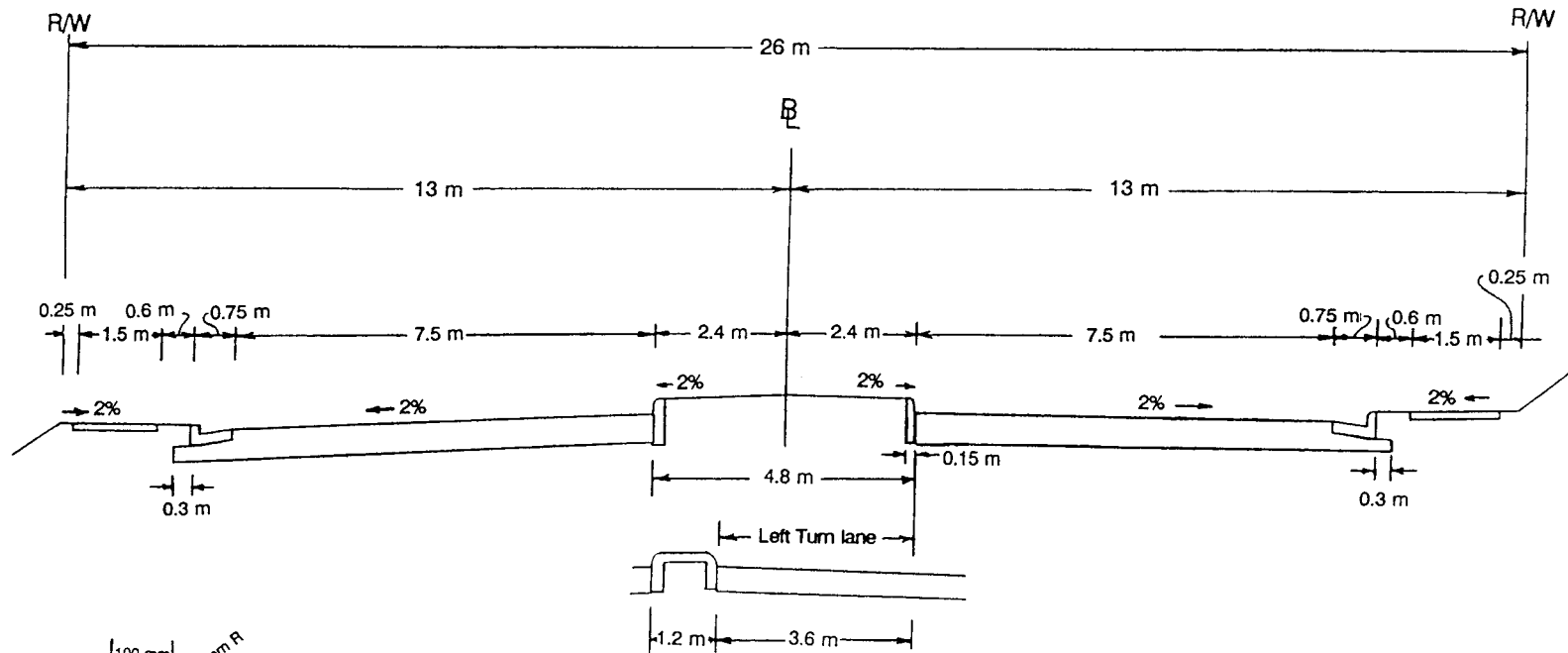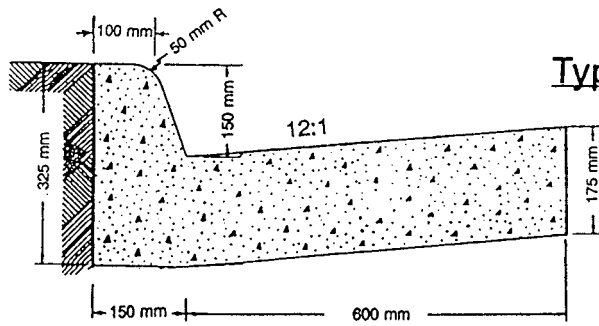
Metric CG-6

TYPICAL METRIC URBAN SECTION

SPIRAL CURVES

In order to approximate the path a vehicle makes when entering or leaving a circular horizontal curve, a spiral transition curve will be provided for horizontal curves with a radius less than or equal to 850 meters, except for interchange ramps and loops.

The spiral to be used is known as the Talbot Transition Spiral and has the following characteristics:

1. - The radius of the spiral at any point is inversely proportional to its length. The radius at the TS (beginning of the spiral) is infinite and at the SC (end of the spiral) is equal to the radius of the circular curve R.

   R   radius of the circular curve
   r   radius at the distance L_x from TS
   LS   length of spiral

   $$R \div r = L_x \div LS$$

2. - The central angle of a spiral curve is exactly 1/2 of a circular curve with the same radius and length.

   DE = central angle of spiral

   $$DE = (28.6479 \times LS) \div R$$

3. - Spiral angles are directly proportional to the squares of their lengths from the TS.

   Δ_L central angle for spiral for a length

   L_x from TS

   $$\Delta_L = (L_x \div LS)^2 \times DE$$

Formulas for computing spiral curve information is shown on the following two pages.

TRANSITION (SPIRAL) CURVES
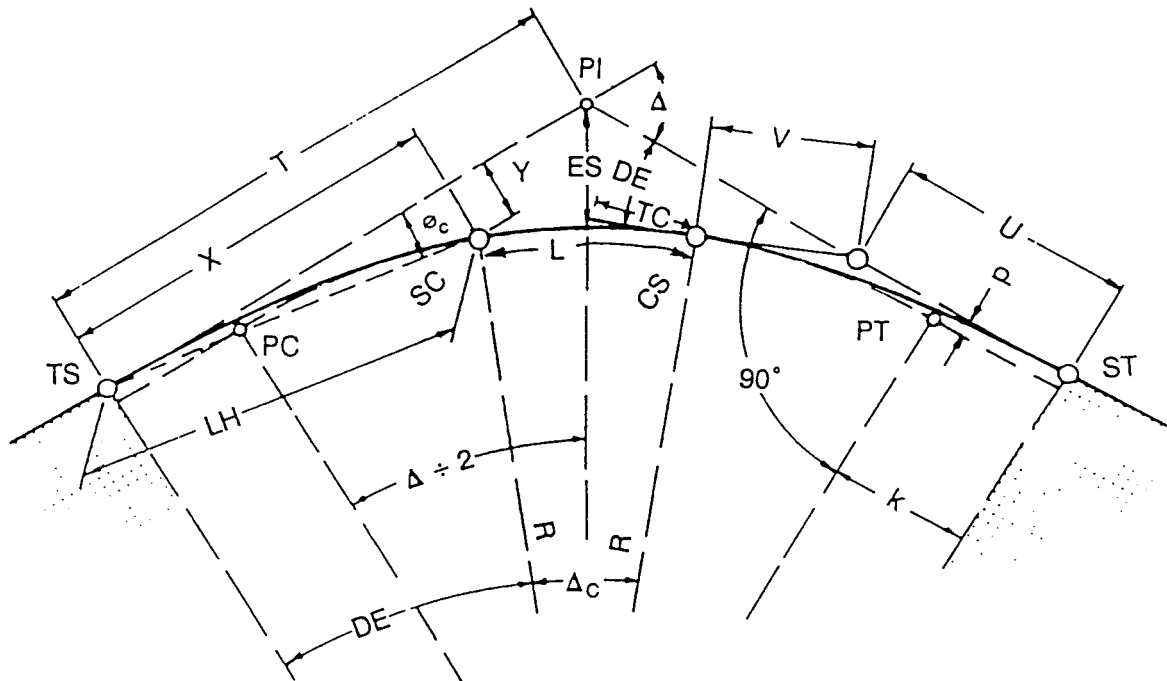
LS =	Length of Spiral	V =	Short Tangent
L =	Length of Circular Curve	X =	Tangent Distance for SC
R =	Radius of Circular Curve	Y =	Tangent Offset of the SC
TC =	Tangent of Circular Curve	k =	Simple Curve Coordinate(Abscissa)
T =	Tangent Distance	P =	Simple Curve Coordinate(Ordinate)
Δ =	Deflection Angle Between the Tangents	$\varnothing_C$ =	Deflection Angle of SpiralCurve
DE =	Spiral Angle	TS =	Tangent to Spiral
Δ_C =	Central Angle Between the SC and CS	SC =	Spiral to Circular Curve
ES =	External Distance	CS =	Circular Curve to Spiral
LH =	Long Chord	ST =	Spiral to Tangent
U =	Long Tangent		

