APPENDIX A

Metric Practice

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METRIC PRACTICE

GENERAL

This Appendix was originally included in the Metric PPM and was used as guidelines for the development of Metric plans. This was a useful tool especially for the English to Metric conversion of design information. This Appendix has now been included in the English PPM as a tool for use in cases where the designer may need to obtain information from Metric plans. This may provide the designer some insight as to how those Metric plans were developed.

SUMMARY OF RULES

1. Convert values related to surveys, right of way and other geometric alignment using the U. S. Survey Foot taken to a minimum of 8 decimal places:

$$1 \text{ foot} = \frac{12 \text{ inches/foot}}{39.37 \text{ inches/meter}} = 0.304\ 800\ 61 \text{ meters}$$

   For other direct mathematical conversions use the SI definition:

   1 foot = 0.3048 meters

2. Display direct mathematical (soft) converted values to the nearest 0.001 m or 1 mm.

3. Do not use commas to separate digits if a number has more than 4 digits. For numbers with more than 4 digits either right or left of the decimal, leave a space when practical. (Where the displayed number must be used in a mathematical operation on a computer the space may not be recognized properly and should not be used).

   Example: 10 000 or 0.609 35 or 13 471.359

4. To the extent practical, use the following rules for dimensioning roadway plans:

   a. For dimensions in meters, display values to at least one decimal place.

b. For dimensions in millimeters, display values as whole numbers with no decimal place.

c. Do not use the centimeter.

d. Using the above rules, do not show the unit symbols "m" and "mm" unless needed for clarification. Show even dimensions in meters with a decimal and following zero digit, e.g. 300.0 to avoid confusion with 300 mm.

5. If a dimensioned item has a numerical quantity that is part of a group of numbers in a different range, select the unit that most adequately covers the range without unduly large or small numbers. For example, if 300 mm is part of a group of numbers shown in meters, show it as 0.3 m.

6. Show long dimensions, including all horizontal and vertical geometry, wall lengths, bridge span lengths and box or three sided culvert lengths, spans and heights in meters.

7. In general, show cross section dimensions of structural members in millimeters. This will normally include most drainage structures (except box culverts), drainage pipe, and special drainage structure details. (Note: The actual size of drainage pipe and standard drainage structure boxes will remain the same. However, label these items in nominal size based on 1" = 25 mm. Example: Label 24" pipe as 600 mm pipe; Label a 4' diameter structure as a 1200 mm structure.)

8. Show pavement thickness descriptions in millimeters.

9. Use 0.1 m for both base extension on rural sections (formerly 3") and for stabilization extension on curbed sections (formerly 6").

10. On typical sections, show type of curb, "E" or "F", not the dimension.

11. As a general rule, display metric dimensions to one more decimal place than the corresponding dimension in English units:

a. Typical Section Elements, including lane widths and shoulder widths - in meters, generally to 1 decimal place.

b. Horizontal control points on plans, including survey centerline, baseline, intersections and alignment - in meters to 3 decimal places. The normal station interval for centerlines and baselines is 100 meters. (1 + 00.000 = 100 m)

c. Vertical alignment control points, (PVC, PVI, PVT) and profile grade elevations - in meters to 3 decimal places.

d. Profile Grade - in percent to 4 decimal places.

e. Proposed flow lines - in meters to 2 decimal places.

f. Manhole tops and grate elevations - in meters to 2 decimal places.

g. Ditch elevations - in meters to 2 decimal places.

h. Box Culvert or Three-sided Spans and Heights - in meters to 1 decimal for new construction; in meters to 2 decimal places for extensions of existing box culverts originally constructed to English dimensions.

12. Where practical, round short radius curves (<150.0 m), including curb returns and control radii, to the nearest meter. Round longer radius curves to the nearest 5 meters. (See attached tables.)

13. Display alignment bearings and delta angles in curve data in degrees, minutes and seconds, rounded to the nearest second.

