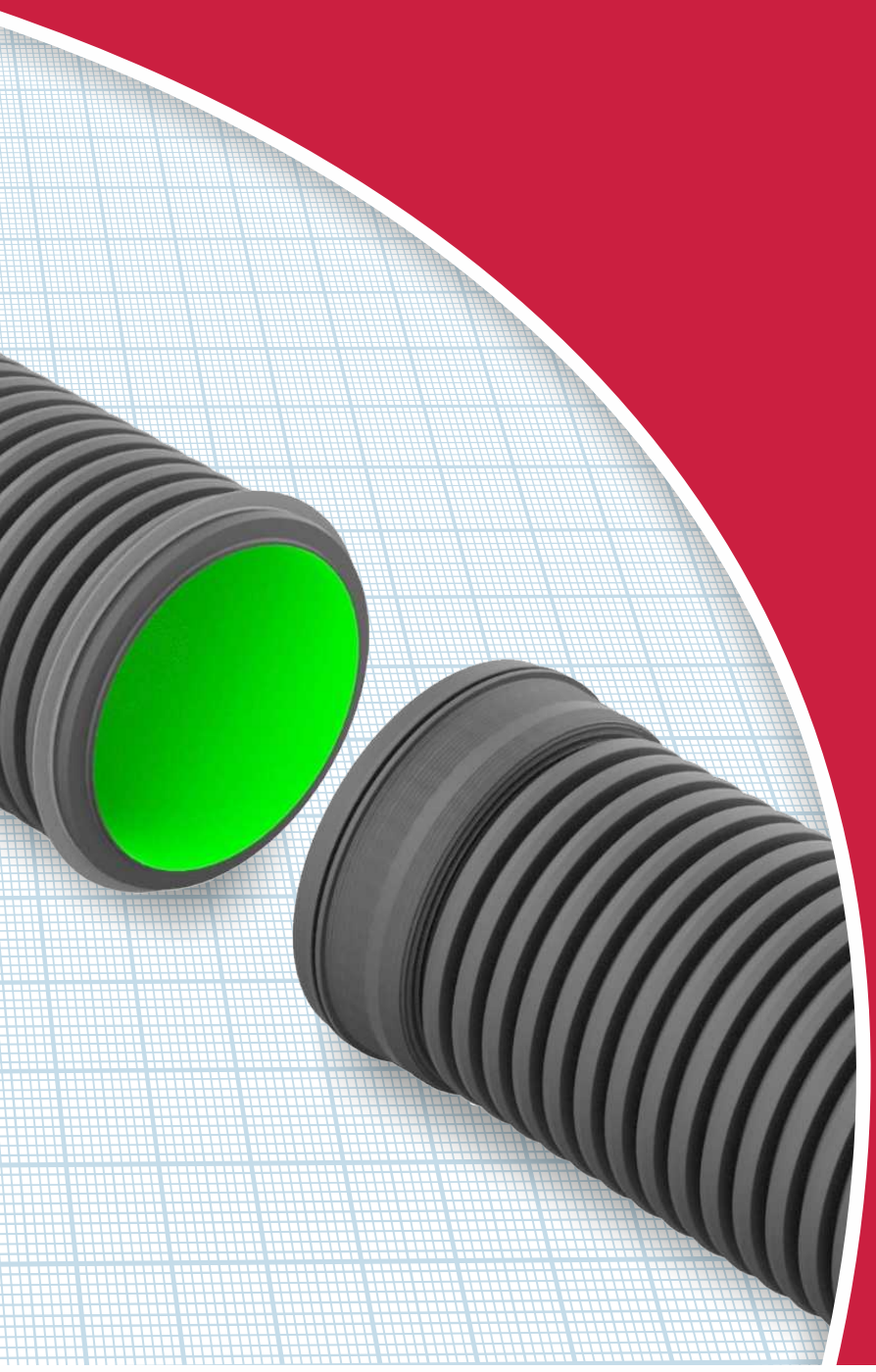
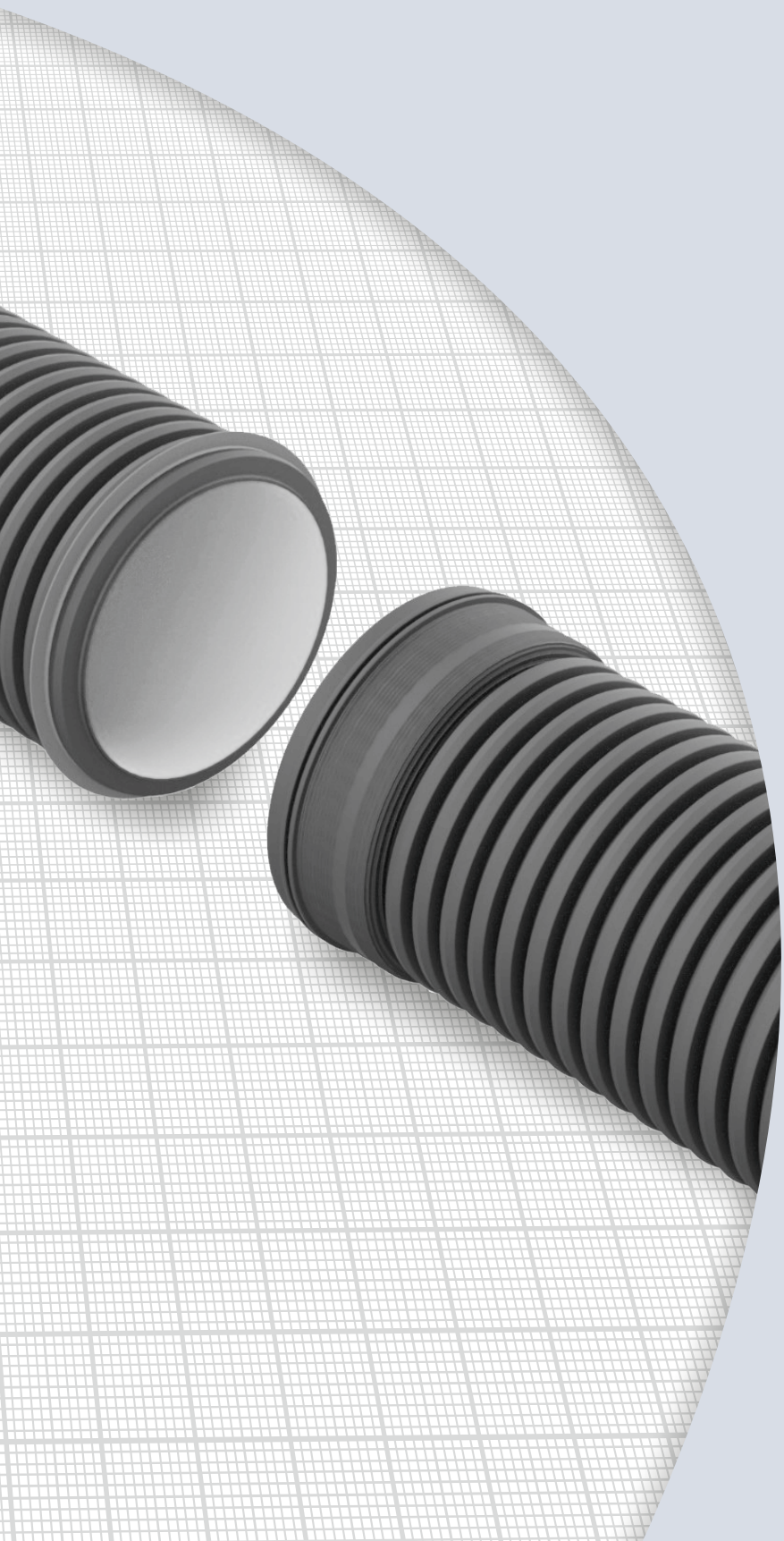
NAYLOR
DRAINAGE
Made in the UK