SPIRAL CURVE FORMULAS

DE =	$(28.6479 \times LS) \div R$	TC =	$R \times [Tan\ (\Delta_C \div 2)]$
Z =	$0.01745 \times DE$	Δ_C =	$\Delta - (2 \times DE)$
X =	$LS \times [1 - (Z^2 \div 10) + (Z^4 \div 216)]$	p =	$Y - [R \times (1 - Cos\ DE)]$
Y =	$LS \times [(Z \div 3) - (Z^3 \div 42) + (Z^5 \div 1320)]$	k =	$X - [R \times (Sin\ DE)]$
L =	$(R \times \Delta_C) \div 57.2958$		

TO CALCULATE T AND ES OF A SIMPLE CURVE WITH EQUAL SPIRALS

T = $[(R + p) \times Tan\ (\Delta \div 2)] + k$

ES = $[(R + p) \times Exsec\ (\Delta \div 2)] + p$

ES = $[(R + p) \div Cos\ (\Delta \div 2)] - R$

TO CALCULATE THE TANGENT DISTANCES OF A SIMPLE CURVE
WITH UNEQUAL SPIRALS

Ti_{in} = $[(R + P)_2 \div Sin\ \Delta] - [(R + p)_1 \times Cot\Delta] + k_1$

T_{out} = $[(R + p)_1 \div Sin\ \Delta] - [(R +p)_2 \times Cot\ \Delta I + k$

**TO FIND COORDINATES OF ANY POINT ON THE SPIRAL
A DISTANCE L_X FROM THE TS**
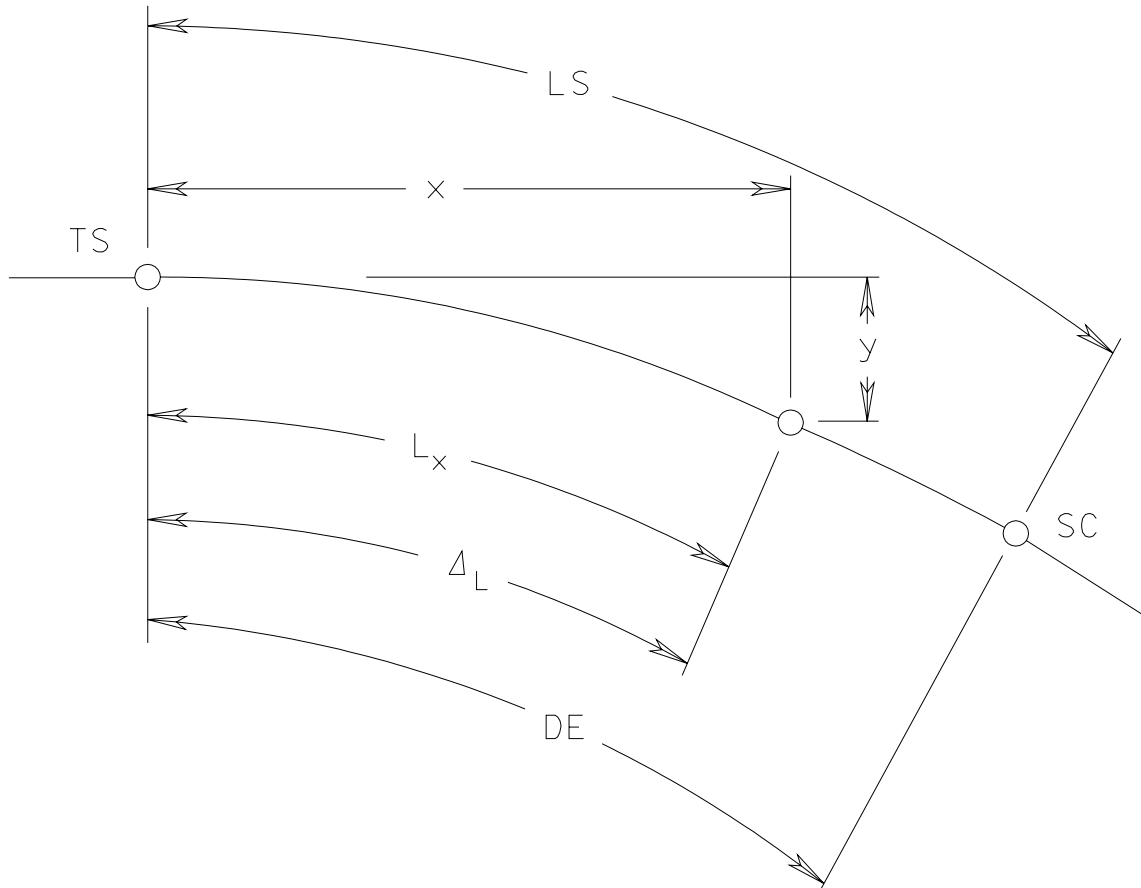
$$DE = (28.6479 \times LS) \div R = (90 \times LS) \div (\pi \times R)$$

