

NDOT required metric conversions to be in accordance with the International System of Units (SI) as published by ASTM 380, unless modified by this document.

Hydraulics

The following list provides relevant physical constants and expressions for drainage applications.

Manning's equation (SI): $V = 1/n (R^{2/3} S_f^{1/2})$

where: V = Velocity, m/s;
 R = Hydraulic radius, m;
 S_f = Longitudinal friction slope, m/m;
 n = Manning's roughness coefficient, dimensionless.

Rational formula (SI): $Q = KCiA$

where: Q = Flow, m³/s;
 i = Rainfall intensity, mm/h;
 A = Drainage area, hectares;
 K = Coefficient, 1/360;
 C = Runoff coefficient, dimensionless.

Acceleration due to gravity (SI): $g = 9.81 \text{ m/s}^2$

Pipe/Conduit

Steel pipe and copper tube sizes will not change by switching to the metric system. American sizes are used in many parts of the world. Initially, they are simply classified by the nominal mm size, but in the future, hard metric pipe metric pipe sizes will probably be utilized.

ASTM B88M, which gives standardized hard metric copper tube sizes, will not be utilized until ample product availability can be established. The ASHRAE SI Guide gives the nominal ISO size for American pipe, but **NDOT** has opted to use a hard conversion of 1 in. = 25 mm. Schedule designations remain the same (example: Schedule 40, and Type K, L, M).

Concrete pipe diameters will be expressed in hard converted sizes. These sizes are found in ASTM C14M for non-reinforced concrete pipe. The English-sized pipes fit into the tolerances of the metric sizes.

The following table lists the inch-pound names for pipe products (called NPS or "nominal pipe size") and their metric equivalents (called DN or "diameter nominal"). The metric names conform to ISO usage and apply to all piping used in buildings and civil works projects.

DN (mm)	NPS (in.)	DN (mm)	NPS (in.)
3	1/8	375	15
6	1/4	450	18
9	3/8	525	21
13	1/2	600	24
16	5/8	750	30
19	3/4	900	36
25	1	1050	42
31	1 1/4	1200	48
38	1 1/2	1350	54
50	2	1500	60
63	2 1/2	1650	66
75	3	1800	72
88	3 1/2	1950	78
100	4	2100	84
113	4 1/2	2250	90
125	5	2400	96
150	6	2550	102
200	8	2700	108
250	10	2850	114
300	12	3000	120

Note: For pipe sizes over 120 in., use 1 in. = 25 mm.

Nominal Pipe Sizes in Inches and Millimeters

Pipe Thickness					
AASHTO SI (mm)	English Value (in.)	Nominal		Rounded Down (mm)	
		Rounded Up (mm)			
1.02	0.040	1.1	(0.04331)	1.0	(0.03937)
1.32	0.052	1.4	(0.05512)	1.3	(0.05118)
1.63	0.064	1.65	(0.06496)	1.6	(0.06299)
2.01	0.079	2.1	(0.08268)	2.0	(0.07874)
2.77	0.109	2.8	(0.11024)	2.7	(0.10630)
3.51	0.138	3.6	(0.14173)	3.5	(0.13780)
4.27	0.168	4.3	(0.16929)	4.2	(0.16535)

Pipe Thickness					
AASHTO SI (mm)	English Value (in.)	Nominal		Rounded Down (mm)	
		Rounded Up (mm)			
0.91	0.036	1.0	(0.03931)	0.9	(0.03543)
1.17	0.046	1.2	(0.04724)	1.1	(0.04331)
1.45	0.057	1.5	(0.05906)	1.4	(0.05512)
1.83	0.072	1.9	(0.07480)	1.8	(0.07087)
2.57	0.101	2.6	(0.10236)	2.5	(0.09843)
3.28	0.129	3.3	(0.12992)	3.2	(0.12598)
4.04	0.159	4.1	(0.16142)	4.0	(0.15748)

Pipe Corrugation Size		
AASHTO SI (mm)	English Equivalent (in.)	
68 x 13	(2.68 in. x 0.512 in.)	2 ² / ₃ x 1/2
76 x 25	(2.99 in. x 0.984 in.)	3 x 1
125 x 25	(4.921 in. x 0.984 in.)	5 x 1
19 x 19 x 190	(0.748 in. x 0.748 in. x 7.48 in.)	3/4 x 3/4 x 7 1/2
19 x 25 x 292	(0.748 in. x 0.984 in. x 11.496 in.)	3/4 x 1 x 11 1/2

The length of pipes can be varied as needed and may depend on limitations of haulers, handlers, designers and installers. The standard length for corrugated steel pipe as proposed by NCSPA is 6 meters. All pipe design lengths for **NDOT** should preferably be to the nearest meter, (to the nearest 0.5 meter is acceptable).

Pipe Lengths			
Metric Value (m)	English Equivalent (ft.)	Shown As (m)	
2.4384	8	2.5	(8.2 ft.)
3.0480	10	3.0	(9.8 ft.)
4.8768	16	5.0	(16.4 ft.)
6.0960	20	6.0	(19.7 ft.)
7.3152	24	7.5	(24.6 ft.)
9.1440	30	9.0	(29.5 ft.)

CONVERSION FACTORS				
FROM		MULTIPLY BY	TO OBTAIN	
Unit	Abbreviation		Unit	Abbreviation
cubic foot per second	cfs	0.02832	cubic meter per second	m ³ /s
foot	ft	0.3048	meter	m
square foot	sq ft	0.0929	square meter	m ²
cubic foot	cu ft	0.0283	cubic meter	m ³
inch	in	25.4	millimeter	mm
square mile	sq mi	2.59	square kilometer	km ²
acre	Ac	0.4047	hectare	Hec
foot per second	fps	0.3048	meter per second	m/s
gallon	gal	3.7854	liter	L

Metric Conversion Factors

UNIT ACCURACY		
UNIT	APPLIES TO	ACCURACY
cubic meter per second	All items with a unit of cubic meter per second	Nearest m ³ /s
meter	All items with a unit of meter except: Culvert Pipe	Nearest 0.1 m Nearest 0.5 m
square meter	All items with a unit of square meter	Nearest m ²
cubic meter	All items with a unit of cubic meter	Nearest m ³
millimeter	All items with a unit of millimeter	Nearest mm
square kilometer	All items with a unit of square kilometer	0.1 km ²
hectare	All items with a unit of hectare	Nearest 0.5 Hec
meter per second	All items with a unit of meter per second	Nearest m/s
liter	All items with a unit of liter	Nearest 10 L
Kiloliter	All items with a unit of 1000 liters	Nearest KL

Metric Unit Accuracy