Surface Water Drainage System

Technical Information

email: info@naylor.co.uk web: www.naylordrainage.co.uk



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Contents

Figures and Tables

1.0 - Introduction

MetroDrain™ and MetroDrain™ LC (Low Carbon) Pipe is a twin wall extruded drainage pipe manufactured by Naylor Drainage. Dual extruded high density polyethylene (HDPE) is used to form a black outer and distinctive green inner wall. MetroDrain™ LC uses HDPE to form a black inner and outer wall.

Designed as a filter and carrier pipe for surface and storm water drainage all our MetroDrain™ sizes up to DN1050 are manufactured to comply with the Manual of Control Document for Highways Works (MCHW) requirements. All MetroDrain™ pipes have a ring stiffness exceeding an SN6 rating. (See table 1.1)

Standards and Approvals

MetroDrain™ pipe sizes DN150-DN900, DN150-DN750 couplers and DN150-DN600 fittings are certified by the British Board of Agrément (BBA) under the certificate number 09/H145.

MetroDrain™ LC is currently undergoing certification.

Nominal Diameter (DN)	Ring Stiffness (ISO 9969)
100	SN4
150	SN6
225	SN6
300	SN6
375	SN6
450	SN6
600	SN6
750	SN6
900	SN6
1050	SN6

Table 1.1 Ring stiffness rating for MetroDrain™

*Higher stiffness pipe available on request, contact Naylor Drainage for different specifications.

Naylor Drainage also manufacture a range of Twinwall extruded ducting to EN 61386-24 for use as cable protection, this product is known as MetroDuct™ and is available in sizes from DN63 to DN300. Further details are available on the website.

1.1 - Features and Benefits

- The full range from DN150-DN900 is manufactured to meet MCHW requirements.
- Sizes up to DN900 are independently certified (HAPAS) by the British Board of Agrément. DN1050 is currently outside the scope for the certification, but is manufactured to the same standard.
- Supplied in 6m standard lengths to DN600. 3m lengths are available from DN750-DN1050. When compared to rigid pipe (generally supplied in 1m or 2m lengths) this results in fewer joints meaning faster installation and less potential for leakage.
- The corrugated, structured wall design gives a superior ring stiffness while retaining a smooth internal bore to maximise flow capacity.
- Lower weight when compared to rigid pipes, easier to transport and handle on site while reducing health and safety risks.
- MetroDrain™ pipes typically are less than 6% of the weight of equivalent traditional materials e.g. concrete pipe allowing for savings in both transportation and fully installed costs.
- Flexible design allows a correctly installed pipe line to withstand ground movement and differential settlement.
- Robust, impact and abrasion resistant construction.
- Integral Socket available in sizes from DN375 to DN1050.
- Fully compliant with the requirements of National Highways.
- Parallel corrugations can be cut to exact length and jointed easily without use of specialist tools.
- Manufactured from 70% recycled HDPE and fully recyclable at end of life, low impact on land fill. MetroDrain™ LC is made from completely recycled HDPE.
- Reduced risk of breakage, puncture and site damage due to strong and flexible nature of plastic pipes.
- Structurally designed to provide maximum strength with minimum product cost and weight.
- Suitable alternative for uPVC surface water application.

1.2 - Applications

The MetroDrain™ premium drainage system has been specified and installed on many civil engineering and construction projects. It has successfully been used in the follow sectors

Highway Drainage

Building Drainage

Environmental

Sport pitches and stadiums

Landfill

Agriculture

Ports (Sea & Air)

Rail

2.0 - Sizes

MetroDrain™ ranges in size from DN150 to DN1050 and is available as either carrier or filter pipe (fully or half perforated).

2.1 - MetroDrain™ Pipe Dimensions

Size DN	Nominal OD (mm)	Length (m)	Weight (kg/m)	Nominal Storage Capacity (m^3/m)
100*	116	6	0.63	0.01
150	173	6	1.4	0.02
225	265	6	3.0	0.04
300	353	6	5.0	0.07
375	432	6	7.4	0.11
450	518	6	10.8	0.16
600	692	6	18.6	0.28
750	860	6	26.8	0.43
900	1034	6	36.0	0.61
1050	1189	6	51.2	0.85

*Non certified N-Drain spec.

2.1.1 - Carrier Drain (Solid) Plain Ended

Size DN	Pack Qty	Code	OD (mm)	Length (m)	Weight (kg/m)
100*	85	71107	116	6	0.63
150	33	71302	173	6	1.4
225	14	71303	265	6	3.0
300	9	71304	353	6	5.0
375	5	71305	432	6	7.4
450	4	71306	518	6	10.8
600	28/Load	71307	692	6	18.6
750**	18/Load	71358	860	6	26.8
900**	8/Load	71359	1034	6	36.0
1050**	8/Load	71360	1189	6	51.2

*Non certified N-Drain spec.