$$\Delta_L = (L_X \div LS)^2 \times DE$$

$$Z_L = 0.01745 \times \Delta_L$$

$$x = L_x \times [1 - (Z_L^2 \div 10) + (Z_L^4 \div 216)]$$

$$y = L_x \times [(Z_L \div 3) - (Z_L^3 \div 42) + (Z_L^5 \div 1320)]$$

HORIZONTAL CURVES EXAMPLE
(Not to Scale)
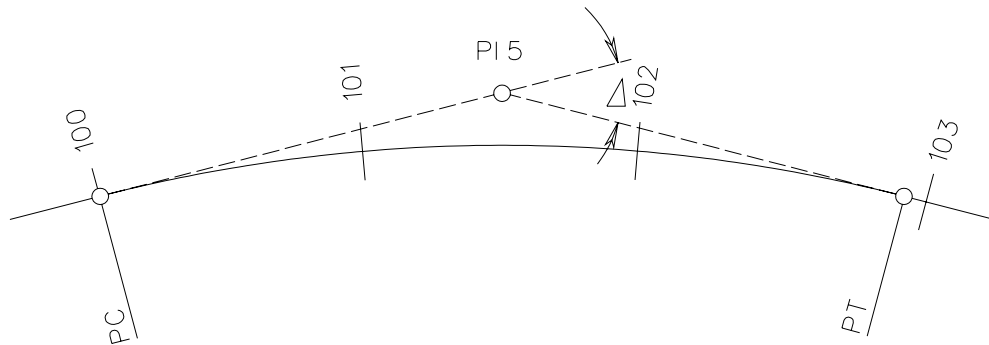
Lane A
PI NO. 5
DELTA = 18° 26' 40" RT
T = 146.126
L = 289.725
R = 900.000
PC = 100+00.000
PI = 101+46.126
PT = 102+89.725
V = 90 km/h
E = 3.1%

URBAN - NO SPIRAL TRANSITION
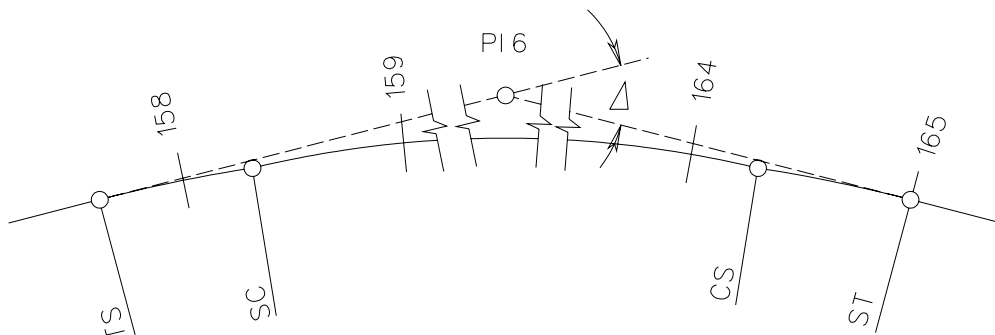
Lane A
PI NO. 6
DELTA = 54° 49' 28" RT
T = 395.663
L = 604.807
R = 700.000
LSIN = 65.000
LSOUT = 65.000
TS = 157+64.500
SC = 158+29.500
PI = 161+60.163
CS = 164+34.307
ST = 164+99.307
V = 100 km/h
E = 6.3%

RURAL - WITH SPIRAL TRANSITION

TYPICAL SECTION

RTE 132 (SAMPLE DR.)

	REVISED	FHWA REGION	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT		3	VA.		132	0132 - 122 - V04, RW - 201 C - 501	2

NOTES:

When liquid asphalt material is used as a curing material for a hydraulic cement or lime stabilized course, it shall be CMS-2, CMS-2h or CRS-2 and applied at the rate of 0.75 L/m^2. Where necessary for maintenance of construction traffic or public traffic, cover material Fine Aggregate Minimum Grading "B" shall be applied at the rate of 6.82 kg/m^2. All costs for such curing materials and any cover materials shall be included in price bid for the hydraulic cement or lime stabilized course.

The surface course shall be placed in two applications, as directed by the Engineer. This will facilitate in the maintaining of two way traffic on the new lane and associated pavement striping.

In cases of temporary connections, tie-ins, and short sections of heavy traffic, Stabilized Subgrade is to be replaced by 150 mm of aggregate base material Type 1, No. 21B. The substitution should only be used where absolutely necessary.

Prime shoulders with Liquid Asphalt Material RC-70 @ 0.95 L/m^2 and cover with Aggr. No. 78 @ 1.1 kg/m^2. Double seal with Liquid Asphalt Material RC-250 @ 0.75 L/m^2 and cover with Aggregate No. 78 (Crushed stone) @ 1.1 Kg/m^2.

The existing roadway that is to be utilized should be overlayed with 75 kg/m^2 of asphalt concrete Type SM-2C and the shoulders should be built up with aggregate base material Type 1, No. 21B. The width and depth would be variable depending upon the existing circumstances.

INSET A

① ASPHALT CONCRETE SURFACE COURSE TYPE SM-2C @ 90 kg/m^2

② 100 mm ASPHALT CONCRETE BASE COURSE BM-2

③ 150 mm AGGREGATE BASE MATERIAL TYPE 1 NO. 21B (For Subbase)

④ HYDRAULIC CEMENT STABILIZED SUBGRADE (10% BY VOLUME, 150 mm DEPTH)

⑤ STABILIZED SHOULDER, 150 mm AGGREGATE BASE MATERIAL TYPE 1, NO. 21B WITH PRIME AND DOUBLE SEAL SURFACE TREATMENT

NOT TO SCALE

MAINLINE B

POINT OF FINISHED GRADE

SEE INSET A

PAVED SHOULDER
PAVED SHOULDER

STD. CS-4
STD. GS-11
STD. GS-11
STD. CS-4

TOPSOIL & SEEDING
TOPSOIL & SEEDING

6 : 1

← 2 %   2 % →

0.3 m
0.6 m
2.4 m
3.0 m   3.0 m   3.6 m   3.6 m   3.0 m
0.3 m
0.6 m
2.4 m

STATION 100+00.00   TO   STATION 104+50.00

SUPERVISED BY H. E. Berry (804) 786-8948
DESIGNED BY F. W. Waring (804) 786-6449
CADD OPERATOR
REVISED BY

SAMPLE TYPICAL SECTION SHEET

	PLAN NO.	PROJECT	FILE NO.	SHEET NO.
A		0132 - 122 - V04		2

SAMPLE PLAN SHEETS

SAMPLE TYPICAL SECTION SHEET

Power Poles Property of Virginia Power
P.O. Box 329 Norfolk, Va. 23501

Telephone Poles Property of Chesapeake &
Potomac Telephone Company
52 Richneck Road, Newport News, Va. 23602

DESIGN FEATURES RELATING TO CONSTRUCTION
OR TO REGULATION AND CONTROL OF TRAFFIC
MAY BE SUBJECT TO CHANGE AS DEEMED
NECESSARY BY THE DEPARTMENT

SHEET	FHWA DESIGN	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	3	VA.		132	0132 - 122 - V04, RW-201	4

SECTION A-A

Tie to existing ground

2:1   2:1
1.2 m

Outlet Ditch

19.0 m -1200 mm Conc. Pipe Req'd. (0.3 m cover)
Inv. (In) 27.0
2 St'd. EW-2 Endwalls Req'd.
15 metric tons Erosion Control Stone
Class I, EC-1 Req'd. Structure Excavation
900 m³ -III mm below bottom of pipe
Excavate 0.3 m below bedding Mat'l.
and backfill with 20 metric tons
Aggr. No.25

001

ROGER L. ROE
D.B.197 - 204
P.B.3 -13
104.39 Ac.