14. Omit "degree of curvature" from curve data. It has no definition in the metric system. Instead, use the radius definition. Equations:

$$\text{Tangent } T = R \tan\left(\frac{\Delta}{2}\right)$$

$$\text{Length } T = R \ (\Delta \text{ in Radians})$$

$$\text{Long Chord } LC = 2R \sin\left(\frac{\Delta}{2}\right)$$

15. On resurfacing projects, hard convert typical section dimensions (lane widths, shoulder widths, etc.) where existing conditions permit. Exception: Use direct mathematical (soft) conversion (Rule Number 2) for existing pavement widths in curbed sections, existing right of way widths, and existing median widths.

16. Continue to post sign messages for speed limits and distances in English units. Note: The posted speed for curb and gutter sections with design speed of 80 km/h (corresponds to 50 mph), should not exceed 45 mph.

17. A "hard" metric project is defined as one where metric standard index drawings and metric specifications are used, and the design complies with adopted metric criteria.

18. Beginning with metric projects express slope ratios in vertical to horizontal (V:H) format. For example, show roadside slopes as 1:6, 1:4, rather than past convention as 6:1 or 4:1.

19. As a general guideline for new construction and reconstruction, show cross sections in 20 meter intervals for urban projects and 50 meter intervals for rural projects. Project specific factors may dictate greater or lesser intervals.

20. When project limits are identified by kilometer point location on the Key Sheet, show the equivalent milepost using direct mathematical conversion.

(example: kp 1.609 = MP 1.000)

21. Label existing and proposed utilities in metric. Use the FDOT Basis of Estimates Handbook utility pay item list of metric sizes as a guide.

PLAN SCALES

ENGLISH SCALE	METRIC SCALE
1" = 2'	1: 25
1" = 5'	1: 50
1" = 10'	1: 100
1" = 20'	1: 200
1" = 40'	1: 400 or 1: 500
1" = 50'	1: 500
1" = 100'	1: 1000
1" = 200'	1: 2000
1" = 400'	1: 5000

Plan sheet size will remain the same. The viewing area of a plan sheet will be 800 mm long on "D" size sheets and 400 mm on "B" size sheets. Allowing for open space at each side, this provides a coverage of 140 m at 1:400 scale, 350 m at 1:1000 and 700 m at 1:2000 on "B" size sheets.

Plan/ Profiles:

	Sheet Size	Horizontal	Vertical
Rural -	D	1:1000	1:50 or 1:100
	B	1:2000	1:100 or 1:200
Urban -	D	1:200	1:50
	B	1:400 or 1:500	1:50 or 1:100

Show centerline major tick marks at each station. Show centerline minor tick marks at 20 meter intervals when using 1:200 and 1:400 scale, and at 25 meter intervals when using 1:500 scale.

Cross Sections:

	Sheet Size	Horizontal	Vertical
Normal	D	1:50	1:25
	B	1:100	1:50
Wide Sections	D	1:100	1:25 or 1:50
	B	1:200	1:50 or 1:100
Narrow Sections	D	1:25	1:25
	B	1:50	1:50

As a guideline, the normal interval for cross sections is 20 meters for urban projects and 50 meters for rural projects.

COMPARISON OF ENGLISH AND METRIC VALUES

LANE WIDTHS

CURRENT	SOFT	HARD
8 ft	2.438 m	2.4 m
9 ft	2.743 m	2.7 m
10 ft	3.048 m	3.0 m
11 ft	3.353 m	3.3. m
12 ft	3.658 m	3.6 m
14 ft	4.267 m	4.2 m
15 ft	4.572 m	4.5 m

BIKE LANE WIDTHS

4 ft	1.219 m	1.2 m
5 ft	1.524 m	1.5 m

SIDEWALK AND UTILITY STRIP WIDTHS

CURRENT	SOFT	HARD
2 ft	0.610 m	0.6 m
3 ft	0.914 m	0.9 m
4 ft	1.219 m	1.2 m
5 ft	1.524 m	1.5 m
6 ft	1.829 m	1.8 m
7 ft	2.134 m	2.1 m
8 ft	2.438 m	2.4 m
9 ft	2.743 m	2.7 m
10 ft	3.048 m	3.0 m

CURB AND GUTTER WIDTHS

TYPE	CURRENT	SOFT	HARD
E	2.25 ft	686 mm	675 mm
F	2.00 ft	610 mm	600 mm
Shoulder Gutter	3.50	1067 mm	1050 mm