2.1.2 - Carrier Drain (Solid) Integrally Socketed

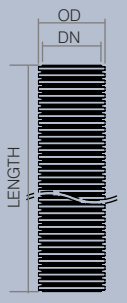
Size DN	Pack Qty	Code	OD (mm)	Socketed OD (mm)	Length (m)	Weight (kg/m)
750	18/Load	71311	860	918	6	26.8
900	8/Load	71321	1034	1093	6	36.0
1050	8/Load	71328	1189	1255	6	51.2

**Made to order, minimum order requirement.

2.1.3 - Filter Drain (Fully Perforated) Plain Ended

Size DN	Pack Qty	Code	OD (mm)	Length (m)	Weight (kg/m)	Permeable Area (mm^2/m)
100*	85	71108	116	6	0.63	
150	33	71312	173	6	1.4	9576
225	14	71313	265	6	3.0	13104
300	9	71314	353	6	5.0	13608
375	5	71315	432	6	7.4	25760
450	4	71316	518	6	10.8	21280
600	28/Load	71317	692	6	18.6	16800
750*	18/Load	71361	861	6	26.8	11616
900*	8/Load	71137	1034	6	36.0	13744
1050*	8/Load	71166	1190	6	51.2	17640

*Non certified N-Drain spec.



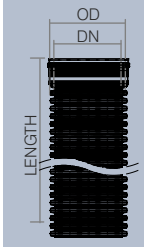
Plain ended pipe

2.1.4 - Filter Drain (Fully Perforated) Integrally Socketed

Size DN	Pack Qty	Code	OD (mm)	Socketed OD (mm)	Length (m)	Weight (kg/m)	Permeable Area (mm^2/m)
750**	18/Load	71319	860	918	6	26.8	11616
900**	8/Load	71320	1034	1093	6	36.0	13744
1050**	8/Load	71329	1189	1255	6	51.2	17640

2.1.5 - Filter Drain (Half Perforated) Plain Ended

Size DN	Pack Qty	Code	OD (mm)	Length (m)	Weight (kg/m)	Permeable Area (mm^2/m)
150	33	71322	173	6	1.4	4788
225	14	71323	265	6	3.0	6552
300	9	71324	353	6	5.0	6804
375	5	71375	432	6	7.4	12880
450	4	71376	518	6	10.8	10640
600	28/Load	71377	692	6	18.6	8400
750**	18/Load	71126	860	6	26.8	5808
900**	8/Load	71155	1034	6	36.0	6872
1050**	8/Load	71183	1189	6	51.2	8820



Socketed pipe

2.1.6 - Filter Drain (Half Perforated) Integrally Socketed

Size DN	Pack Qty	Code	OD (mm)	Socketed OD (mm)	Length (m)	Weight (kg/m)	Permeable Area (mm^2/m)
750**	18/Load	71318	860	918	6	26.8	5808
900**	8/Load	71327	1034	1093	6	36.0	6872
1050**	8/Load	71330	1189	1255	6	51.2	8820

MetroDrain™ Low Carbon (LC) provides the same strength as MetroDrain™ with up to 48% reduced carbon equivalent emissions. These pipes range in size from DN150 to DN600.

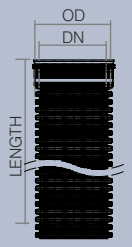
Plain ended pipe

2.2 - MetroDrain™ LC Pipe Dimensions

Size DN	Nominal OD (mm)	Length (m)	Weight (kg/m)	Nominal Storage Capacity (m^3/m)
150	173	6	1.6	0.02
225	265	6	3.3	0.04
300	353	6	5.0	0.07
375	432	6	7.4	0.11
450	518	6	10.8	0.16
600	691	6	21.0	0.28

2.2.1 - LC Carrier Drain (Solid) Plain Ended

Size DN	Pack Qty	Code	OD (mm)	Length (m)	Weight (kg/m)
150	33	74202	173	6	1.6
225	14	74203	265	6	3.3
300	9	74204	353	6	5.0
375	5	74205	432	6	7.4
450	4	74206	518	6	10.8
600	28/Load	74207	691	6	21.0



Socketed pipe

2.3 - Couplers

Coupler Size DN (mm)	Code
100*	71085
150	71332
225	71333
300	71334
375	71335
450	71336
600	71337
750	71045
900	71047
1050	71050

*Non certified N-Drain spec, only suitable for prevention of dirt ingress.
Not suitable for a sealed system.

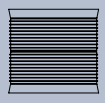
2.4 - Seals

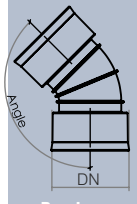
Seal Size DN (mm)	Material	Code
100*	EPDM	71001
150	EPDM	71342
225	EPDM	71343
300	EPDM	71344
375	EPDM	71345
450	EPDM	71346
600	EPDM	71347
750	EPDM	71099
900	EPDM	71102
1050	EPDM	71104

2.5 - Bends

Size ID DN (mm)	Angle (Degrees)	Code
100*	11.25	71401
100*	22.5	71402
100*	45	71403
100*	90	71404
150	11.25	71351
150	22.5	71352
150	45	71353
150	90	71354
225	11.25	71563
225	22.5	71573
225	45	71583
225	90	71593
300	11.25	71504
300	22.5	71514
300	45	71524
300	90	71534
375	11.25	71505
375	22.5	71515
375	45	71525
375	90	71535
450	11.25	71506
450	22.5	71516
450	45	71526
450	90	71536
600	11.25	71507
600	22.5	71517
600	45	71527
600	90	71537
750**	11.25	71508
750**	22.5	71518
750**	45	71528
750**	90	71538
900**	11.25	71509
900**	22.5	71519
900**	45	71529
900**	90	71539
1050**	11.25	71510
1050**	22.5	71520
1050**	45	71530
1050**	90	71540

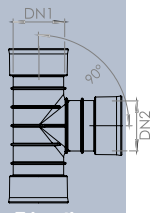
*Non certified N-Drain spec.
**Plain-ended pipe, not socketed