Outlet Ditch

5.0 m St'd. PE-1 Req'd.
10 m - 375 mm Pipe Req'd. (0.3 m cover)

003

MARION L. VanMETER
D.B.198 - 210
P.B.4 -154
2.39 Ac.

2 - Sty.
Fr. Dwl.

Fr. Shed

0.360 m Cedar

0.70 m Cedar

19.0 m - 450 mm Conc. Pipe Req'd. (0.6 m cover)
Inv. (In) 28.3 Req'd.
2 St'd. ES-1 End Sections Req'd.
3 metric tons Erosion Control Stone
Class I, EC-1 Req'd.

PROP. PRIVATE ENTRANCE
PI = 10-15.000
DELTA = 15°00'00" RT
T = 5.266
L = 10.472
R = 40.000
PC = 10-15.000
PT = 10-25.472

Gravel Entr.

3.6 m St'd. PE-1 Req'd.

20.0 m - 600 mm Conc. Pipe (0.6 m cover) 30° Skew
Inv. (In) 27.7 (out) 27.5
2 St'd. ES-1 End Sections Req'd.
4 metric tons Erosion Control Stone
Class I, EC-1 Req'd.

Rte. 132
SAMPLE ROAD
Sur. & Constr. BL.

PROPOSED ROUTE 132
PI = 100-73.120
DELTA = 8°18'30" RT
T = 80.856
L = 41.505
R = 700.000
LSIN = 60.000
LSOUT = 60.000
TS = 99-92.264
SC = 100-52.264
CS = 100-93.769
ST = 101-53.769
V = 100 km/h
E = 6.3%

ROUTE 132 SUR
PI = 100-73.120
DELTA = 8°18'30" Rt.
T = 50.736
L = 101.295
R = 698.550
PC = 100-22.384
PT = 101-23.679

BM USC & GS Marker No.U-307
8 m Rt. Sta. 101-5.00
Elev. 26.550

10 m - 375 mm Exist. Pipe

002

ROGER L. ROE
D.B.197 - 204
P.B.3 -13
208.39 Ac.

PROPOSED ROUTE 132
PI = 103-95.000
DELTA = 25°01'00" RT
T = 123.844
L = 104.652
R = 400.000
LSIN = 70.000
LSOUT = 70.000
TS = 102-71.156
SC = 103-41.156
CS = 104-45.808
ST = 105-15.805
V = 100 km/h
E = 8%

NOTES:

C _ Denotes Construction Limits In Cuts

F _ Denotes Construction Limits In Fills

Note : Figures In brackets and dot - dashed lines
denote Permanent Easements.

Note : Figures In parenthesis and dot - dot - dashed
lines denote Temporary Easements.

×—□—× Denotes Temporary Silt Fence

Denotes Demolition of Pavement

△ Denotes St'd. GR-2 Req'd.

△ Denotes St'd. GR-7 Req'd.

THESE PLANS ARE UNFINISHED
AND UNAPPROVED AND ARE NOT
TO BE USED FOR ANY TYPE
OF CONSTRUCTION OR THE
ACQUISITION OF RIGHT OF WAY.

1:500
METRIC SCALE
0   20 m   40 m

SAMPLE PLAN SHEET (RURAL)

PLAN NO.	PROJECT	FILE NO.	SHEET NO.
A	0132 - 122 - V04		4

SAMPLE PLAN SHEET (RURAL)

Vertical Metric
Scale 1:100

Horizontal Metric
Scale 1:500

DESIGN FEATURES RELATING TO CONSTRUCTION
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NECESSARY BY THE DEPARTMENT

	FRWA DESIGN	STATE	FEDERAL AID PROJECT	ROUTE	STATE PROJECT	SHEET NO.
	3	VA.		132	0132 - 122 - V04, RW-201	4A

BM U.S.C. & G.S. Marker No. U-307
8 m. Rt. Sta. 101+5.000
Elev. 36.550

Begin Entr.
Sta.10+2.000

ENTRANCE
STA.103+750 Lt.

End Entr.
Sta.10+25.000

Existing Grade

Proposed Grade

1.333%

0.600%

C.C. = 50.000 m
V.C. = 220 m
V50:210 km/h
V100 km/h
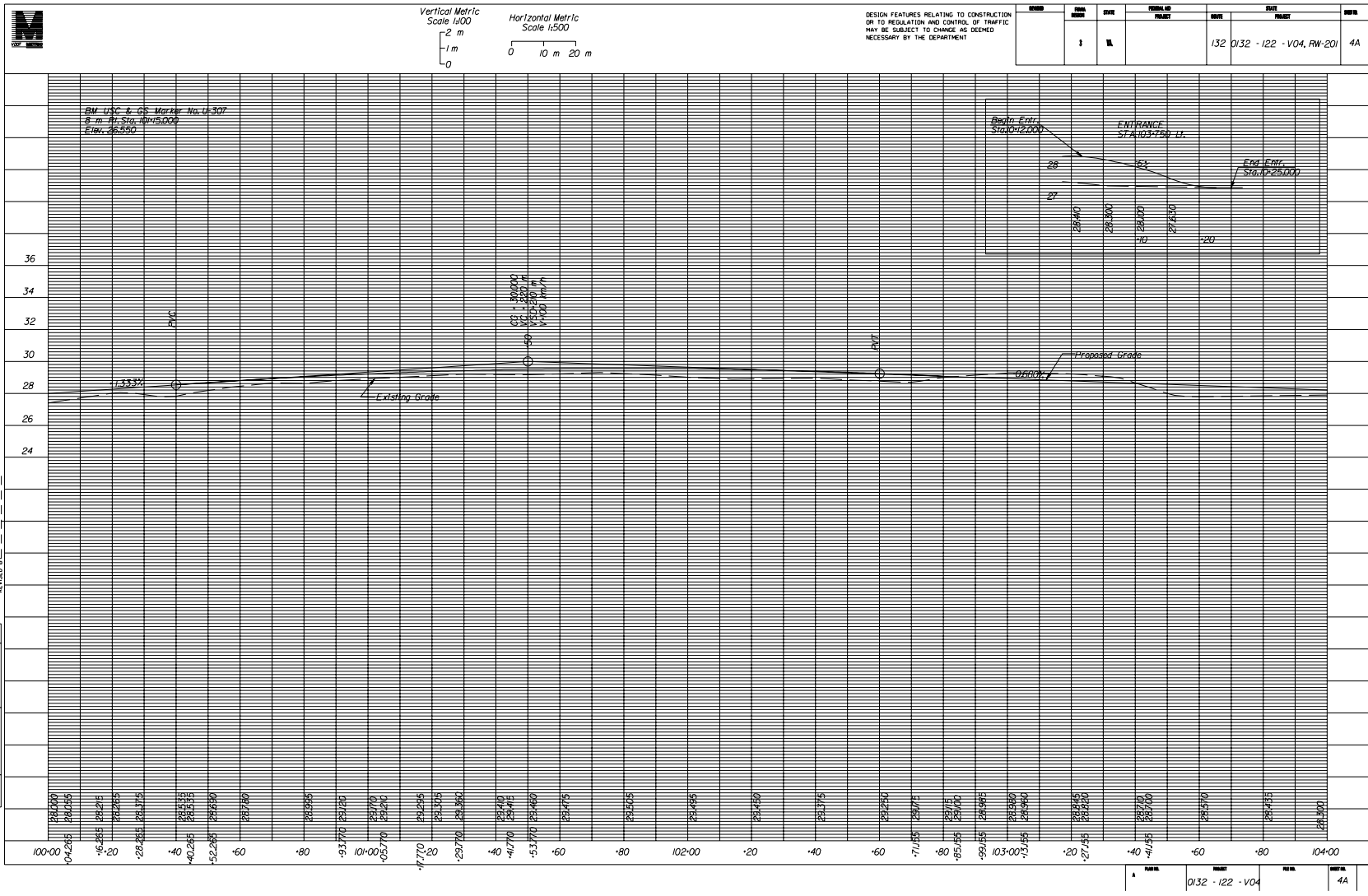
SAMPLE PROFILE SHEET (RURAL)