SHOULDER WIDTHS

CURRENT	SOFT	HARD
2 ft	0.610 m	0.6 m
4 ft	1.219 m	1.2 m
5 ft	1.524 m	1.5 m
6 ft	1.829 m	1.8 m
8 ft	2.438 m	2.4 m
10 ft	3.048 m	3.0 m
12 ft	3.658 m	3.6 m

COMPARISON OF ENGLISH AND METRIC VALUES

TRAFFIC SEPARATOR WIDTHS

CURRENT	SOFT	HARD
4 ft	1.219 m	1.2 m
6 ft	1.829 m	1.8 m
8.5 ft	2.591 m	2.6 m

MEDIAN WIDTHS

CURRENT	SOFT	HARD
15.5 ft	4.724 m	5.0 m
17.5 ft	5.334 m	N/A
19.5 ft	5.944 m	6.0 m
22 ft	6.706 m	6.6 m
26 ft	7.925 m	7.8 m
30 ft	9.144 m	9.0 m
40 ft	12.192 m	12.0 m
50 ft	15.240 m	15.0 m
60 ft	18.288 m	18.0 m
64 ft	19.507 m	19.2 m
88 ft	26.822 m	26.4 m

DITCH WIDTHS

CURRENT	SOFT	HARD
3 ft	0.914 m	0.9 m
3.5 ft	1.067 m	1.0 m
4 ft	1.219 m	1.2 m
5 ft	1.524 m	1.5 m

DESIGN SPEED

CURRENT	METRIC	
20	30	
25	40	
30	50	
35	60	low speed
40	60	
45	70	⇧
50	80	⇩
55	90	
60	100	high speed
65	110	
70	110	

METRIC CONVERSIONS

RETURN RADII
CONTROL RADII
SHORT RADIUS CURVE RADII

TURNING SPEED mph	RADIUS (feet)	SOFT (meters)	HARD (meters)	TURNING SPEED km/h	RADIUS (meters)
	15	4.572	5.0		
	20	6.096	6.0		
10	25	7.620	8.0	15	7.0
	30	9.144	9.0	20	10.0
	35	10.668	11.0		
	40	12.192	12.0		
	45	13.716	14.0		
15	50	15.240	15.0		
	60	18.288	18.0		
	75	22.860	23.0		
20	90	27.432	27.0	30	25.0
	100	30.480	30.0		
25	150	45.720	46.0	40	50.0
30	230	70.104	70.0	50	80.0
35	310	94.488	94.0	60	115.0 Small
40	430	131.064	131.0	60	115.0 Radii ⇑
	550	167.640	170.0		⇓
	690	210.312	210.0		Large
	840	256.032	255.0		Radii
	1040	316.992	315.0		

Note: Selection of appropriate radii should also consider design vehicle.

Conversions on this sheet and the next are accomplished as follows:

1. Radius in feet x (12 ÷ 39.37) = radius in meters (soft)

2. Values for metric turning speeds based on proposed AASHTO metric criteria.

COMPARISON OF ENGLISH AND METRIC VALUES

DEGREE OF CURVE TO RADIUS VALUES			
DEGREE	**RADIUS**	**RADIUS-Soft (meters)**	**RADIUS-Hard (meters)**
0°-15'	22918.31	6985.515	6985.0
0°-30'	11459.16	3492.758	3495.0
0°-45'	7639.44	2328.505	2330.0
1°-00'	5729.58	1746.379	1745.0
1°-15'	4583.66	1397.103	1395.0
1°-30'	3819.72	1164.253	1165.0
1°-45'	3274.04	997.931	1000.0
2°-00'	2864.79	873.189	875.0
2°-15'	2546.48	776.168	775.0
2°-30'	2291.83	698.552	700.0
2°-45'	2083.48	635.047	635.0
3°-00'	1909.86	582.126	580.0
3°-15'	1762.95	537.347	535.0
3°-30'	1637.02	498.965	500.0
3°-45'	1527.89	465.701	465.0
4°-00'	1432.39	436.595	435.0
4°-15'	1348.14	410.913	410.0
4°-30'	1273.24	388.084	390.0
4°-45'	1206.23	367.659	370.0
5°-00'	1145.92	349.276	350.0
5°-30'	1041.74	317.523	320.0
6°-00'	954.93	291.063	290.0
7°-00'	818.51	249.483	250.0
8°-00'	716.20	218.297	220.0
9°-00'	636.62	194.042	195.0
10°-00'	572.96	174.638	175.0

Note: Degree of Curvature is not used in the Metric System.