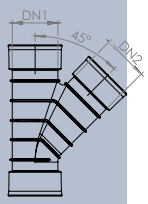


2.6 - Junctions

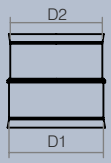
Size DN (mm) Main Bore	Size DN (mm) Branch	Type (°)	Code	Type (°)	Code
100*	100*	T (90)	71406	Y (45)	71405
150*	100*	T (90)	71271	Y (45)	71270
150	150	T (90)	71585	Y (45)	71581
225	150	T (90)	71587	Y (45)	71586
225	225	T (90)	71588	Y (45)	71584
300	150	T (90)	71624	Y (45)	71623
300	225	T (90)	71626	Y (45)	71625
300	300	T (90)	71628	Y (45)	71627
375	150	T (90)	71634	Y (45)	71633
375	225	T (90)	71636	Y (45)	71635
375	300	T (90)	71638	Y (45)	71637
375	375	T (90)	71640	Y (45)	71639
450	150	T (90)	71644	Y (45)	71643
450	225	T (90)	71646	Y (45)	71645
450	300	T (90)	71648	Y (45)	71647
450	375	T (90)	71650	Y (45)	71649
450	450	T (90)	71652	Y (45)	71651
600	150	T (90)	71664	Y (45)	71663
600	225	T (90)	71666	Y (45)	71665
600	300	T (90)	71668	Y (45)	71667
600	375	T (90)	71670	Y (45)	71669
600	450	T (90)	71672	Y (45)	71671
600	600	T (90)	71674	Y (45)	71673
750†	150†	T (90)	71834	Y (45)	71833
750†	225†	T (90)	71836	Y (45)	71835
750†	300†	T (90)	71838	Y (45)	71837
750†	375†	T (90)	71840	Y (45)	71839
750†	450†	T (90)	71842	Y (45)	71841
750†	600†	T (90)	71844	Y (45)	71843
750†	750†	T (90)	71846	Y (45)	71845
900†	150†	T (90)	71854	Y (45)	71853
900†	225†	T (90)	71856	Y (45)	71855
900†	300†	T (90)	71858	Y (45)	71857
900†	375†	T (90)	71860	Y (45)	71859
900†	450†	T (90)	71862	Y (45)	71861
900†	600†	T (90)	71864	Y (45)	71863
900†	750†	T (90)	71866	Y (45)	71865
900†	900†	T (90)	71868	Y (45)	71867
1050†	150†	T (90)	71884	Y (45)	71883
1050†	225†	T (90)	71886	Y (45)	71885
1050†	300†	T (90)	71888	Y (45)	71887
1050	375†	T (90)	71890	Y (45)	71889
1050†	450†	T (90)	71892	Y (45)	71891
1050†	600†	T (90)	71894	Y (45)	71893
1050†	750†	T (90)	71896	Y (45)	71895
1050†	900†	T (90)	71898	Y (45)	71897
1050†	1050†	T (90)	71900	Y (45)	71899



T junction



Y junction



Level invert reducers

*Non certified N-Drain spec.
†Spigot ended.
Fittings above 600mm are non-certified. Fittings and junctions 750 and above are supplied spigot ended as standard.
Contact Naylor for alternative sizes and configurations.

2.7 - Level Invert Reducers

ID (mm) D1xD2	Code
150 x 100*	71265
225 x 150	71703
300 x 150	71705
300 x 225	71706
375 x 150	71708
375 x 225	71709
375 x 300	71710
450 x 150	71712
450 x 225	71713
450 x 300	71714
450 x 375	71715
600 x 150	71717
600 x 225	71718
600 x 300	71719
600 x 375	71720
600 x 450	71721
750 x 150	71742
750 x 225	71743
750 x 300	71744
750 x 375	71745
750 x 450	71746
750 x 600	71747
900 x 150	71752
900 x 225	71753
900 x 300	71754
900 x 375	71755
900 x 450	71756
900 x 600	71757
900 x 750	71758
1050 x 150	71772
1050 x 225	71773
1050 x 300	71774
1050 x 375	71775
1050 x 450	71776
1050 x 600	71777
1050 x 750	71778
1050 x 900	71779

*Non certified N-Drain spec.

Telephone: 01226 790591 Email: sales@naylor.co.uk www.naylordrainage.co.uk

2.8 - Accessories

2.8.1 - Naylor Drainage Universal Joint Lubricant

Size kg	Code
1	50001
2.5	50002

Supplied in plastic tubs
Approximate coverage:

Pipe Size DN	100	150	225	300	375	450	600	750	900	1050
Average No. of Joints per kg.	100	50	30	24	15	10	8	5	3	2

We cannot guarantee the performance of the product if Naylor Drainage Lubricant is not used.

3.0 - Design

MetroDrain™ and MetroDrain™ LC is supplied in 6m lengths as standard but can be manufactured in 3m lengths for diameter ranges DN750 - DN1050.

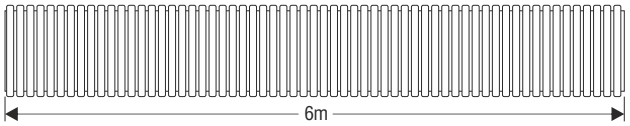


Figure 3.1 Standard Pipe length

3.1 - Structural Performance

Rigid pipe fails when the vertical load exceeds its capacity and the pipe fractures. Therefore to withstand a suitable load the pipe wall thickness must be very substantial. The bedding or surround area and pipe must not be allowed to settle or it will cause a high stress concentration and the pipe will fail.

The benefit of MetroDrain™ is its ductile nature, which deforms when overloaded rather than failing catastrophically.

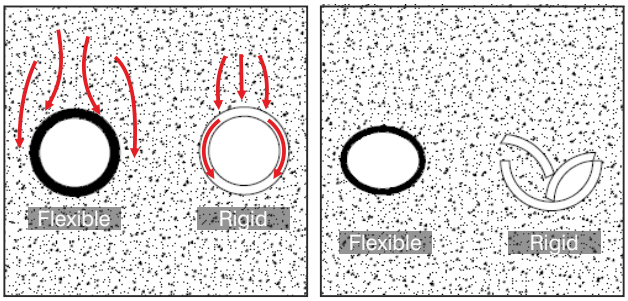


Figure 3.2 Flexible versus Rigid pipe deformation example

MetroDrain™ and MetroDrain™ LC pipe are approved for use under Manual Contract Document of Highway Works (MCHW); Volume 1, Series 500, clause 518. This clause specifies a comprehensive range of performance and structural requirements for thermoplastic structured walled pipes and fittings, summarised in the table below:

Property	Specification
Ring Stiffness	BS EN ISO 9969
Creep Ratio	BS EN ISO 9967
Impact resistance	BS EN 1411 (with d25 striker of 1kg)
Leak tightness of joints - Distortion	BS EN ISO 1277
Leak tightness of joints - Deflection	BS EN ISO 1277
High volume low pressure jetting	WRC Jetting Test Method, >137bar
Longitudinal bending	MCHW Clause 518.11
Rodding resistance	MCHW Clause 518.12

Table 3.3 MetroDrain™ Test specification

3.2 - Material

Naylor Drainage uses a mix of recycled and virgin high density polyethylene (HDPE) for MetroDrain™ pipe. MetroDrain™ LC is made from recycled HDPE.