SUPERVISED BY N.E.Berry (804) 786-6946
DESIGNED BY F.W.Wridge (804) 117-6449
CADD OPERATOR
REVISED BY

0132 - 122 - V04

4A

SAMPLE CROSS SECTION SHEET

DRAINAGE SUMMARY

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT

U000-155-103, RW-201
C-501

SHEET NUMBER	STRUCTURE NUMBER	COVER	\multicolumn{11}{c}{CONCRETE PIPE}	\multicolumn{5}{c}{C. M. PIPE}	\multicolumn{2}{c}{ELLIP. CONC. PIPE}	MINOR STRUCTURE EXCAV.	BEDDING MATERIAL AGGREGATE NUMBER 25 OR 26	\multicolumn{3}{c}{END-SECTIONS}	HEIGHT OF INLETS	\multicolumn{many}{c}{DROP INLETS}	REMARKS

Pipe size columns: 300mm 375mm 450mm 525mm 600mm 750mm 900mm 1200mm 1650mm (Concrete); 300mm 375mm 450mm 600mm 1350mm (C.M.); 1535mm×975mm 1730mm×1095mm (Ellip.)

End-sections: STANDARD ES-I,375mm / STANDARD ES-I,450mm / STANDARD ES-I,900mm

Drop Inlet columns: DI-I, DI-2A, SPECIAL DESIGN DROP INLET, DI-3A, DI-2B (L-2.4m, L-3.6m, L-4.8m), DI-2D, DI-2E (L-2.4m, L-3.0m, L-6.0m), DI-3B (L-1.2m, L-2.4m, L-3.0m, L-3.6m, L-6.0m), DI-3C (L-1.8m, L-6.0m), DI-4A, DI-4AA, DI-4B (L-1.8m, L-4.8m), DI-4BB L-1.8m, DI-4D, DI-4E L-2.4m, DI-7, DI-7A, DI-12 L-1.2m, DI-12C MODIFIED (L-1.2m, L-1.8m), DI-2E L-2.4m, DI-3B L-2.4m, DI-3C L-1.8m, MANHOLE MH-I OR 2, MANHOLE MH-I FRAME & COVER, SPECIAL DESIGN TRENCH INLET (L-6.0m, L-12.0m), EROSION CONTROL STONE CLASS I EC-I, EROSION CONTROL STONE CLASS II EC-I

Sheet	Struct	Cover	(pipe/data)	Remarks
7	7-1	0.6	900mm: 63.5; Bedding: 261; Height inlets: ...	(2) EW-7S ENDWALLS-2:1 SLOPES
7	7-2 to 7-8	0.7	375mm: 10.0; H: 1.3; DI: 1	STANDARD IS-1 REQUIRED
7	7-3 to 7-12	0.5	375mm: 17.5; H: 1.2; DI: 1	
7	7-5	0.3	1.0; ES: 1	
7	7-6 to 7-9	1.0	600mm: 45.0; H: 1.7; DI: 1	IS-1,900mm X 1650mm WYE JOINT
7	7-7 to 7-14	0.6	375mm: 31.0; H: 0.9; ES: 1	
7	7-8		H: 1.2; DI: 1	STANDARD IS-1 REQUIRED
7	7-10 to 7-14	0.3	450mm: 12.5; H: 0.8; DI: 1	STANDARD IS-1 REQUIRED
7	7-11 to 7-12	0.9	525mm: 16.5; H: 1.3; DI: 1	STANDARD IS-1 REQUIRED
7	7-12 to 7-4	1.0	600mm: 5.0; H: 1.5; DI: 1	STANDARD IS-1 REQUIRED
7	7-13 to 7-10	0.4	300mm: 2.5; ES: 1; EC: 2	
7	7-14 to 7-11	0.5	375mm: 14.0; H: 1.1; DI: 1	STANDARD IS-1 REQUIRED
7	7-8 to 7-11	0.6	375mm: 19.5	
7	7-15			SEE S.M.W. SUMMARY

	SHEET 2V SUBTOTAL		195.0 140.5 123.0 28.0	292.5	10.5 12.0 7.0	5.0 47.5 59.0 2457	252	1 ...	
	SHEET 2W SUBTOTAL	8.5	394.0 88.5 42.5 35.0 323.5	49.0	1.0	10.0 360	150	...	
	SHEET 2X SUBTOTAL		107.0 21.5	46.0	63.5	261	...	
	TOTAL	8.5	696.0 250.5 123.0 70.5 35.0 369.5 341.5 63.5	0.5 12.0 7.0 1.0	5.0 57.5 59.0 3078	372	2 1 1 7 1 1 6 1 1 2 4 5 7 3 3 1 1 2 2 3 1 2 2 7 1 1 18.3 10 2 1 63 54	

STORMWATER MANAGEMENT CONTROL SUMMARY

LOCATION		HEIGHT OF COVER	600 mm CONC. PIPE	SWM BASIN EXCAVATION	SWM DRAINAGE STRUCTURE SWM-I	SWM RISER PIPE 1200 mm	SWM DAM CONC. CLASS A-3 MISC.	REINF. STEEL	REMARKS
SHEET NO.	STRUCT. NO.	m	m	m³		m	m³	kg	
7									
	7-15	0.5	5.0	——	——	1.0	——	——	SEE SHEET 20 FOR ADDITIONAL DETAILS

⊗ Denotes Items to be paid for on basis Of Plan Quantities In accordance with current Road And Bridge Specifications.