GENERAL METRIC INFORMATION

SI PREFIXES

M mega 10^{6} = 1 000 000
k kilo 10^{3} = 1 000
m milli 10^{-3} = 0.001

Base SI Units			Related Units		
Quantity	**Unit**	**Symbol**	**Unit**	**Symbol**	**Relation**
length	meter	m	millimeter	mm	=0.001 m (10^{-3} m)
			kilometer	km	=1000 m (10^{3} m)
mass	kilogram	kg	gram	g	=0.001kg (10^{-3} kg)
			megagram	Mg	=1000 kg (10^{3} kg)
			metric ton	t	=1000 kg (10^{3} kg)
time	second	s	hour	h	=3600 s

DERIVED SI UNITS WITH SPECIAL NAMES

Quantity	Unit	Symbol	Formula
force	newton	N	$kg \cdot m/s^2$
pressure	pascal	Pa	N/m^2
moment	newton meter	N·m	N·m
Temperature	degree Celsius	°C	---

GENERAL METRIC INFORMATION

Common Derived Units of SI			Related Units			
Quantity	**Unit**	**Symbol**	**Unit**	**Symbol**	**Relation**	
acceleration	meter/second ^{2}	m/s^2				
area	square meter	m^2	sq. millimeter	m m^2	$=0.000\ 001\ m^2$	$(10^{-6} m^2)$
			hectare	ha	$=10\ 000\ m^2$	$(10^{4} m^2)$
			sq. Kilometer	k m^2	$=1\ 000\ 000\ m^2$	$(10^{6} m^2)$
density, mass	kilogram/cubic	kg/m^3				
velocity	meter/second	m/s	kilometer/hour	km/h	=0.2778 m/s	
volume	cubic meter	m^3	liter	L	$=0.001\ m^3$	$(10^{-3} m^3)$
			milliliter	mL	$-0.000\ 001\ m^2$	$(10^{-6} m^3)$

GENERAL METRIC INFORMATION

SOFT CONVERSION FACTORS

CLASS	MULTIPLY	BY	TO GET
LENGTH	inches	25.400 000	mm
	inches	0.025 400	m
	feet	0.304 800 **	m
	yards	0.914 400	m
	miles	1609.344 000	m
	miles	1.609 344	km
AREA	sq inches	645.160 000	mm^2
	sq feet	0.092 903	m^2
	sq yard	0.836 127	m^2
	acres	4046.873 000	m^2
	sq miles	2.589 988	km^2
VOLUME	board feet	0.002 360	m^3
	cubic feet	0.028 317	m^3
	cubic yard	0.764 555	m^3
	gallon (fluid)	3.785 412	L
	ounce (fluid)	29.573 530	ML
	bushels	0.035 239	m^3
MASS	ounce	0.028 350	kg
	pound	0.453 592	kg
	ton	907.184 700	kg
	lb/ft	1.488 164	kg/m
	lb/ft^2	4.882 425	kg/m^2
	lb/ft^3	16.018 460	kg/m^3
	$ounces/ft^2$	0.305 152	kg/m^2
FORCE	pound (force)	4.448 222	N
	lb/ft	14.593 900	N/m
	lb/ft^2	47.880 260	N/m^2
	lb/ft^3	157.087 5	n/m^3
STRESS	psi	6894.757 000	Pa
	$kips/in^2$	6.894 757	N/mm^2
VELOCITY	fps	0.304 800	m/s
	mph	0.447 040	m/s
	mph	1.609 344	km/h
TEMPERATURE	(°F-32) / 1.8 = °C		
ANGLES	(no change)	deg, min, sec	

** For conversion from U.S. Geodetic Survey, the U.S. survey foot equals 0.304 800 610 m