HDPE has excellent chemical resistance to the types of contamination that can occur in storm water.

For example:

- Resistant to a wide range of common contaminants found in stormwater and standard ground conditions.
- Unaffected by inorganic salts.
- Unaffected by pH range of 0.1-14 including Hydrofluoric acid.

For more material chemical resistance information see tables at the end of the brochure.

3.3 - Flotation

Although unlikely to occur, the potential for flotation should be checked in installations where the water table is above the pipe invert level. The uplift forces are due to air trapped within the corrugations and in the pipe bore when empty.

(A fluid density of 1000kg/m^3 is assumed. A factor of safety must be applied to ensure that the system does not float after installation.)

3.4 - Hydraulic Design

It is important that drainage runs are correctly sized so that the flow is discharged off the site in an effective and efficient manner. Guidance is offered in this document, however the following notes should assist you to design drainage to a good standard.

Undersized drains result in the flow running at too high a level with serious risk of surcharge at times of heavy rainfall.

Oversized drains reduce the depth of flow in the system causing settlement of solids, silt or grit which could result in blockages. Although this situation is normally avoided, it may be considered acceptable on some surface water systems. In certain instances pipes can be used as a attenuation tank to store flood water and help prevent problems further downstream.

There are various methods of determining flow characteristics of drains. This section of the guide shows ways of calculating hydraulic flow characteristics for surface drain pipes the two main formulas for hydraulic calculations used are Manning's and Colebrook-White.

3.4.1 - Manning's Equation

Manning's Equation is a simpler formula to apply and will give an acceptable level of accuracy, for more detailed and accurate investigations the Colebrook-White Equation is recommended.

$$V = \frac{1}{n} R_h^{\frac{2}{3}} S^{\frac{1}{2}}$$

V = Volocity [m/s]

n = Manning's coefficient of roughness

Rh = Hydraulic radius [m]

S = Pipe gradient [m/m]

3.4.2 - Colebrook-White Equation

The Colebrook-White equation provides accurate results for many flow conditions and is commonly used across the industry.

https://condronconcrete.ie/concrete/hydraulic-

$$V = -2\sqrt{2g\,Di}\,\log\left(\frac{k_s}{3.7D} + \frac{2.51\mu}{D\sqrt{2gDi}}\right)$$

V=Velocity [m/s]

i= Hydraulic gradient [m/m]

k_s= Hydraulic roughness [m]

D= Internal diameter of pipe

g= Gravitational acceleration = 9.81[m/s^2]

μ = Kinematic viscosity of water [m^2/s]

Q= Discharge [m^3/s}

A= Hydraulic Radius = [m ^ 2]

Where Q = VR

3.4.3 - Hydraulic Roughness

An appropriate value of roughness coefficient should be selected when designing the drainage system. For new pipes, a value of 0.006 mm is applicable, but for design calculations, a value of 0.6 mm is generally used.

Unless initial flow rate is being calculated, pipe age and use will influence the choice of pipe roughness. Environmental considerations should be factored in such as sediment and biological deposits.

3.4.4 - Hydraulic Gradient

The value of Hydraulic Gradient is governed by the pipe slope.

Colebrook-White is an iterative process for determining the correct gradient, discharge capacity and pipe size. Refer to "Tables for the hydraulic design of pipes, sewers and channels" by H. R. Wallingford and D.I.H. Barr for published tables of data to assist in the process.

Over the next two pages are surface flow tables for MetroDrain™ pipes DN100-DN1050 at various gradients.

Pipes are calculated as flowing full utilising a Ks value of 0.6mm

It is good practise to ensure that self-cleaning velocity (0.75m/s) is achieved.

Surface Water Flow Tables

GRAD	100		150		225		300		375		450	
	Velocity m/s	Discharge l/s	Velocity m/s	Discharge l/s	Velocity m/s	Discharge l/s	Velocity m/s	Discharge l/s	Velocity m/s	Discharge l/s	Velocity m/s	Discharge l/s
1/10	2.47	19.40	3.22	56.90	4.18	166.20	5.01	354.10	5.77	637.30	6.47	1029
1/20	1.75	13.74	2.28	40.29	2.95	117.30	3.54	250.20	4.08	450.60	4.58	728
1/30	1.43	11.23	1.86	32.87	2.41	95.82	2.89	204.30	3.33	367.80	3.74	595
1/40	1.24	9.74	1.61	28.45	2.09	83.10	2.51	177.40	2.89	319.20	3.24	515
1/50	1.11	8.72	1.44	25.45	1.87	74.35	2.24	158.30	2.58	285.00	2.89	460
1/60	1.01	7.93	1.31	23.15	1.70	67.59	2.05	144.90	2.36	260.70	2.64	420
1/70	0.93	7.30	1.22	21.56	1.58	62.82	1.89	133.60	2.18	240.80	2.45	390
1/80	0.87	6.83	1.14	20.15	1.48	58.85	1.77	125.10	2.04	225.30	2.29	364
1/90	0.82	6.44	1.07	18.91	1.39	55.27	1.67	118.00	1.92	212.10	2.16	344
1/100	0.78	6.13	1.02	18.02	1.32	52.48	1.59	112.40	1.82	201.00	2.05	326
1/110	0.75	5.89	0.97	17.14	1.26	50.10	1.51	106.70	1.74	192.20	1.95	310
1/120	0.71	5.58	0.93	16.43	1.21	48.11	1.45	102.50	1.67	184.40	1.87	297
1/130	0.69	5.42	0.89	15.73	1.16	46.12	1.39	98.25	1.60	176.70	1.79	285
1/140	0.66	5.18	0.86	15.20	1.12	44.53	1.34	94.72	1.54	170.10	1.73	275
1/150	0.64	5.03	0.83	14.67	1.08	42.94	1.29	91.18	1.49	164.60	1.67	266
1/175	0.59	4.63	0.77	13.61	1.00	39.76	1.20	84.82	1.38	152.40	1.55	247
1/200	0.55	4.32	0.72	12.72	0.93	36.98	1.12	79.17	1.29	142.50	1.45	231
1/225	0.52	4.08	0.68	12.02	0.88	34.99	1.06	74.93	1.22	134.70	1.36	216
1/250	0.49	3.85	0.64	11.31	0.84	33.40	1.00	70.69	1.15	127.00	1.29	205
1/275	0.47	3.69	0.61	10.78	0.80	31.81	0.96	67.86	1.10	121.50	1.23	196
1/300	0.45	3.53	0.59	10.43	0.76	30.22	0.92	65.03	1.05	116.00	1.18	188
1/400	0.38	2.98	0.50	8.77	0.65	25.76	0.78	55.13	0.90	99.40	1.01	161
1/500	0.34	2.65	0.44	7.83	0.58	22.98	0.70	49.20	0.80	88.80	0.90	143