129.5 m TRIPLE 1.52 m X 1.22 m BOX CULVERT SUMMARY
STRUCTURE 3-23 & 3-14, 3B-2
PROJECT U000-155-103
SEE SHEETS 12 (1 THRU 4) FOR DETAILS

CONCRETE CLASS 30 BOX CULVERT	⊗	m³	471.5
EPOXY COATED REINFORCING STEEL	⊗	kg	45,414
MINOR STRUCTURE EXCAVATION BOX CULVERT	⊗	m³	1,055
BEDDING MATERIAL AGGREGATE NUMBER 25 OR 26	⊗	Metric Tons	303

UNDERDRAIN SUMMARY

STATION	CD-1	CD-2
	m	m
11+40 LT.	12	
11+55 RT.	17	
18+45 LT.	12	
19+40 RT.	12	
26+30	24	
40+30		16
TOTAL	77	16

SAMPLE

U000-155-103

SAMPLE DRAINAGE SUMMARY SHEET

#REF00I #REF002 #REF003 #REF004 #REF005 #REF006
#DGR## #LEV00I #LEV002 #LEV003 #LEV004 #LEV005 #LEV006
#DGRLEV

DESIGN FEATURES RELATING TO CONSTRUCTION
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NECESSARY BY THE DEPARTMENT

U000-155-103, RW-201
C-501 | 2Z

Depot Street Extension

PAVEMENT SUMMARY

LOCATION	STATION FROM	STATION TO	PAVEMENT AREA m²	SURFACE ASPHALT CONCRETE TYPE SM-2B @ 100 kg PER m² METRIC TONS	BASE ASPHALT CONCRETE TYPE BM-2 100 mm DEPTH METRIC TONS	BASE 150 mm DEPTH METRIC TONS	BASE 250 mm DEPTH METRIC TONS	SUBBASE AGGREGATE BASE MATERIAL TYPE I NO. 21B 100 mm DEPTH METRIC TONS	SUBBASE 200 mm DEPTH METRIC TONS	RESURFACING ASPHALT CONCRETE TYPE SM-2B @ 100 kg/m² VARIABLE DEPTH METRIC TONS	ASPHALT CONCRETE SURFACE COURSE TYPE SM-2B @ 120 kg/m² METRIC TONS	ASPHALT CONCRETE SURFACE COURSE TYPE SM-2B @ 100 kg/m² METRIC TONS	ASPHALT CONCRETE BASE COURSE TYPE BM-2 100 mm DEPTH METRIC TONS	⊗ CONCRETE ENTRANCE PAVEMENT 175 mm m²	ENTRANCES AGGREGATE BASE MATERIAL TYPE I NO. 21B 100 mm DEPTH METRIC TONS	ENTRANCES 150 mm DEPTH METRIC TONS	CRUSHER RUN AGGREGATE NUMBER 25 OR 26 METRIC TONS	CRUSHER RUN AGGREGATE NUMBER 25 OR 26 PE-1 METRIC TONS	⊗ FLEXIBLE PAVEMENT PLANING m²
DEPOT ST. EXT.	10+45.760	21+39.543	17,308	1,549			10,892	5,795												
FRANKLIN STREET	17+05.000	20+99.725	1,068	95			671	473												
RADFORD STREET	57+11.000	60+88.657	6,231	538			3,921	2,064												
COLLEGE ST.(N)	10+24.000	10+39.541	233	21	58				124											
BETTY DRIVE	10+34.100	10+54.196	217	19	54				115											
NEW STREET	10+24.280	10+50.410	233	21	58				122											
SHELTMAN ST.	10+23.480	10+49.855	245	22	62				128											
SULLIVAN ST.	10+04.220	10+49.573	398	35	100				209											
BRACKENS ST.	10+18.360	10+51.786	293	26	73				100											
SCHOOL ENTR.	10+50.930	10+90.272	414	37	104				217											
TAYLOR ST.	10+30.240	10+81.987	394	35	99				126											
JAMES ST.	10+26.410	10+48.848	232	22	60				110											
LEE-HY COURT DR.	10+22.960	10+42.482	198	18	50				168											
HILLCREST DR.	10+02.990	10+40.181	316	28	80				282											
COLLEGE ST.(S) LT.SIDE	37+00.000	37+55.956	516	46	130				269											
CHERRY LANE	9+90.330	10+54.248	495	44	124				282											
COLLEGE ST.(S) RT.SIDE	39+63.390	40+09.300	504	45	126				206											
MAIN ST.(RTE 8)			1,570							141										1,087
ENTRANCES											20	104	297	226	21	489	205	39	
MAINTENANCE of TRAFFIC						476										907			
PARKING LOT (023)												83	61		337				
TOTAL			2,631	1,178	476	15,484	8,332	2,458	141	20	187	358	226	21	826	1,112	39	1,087	