Table 3.4 - Surface water flow table (For DN100-450)

GRAD	600		750		900		1050	
	Velocity m/s	Discharge l/s	Velocity m/s	Discharge l/s	Velocity m/s	Discharge l/s	Velocity m/s	Discharge l/s
1/10	7.73	2186	8.88	3923	9.94	6324	10.90	9438
1/20	5.46	1544	6.27	2770	7.02	4466	7.72	6685
1/30	4.45	1258	5.12	2262	5.73	3645	6.30	5455
1/40	3.86	1091	4.43	1957	4.96	3155	5.46	4728
1/50	3.45	975	3.96	1749	4.44	2825	4.88	4226
1/60	3.15	891	3.62	1599	4.05	2576	4.45	3853
1/70	2.91	823	3.35	1480	3.75	2386	4.12	3568
1/80	2.72	769	3.13	1383	3.51	2233	3.85	3334
1/90	2.57	727	2.95	1303	3.30	2099	3.63	3143
1/100	2.44	690	2.80	1237	3.13	1991	3.45	2987
1/110	2.32	656	2.67	1180	2.99	1902	3.29	2849
1/120	2.22	628	2.55	1127	2.86	1819	3.14	2719
1/130	2.13	602	2.45	1082	2.75	1749	3.02	2615
1/140	2.06	582	2.36	1043	2.65	1686	2.91	2520
1/150	1.99	563	2.28	1007	2.55	1622	2.81	2433
1/175	1.84	520	2.11	932	2.36	1501	2.60	2251
1/200	1.72	486	1.98	875	2.21	1406	2.43	2104
1/225	1.62	458	1.86	822	2.08	1323	2.29	1983
1/250	1.54	435	1.77	782	1.98	1260	2.18	1888
1/275	1.46	413	1.68	742	1.88	1196	2.07	1792
1/300	1.40	396	1.61	711	1.80	1145	1.98	1714
1/350	1.29	365	1.49	658	1.67	1062	1.83	1585
1/400	1.21	342	1.39	614	1.56	992	1.72	1489
1/450	1.14	322	1.31	579	1.47	935	1.62	1403
1/500	1.08	305	1.24	548	1.39	884	1.53	1325
1/750	0.88	249	1.01	446	1.13	719	1.25	1082
1/1000	0.76	215	0.88	387	0.98	625	1.08	935

Table 3.5 - Surface water flow table (For DN600-1050)

4.0 - Installation

Naylor Drainage recommends that MetroDrain™ and MetroDrain™ LC is installed as detailed in the following section which is in-line with MCVHW requirements. Ground conditions may require additional work to maintain pipe support.

Authorities may have specific requirements for installation, clarification should be sort to establish the acceptable installation method prior to carrying out works.

Detail for filter drain installations can be found in figure 4.7, and detail for carrier drains can be found in figure 4.8.

4.1 - Trench Preparations

All excavation works including inspection, to be carried out in line with up to date guidance and regulations; such as, but not exclusively:

The Construction (Design and Management) Regulations 2015

Health and Safety in Construction, HSG150

Manual of Contract Documents for Highway Works Volume 1 Specification for Highway Works Series 500

Excavation of the trench should be carried out as the pipe is laid, so as to not extend too far in advance of the pipe installation. Trenches should be kept as narrow as possible while still allowing all necessary work to be carried out in a safe and acceptable manner. If needed, trench supports should be placed to reduce the risk of a collapse.

The trench should be supported in a suitable way to comply with all health & safety requirements.

The trench width should be the width of the pipe plus between 300mm and 600mm. The exact width will be dictated by the pipe diameter and installation requirements/condition.

If more than one pipe is to be installed in the trench, adequate space between the pipes must be left to allow for material to be placed and compacted without damaging or moving the pipes. See Table 4.1

Any standing water in the trench should be removed, pipe uplift can occur if excess water is left in the trench.

Minimum and maximum trench width by size

Size DN	Minimum Width (mm)	Maximum Width (mm)
100	400	700
150	450	750
225	525	825
300	600	900
375	675	975
450	750	1050
600	900	1200
750	1050	1350
900	1200	1500
1050	1350	1650

Table 4.1 - Minimum and Maximum Trench width

4.2 - Pipe Bedding

Bedding material should be laid in the trench to provide support along the length of the pipe run and allow for small adjustments to the pipes line and level.

The bedding of the pipe should be granular material at least 150mm deep with soft spots removed and replaced with hard-core. The pipe should sit evenly on the bedding and where socketed pipes or couplers are used, the bedding should be modified as to not distort or buckle the socket or coupler.

Items should not be placed under the pipe to adjust the level before bedding is added as this could cause damage to the pipe through high localised stress. Damaged pipes may be difficult to remove once filling is started.

Nominal Pipe dia. (mm)	Aggregate size (mm)			
	Graded	Single sized	Fine	All-in
Not exceeding 140	-	4/10	0/1, 0/2, 0/4 or 0/6	0/10
Between 140 and 400	2/14 or 4/20	4/10, 6/10 or 10/20		0/10 or 0/20
Exceeding 400	2/14, 4/20 or 4/40	4/10, 6/14, 10/20 or 20/40		0/10, 0/20 or 0/40

Table 4.2 – Bedding material size[1]

4.3 - Side fill Placement

Once the pipe has been laid, any gaps made for sockets and coupler clearance should be filled in and no part of the pipe left unsupported. Self compacting material should be placed evenly around the pipe in layers between 150 and 300mm and compacted to 95% unless otherwise specified. Self compacting material should be placed carefully so as to not dislodge or damage the pipe. Consideration should be given to the gap beneath the pipe before filling and compaction of surrounding areas.

Equipment used to compact the material must not under any circumstance come in contact with the pipe during use.

If using trench supports, these should be removed as the side fill takes up the trench allowing it to be compacted fully against the side walls.

4.4 - Backfill Placement

Back fill is to be at least 300mm above the crown of the pipe with class 8 lower trench fill material as given in the specification. The material should not have any particles larger than 40mm. Do not compact until the minimum level of backfill is achieved, to avoid any risk of damage to pipe. Compaction equipment should be chosen with a suitable size as not to exert undue stress on the pipe. Extra backfill to required level should be laid in 300mm layers.

[1] MCDHW 503

Compaction Plant and Weight Category	Cohesive Material (less than 20% granular content)			Granular Material (20% or more granular content including cement bound material)		
	Minimum passes/lLift for compacted lift thickness up to			Minimum passes/lift for compacted lift thickness up to		
	100 mm	150 mm	200 mm	100 mm	150 mm	200 mm
Vibro tamper						
50 kg minimum	4	8#	NP	4	8	NP
Single Drum						
600-1000kg/m	NP	NP	NP	12	NP	NP
1000-200kg/m	8	NP	NP	6	NP	NP
2000-3500kg/m	3	6	NP	3	5	7
over 3500kg/m	3	4	6#	3	4	6
Twin Drum						
600-1000kg/m	NP	NP	NP	6	NP	NP
1000-2000kg/m	4	8	NP	3	6	NP
Over 2000kg/m	2	3	5#	2	3	4
Vibrating Plate						
1400-1800kg/m^2	NP	NP	NP	5	NP	NP
Over 1800kg/m^2	3	6	NP	3	5	7
All Above Plant	For maximum and minimum compacted lift thickness See Table 2					
Alternative Compaction Plant for areas of restricted access (Including small excavations and trenches less than 200m width)						
Vibro Tamper 25kg min.	Minimum of 6 compaction Passes					
Percussive Rammer 10kg min.	Maximum of 100mm compacted lift thickness					

Table 4.3 Backfill compaction requirements[2]
NP = Not permitted

Material	Compacted lift thickness (mm)		
	Minimum at any point	Nominal lift thickness	Maximum at point
CBGM B	75	100 to 150	200
C25/30 Concrete	100	As required	As existing
C32/40 Concrete	100	As required	As existing
GSB1	75	100 to 150	200
Classes A & B	75	100 to 150	200
Classes C & D	75	100 to 150	200
SMF-A & SMF-B	75	100 to 150	200
SMF-C & SMF-D	75	100 to 150	200

Table 4.4 - Compaction lift

4.5 - Cover Depth

Naylor Drainage recommends a minimum cover depth in the following applications;

4.5.1 - For Trafficked Areas

Subject to Highways Agency requirements, 1.2m to finished surface from crown of pipe.

Not subject to Highways Agency requirements, 0.9m to finished surface from crown of pipe

4.5.2 - Domestic Areas[3]

Driveways, parking areas and yards with restrictions on vehicles weighting over 7.5 tonnes, 0.5 m

Gardens and pathways without any possibility of vehicular access, 0.35m

4.5.3 - Field load cover depth

0.6m to ensure the pipes are not damaged by cultivating and agricultural traffic loading as per CD533.

4.6 - Maximum Cover Depth

The maximum depth of cover for MetroDrain™ pipe range is dependent on local conditions, and installed detail.

The maximum allowable cover level is dependent on the following factors.

- Native soil stiffness and ground properties
- The pipe bed and surround stiffness
- Size of trench
- Density of the over burden and dead loads
- Imposed live loads (i.e. traffic and temporary loads)
- Required safety factor
- Maximum allowable deflection. (Specified)

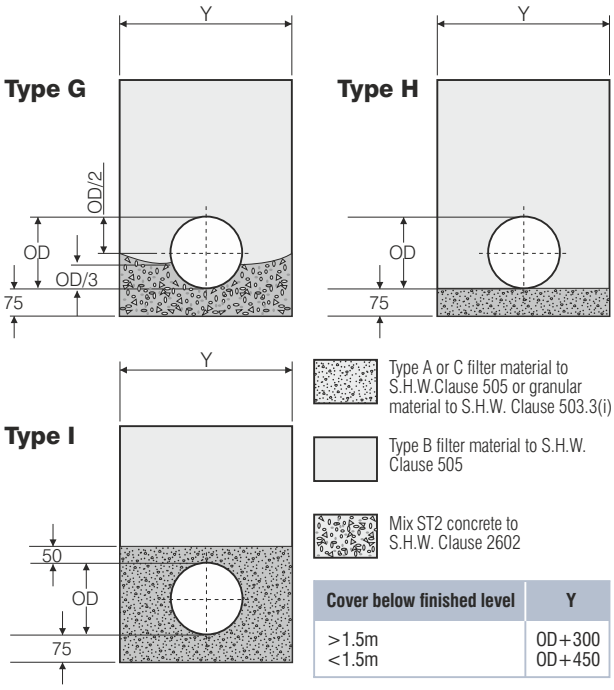
While MetroDrain™ will generally be adequate if correctly installed up to a cover of 4.5m for main road and 5m for field loading conditions if using a type S-bed and surround. Type-T can be lower. Refer to Cd533 and MCHW Vol 3 section 1 for the appropriate instillation types and depths for the pipe, Naylor Drainage recommends that if depths are higher, or loading conditions (including surcharge loading) are abnormal a structural calculation is undertaken in accordance with the method given in BS 9295.