INCIDENTAL SUMMARY

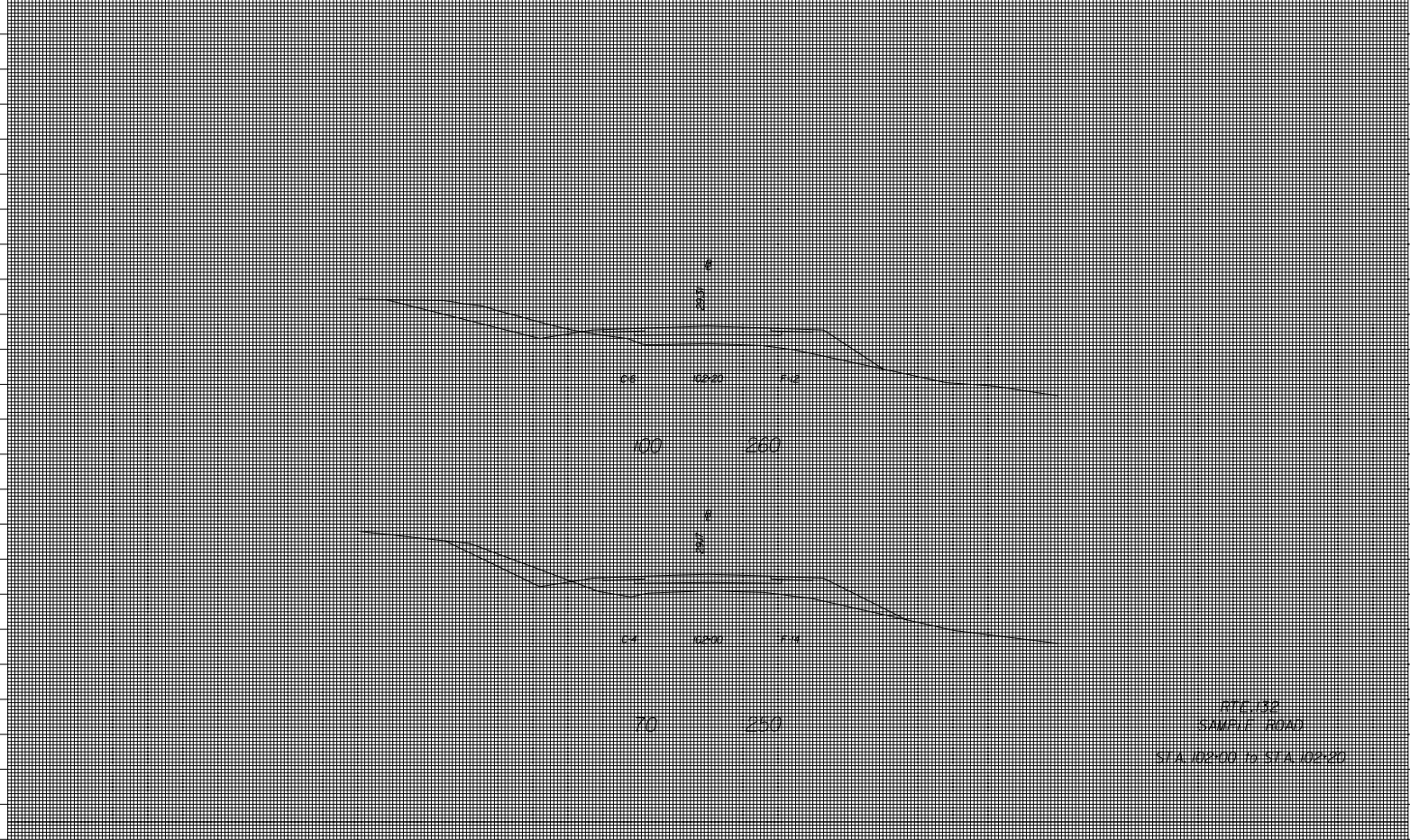| SHEET NO.	COMBINATION CURB & GUTTER CG-6 STANDARD m	COMBINATION CURB & GUTTER RADIAL m	CURB CG-2 STANDARD m	CURB CG-2 RADIAL m	ENTRANCE GUTTER CG-9D m²	ENTRANCE GUTTER CG-13 m²	EXPOSED AGGREGATE SIDEWALK 100 mm m²	HYDRAULIC CEMENT CONCRETE SIDEWALK 175 mm m²	GUARDRAIL GR-2 STANDARD m	GUARDRAIL GR-2 RADIAL m	GUARDRAIL TERMINAL GR-T m	FIXED OBJECT ATTACHMENT GR-FOA-2 TYPE I EA.	R/W MONUMENT RM-1 EA.	DEMOLITION OF PAVEMENT UNIT	OBSCURING ROADWAY	REMOVE EXISTING BOX CULVERT 65 m OF 1.52 m X 1.68 m BOX CULVERT STATION 11+50 DEPOT ST. L.S.	STRUCTURE TO BE REMOVED EXISTING BRIDGE STATION 19+20 FRANKLIN L.S.	STRUCTURE TO BE REMOVED EXISTING BRIDGE STATION 29+30 FRANKLIN L.S.	REMOVE EXISTING GUARDRAIL m	REMOVE EXISTING DROP INLET EA.	ADJUST EXISTING MANHOLE EA.	PIPE PLUGGING CONC. CLASS 20 MISC. m³	STEPS CONCRETE CLASS 20 MISC. m³	STEPS REINFORCING STEEL kg	HANDRAIL HR-1 m	POROUS BACKFILL m³	CONC. RETAINING WALL RETAINING WALL EXCAVATION m³	CONC. RETAINING WALL BEDDING MAT'L AGGREGATE NO.25 OR 26 METRIC TON	CONC. RETAINING WALL RETAINING WALL RW-3 m³	PAVED DITCH PG-2A m²	PG-5 m²	PAVED FLUME PG-4 m²	DRY RIP-RAP CLASS I 450 mm METRIC TON	FENCE FE-CL m	CORNER BRACE UNIT FE-CL EA.	MOBILIZATION L.S.	CONSTRUCTION SURVEYING L.S.	DIRECTIONAL ISLAND CURB SI-3 m	CLEARING AND GRUBBING L.S.	FIELD OFFICE TYPE II No.	ALLAYING DUST Hr.	GROUP 2 CHANNELIZING DEVICES Day	ELECTRONIC ARROW Hr.	FLAGGER SERVICE Hr.	WARNING LIGHT TYPE A Day	TRAFFIC BARRIER SERVICE CONCRETE m
3	200	99		11	63	181	13	33	542					18	2,419	1				12	4					1.1						23														
3B	79	4			130		3		141					2			1	1																												
3C	97				53		8		175					2																																
4	262	58	2	19	250	186	9	51	756					12	2,903								0.9	0.9	2							23															
5	354	98	15		108	93	13	14	1,024					12	3,523	1							0.4	0.5	2							31		3													
6	462	172	3		130		29		1,341					27	4,076	1							2.9	104	8	1	18	5	13																		
6B	203	16	6		36		5		449					7	1,562							1	1.0		4																						
6C	53	50		3	95	122	8	28	187					13	1,759								0.5	0.9	4							19															
7	287	36			17		7		678	88	9	2	1	17	408	1														58	91	4					37									
8	86	57					7		191					10	418								0.8	29	5																						
1G, 1H															1,263																															100
TOTAL	2,083	590	26	33	882	582	102	126	5,484	88	9	2	1	120	18,331	2	L.S.	L.S.	L.S.	12	4	1	2.9	7.0	133	25	1	18	5	13	54	19	3	58	91	4	L.S.	L.S.	37	L.S.	No.	1,500	18,500	500	2,500	4,000	100

⊗ Denotes items to be paid for on basis of plan quantities
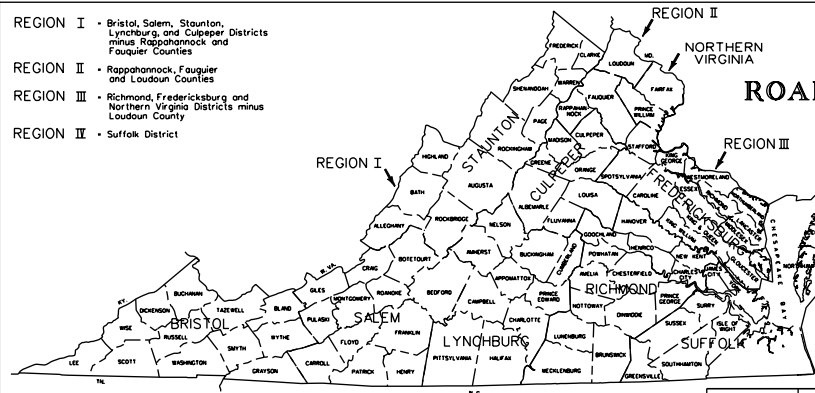in accordance with current Road & Bridge Specifications.

SURVEYED BY
SUPERVISED BY
DESIGNED BY
CADD OPERATOR
REVISED BY

	U000-155-103		2Z

SAMPLE PAVEMENT AND INCIDENTAL SUMMARY

ROADSIDE DEVELOPMENT

REGION I · Bristol, Salem, Staunton, Lynchburg, and Culpeper Districts minus Rappahannock and Fauquier Counties

REGION II · Rappahannock, Fauquier and Loudoun Counties

REGION III · Richmond, Fredericksburg and Northern Virginia Districts minus Loudoun County

REGION IV · Suffolk District

REGION II
NORTHERN VIRGINIA

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT

SECTION OF SEED LOCATIONS

NOTES

Approximately _____ hectares will be disturbed on this project and will require the establishment of grasses and / or legumes.

⚘ NOTES FOR FIELD USE ONLY

Supplemental seeding consists of overseeding or regular seeding as determined by the Engineer.

Overseeding rates shall be 50% of the seed mixture specified and fertilizer rates shall be 33% of the rates specified.

The Engineer will require the Contractor to perform supplemental seeding when less than 75 percent uniform stand of the permanent grass specified in the mixture is obtained. (Annual species such as, Rye and Millet are temporary varieties and require supplemental seeding.)

Tall and Fine Fescue shall not be used in Loudoun, Fauquier and Rappahannock Counties. (Mix 4 only) Orchard Grass mixture shall be used for these counties. Type II mulch only.

NOTES APPLY TO SCHEDULE

Legume seed mixes (Crown Vetch and Sericea Lespedeza) and weeping Lovegrass shall not be used on shoulders and other locations flatter than 3:1 slope.

A temporary mix or erosion control mulch, as directed by the Engineer, is to be used only on areas that are to be regraded or later disturbed, if left dormant for more than 30 days, between March 1 and November 30.

Spring and Fall defined for the purpose of determining whether hulled or unhulled Bermuda and Sericea Lespedeza seed is required:

Spring - May 1 - Sept. 30
Fall - Oct. 1 - Apr. 30

Type I mulch (Straw or Hay) to be used on newly seeded areas adjacent to all waterways, wetlands, swamps, or any area in which drainage flows toward areas under the jurisdiction of the environmental regulatory agencies.

Type I mulch shall be applied at 4.5 metric tons per hectare to provide a minimum 90% coverage.

Type I mulch shall be tacked with Fiber mulch at the rate of 840 kg per hectare.

Type II mulch (Fiber mulch) may be substituted for Type I mulch at the recommendation of the District Environmental Manager.

Type II mulch shall be applied at a rate of 2000 kg (net dry weight) per hectare.

Erosion Control Mulch, as listed on the VDOT Approved Products List, shall be applied in accordance with the manufactures' recommendations.

Erosion control mulch shall provide 100% coverage of all denuded areas.

All topsoil is to be free of hard lumps, clods, rocks and foreign debris and is to be hand raked to tie into existing lawns.

All seed must be in conformance with VDOT seed specifications for Grasses & Legumes and be provided at the project site in bags not opened and labled for use on VDOT projects with a green tag certifying inspection by the Virginia Crop Improvement Association.

CORE MIX

MIX	MINIMUM kg/hectare	DESCRIPTION
1	115	100% CERTIFIED FINE FESCUE
2	115	100% CERTIFIED TALL FESCUE
3	60	50% CERTIFIED TALL FESCUE
	60	50% CERTIFIED FINE FESCUE
4	60	50% ORCHARD GRASS
	60	50% CERTIFIED KENTUCKY BLUEGRASS
5	60	100% BERMUDA GRASS
TEMPORARY		
3/1 - 5/16 and	60	50% CERTIFIED TALL FESCUE
8/16 - 3/1	60	50% WHEAT, BARLEY OR RYE
5/16 - 8/16	60	50% FOXTAIL MILLET
	60	50% CERTIFIED TALL FESCUE

ADDITIVES

TYPE	MINIMUM kg/hectare	DESCRIPTION
A	2	100% LOVE GRASS OR
	10	100% FOXTAIL MILLET
B	25	100% RYE GRAIN, WHEAT OR BARLEY
C	25	100% CROWN VETCH
D	25	100% SERICEA LESPEDEZA
E	10	100% FOXTAIL MILLET OR
	10	100% ANNUAL RYEGRASS

SEEDING SCHEDULE

REGIONS	SLOPES SEED MIX WITH ADDITIVE	MOWED SEED MIX WITH ADDITIVE	SLOPES SEED MIX WITH ADDITIVE	MOWED SEED MIX WITH ADDITIVE	SLOPES SEED MIX WITH ADDITIVE	MOWED SEED MIX WITH ADDITIVE
I	2, 3, 4 B, C, D	1, 2, 3, 4 B	2, 3, 4 A, C	1, 2, 3, 4 A, E	2, 3, 4 B, C, D	1, 2, 3, 4 B
II	4 B, C	4 B	4 A, C	4 E	4 B, C	4 B
III	2, 3 B, C	2, 3 B	2, 3 A, C, D	2, 3 E	2, 3 B, D	2, 3 B
IV	2, 5 B, C, D	2, 5 B	2, 5 A, C, D	2, 5 E	2, 5 B, C, D	2, 5 B

REGIONS	SPRING & FALL MONTH & DATE	SUMMER MONTH & DATE	LATE FALL & WINTER MONTH & DATE
I	4/1 - 6/15 8/1 - 9/30	6/16 - 7/31	10/1 - 3/31
II	3/1 - 5/15 8/1 - 9/30	5/16 - 7/31	10/1 - 2/29
III, IV	3/1 - 4/30 8/1 - 10/31	5/1 - 7/31	11/1 - 2/29

MIX REQUIREMENTS THIS PROJECT

SEED MIXTURE RECOMMENDATIONS MAY AT TIMES DEVIATE FROM THE SEED MIXTURE GUIDELINES ON THE ROADSIDE DEVELOPMENT SHEET. RECOMMENDATIONS FOR THE APPLICATION OF SEED MIXTURES (CORE MIX AND ADDITIVES), FERTILIZER, LIME, ETC. ARE TO BE OBTAINED FROM THE DISTRICT ENVIRONMENTAL MANAGER ON FORM RD-100.

PROJECT NUMBERS				

EROSION & SEDIMENT CONTROL SUMMARY

PROJECT NUMBERS	SLOPE DRAINS	Erosion Control Stone EC-1 Class I	DEWATERING BASIN	SILTATION CONTROL EXCAVATION	TEMPORARY FILTER BARRIER	FILTER CLOTH DRAIN FABRIC TYPE I	CONSTR. ENTRANCE	TEMP. SILT FENCE	CHECK DAM TY. I	CHECK DAM TY. II	TEMPORARY SEDIMENT BASIN EXCAVATION	TEMP. SEDIMENT RISER PIPE (____ mm)	TURBIDITY CURTAIN		EROSION CONTROL MULCH
													PERVIOUS	IMPERVIOUS	
	EACH	METRIC TONS	EACH	m³	m	m²	NUMBER⊕	m	EACH	EACH	m³	m	m	m	m²

NOTE: THIS IS A SAMPLE INSERTABLE SHEET. FOR A MORE LEGIBLE AND CURRENT VERSION, ACCESS THE CADD INSERTABLE SHEET DIRECTORY.

ROADSIDE DEVELOPMENT SUMMARY

PROJECT NUMBERS	⊗ TOPSOIL 50 mm CLASS A I B	REGULAR SEED	OVER SEEDING	LIME	FERT. 15-30-15	LEGUME SEED	LEGUME OVER SEEDING
	hectares	kg	kg	metric tons	metric tons	kg	kg

⊕ NOT A PAY ITEM. COST TO BE INCLUDED IN OTHER PAY ITEMS.

⊗ DENOTES ITEM(S) TO BE PAID FOR ON BASIS OF PLAN QUANTITIES IN ACCORDANCE WITH CURRENT ROAD AND BRIDGE SPECIFICATIONS.

Rev. 2/97

UNLESS OTHERWISE NOTED, ALL DIMENSIONS ON THIS SHEET ARE IN MILLIMETERS | SPECIAL DESIGN SECTION DRAWING NO. A 4

SURVEYED BY:
SUPERVISED BY:
DESIGNED BY:
CADD OPERATOR:
REVISED BY:

SAMPLE ROADSIDE DEVELOPMENT SHEET