[2]New Roads and Street Works Act 1991 - Specification for the Reinstatement of Openings in Highways

[3]National Build Standards Design and Construction of new gravity foul sewers and lateral drains Water Industry Act 1991 Section 106B Flood and Water Management Act 2010 Section 42

4.7 - Typical Installation Detail

Filter Drains



Cover below finished level	Y
>1.5m	OD+300
<1.5m	OD+450

Figure 4.7 - Filter drain installation detail

Source: MCHW Volume 3, Section 1, F2

Carrier Drain

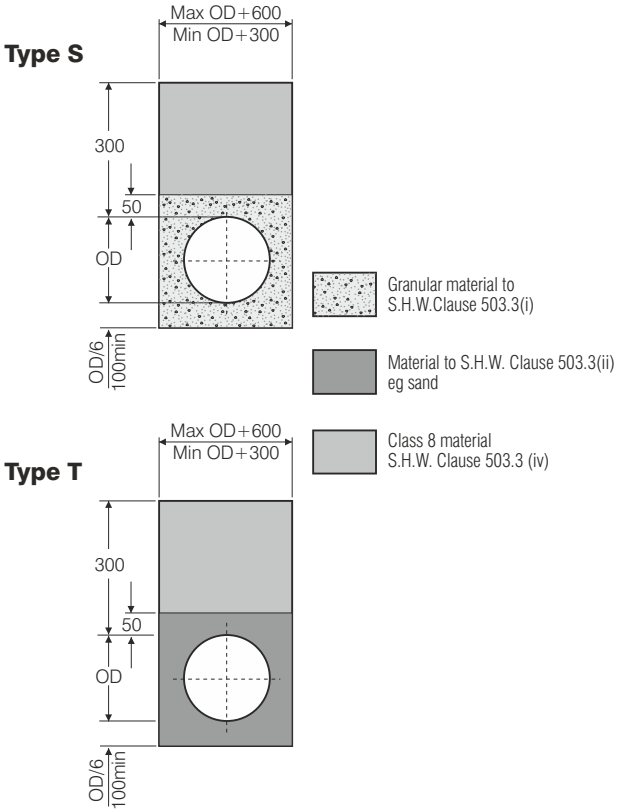


Figure 4.8 - Carrier drain installation detail

Source: MCHW Volume 3, Section 1, F1

MetroDrain™ Pipes and Couplers must be installed in accordance with National Highways requirements and the Manual of Contract Documents for Highway Work, Volume 1, Clauses 503, 505, 518.8 and 518.9 as published by the Highways Agency.

1. Pipes can be cut using conventional hand tools, and should be cut square between the corrugations.
2. For a watertight joint, the pipe ends and coupler or socket pipe end should be cleaned and a rubber seal fitted externally. For all sizes of pipe the seal is fitted in the first corrugation. The seal and inside of the coupler or socket pipe end should be lubricated with a Naylor Drainage approved lubricant and the pipe pushed fully home to the register, either by hand or using a lever, or mechanical assistance depending on pipe size. (For detail see Jointing + Air Test section)
3. The pipes and couplers must be protected against damage from site construction traffic, particularly if the trench is not to be made up to the final level for some time after installation.
4. Care should be taken during backfill to maintain the line and level of the pipeline. If necessary, the pipe should be restrained to prevent uplift.
5. The bedding, surround + backfill shall be installed so as to cause no damage to the pipes + fittings.

5.0 - Jointing and Air Testing

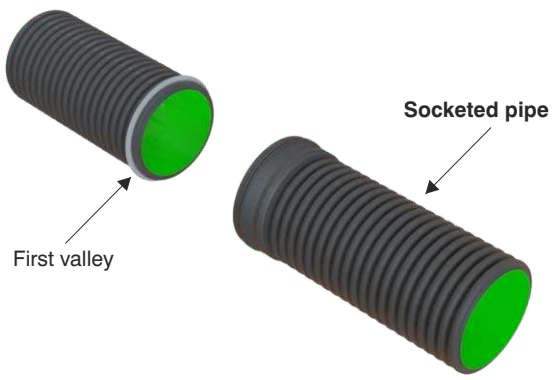
5.1 - Jointing

Before jointing, the pipe and seal should be cleared of all sharp edges and dirt.

5.1.1 - Positioning the Seal

Naylor Drainage lubricant should be applied to the pipe end before assembling the correct sized seal. Different profiles exist for each size of Naylor Drainage pipe. To identify the correct seal for the pipe, the seal identification will be printed on the side of seal.

The seal should be located in the first valley of the pipe, between the first and second corrugation.

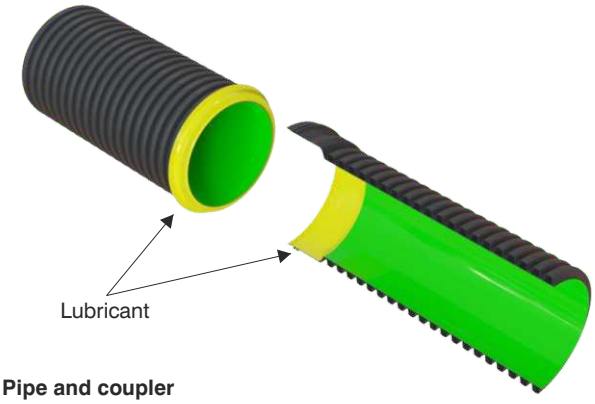


Application of Lubricant:

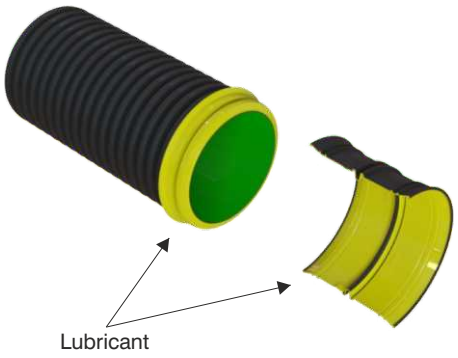
Jointing is aided by the addition of some lubricant into the valley of the pipe, prior to fitting the seal. In winter months efforts should be taken to prevent the seal falling below 4°C and stiffening up as this can cause jointing difficulties.

1. Ensure the seal and pipe end are clean and apply a light coat of lubricant over the seal.
2. Ensure the inside of the mating coupler/socket or fitting is clean and then apply lubricant liberally to the inside surface.

Socketed pipe



Pipe and coupler



Telephone: 01226 790591 Email: sales@naylor.co.uk www.naylordrainage.co.uk

5.1.2 - Jointing

Position the coupler/socket or fitting over the lubricated seal and onto the pipe, ensuring all surfaces are kept clean during the assembly process.

The pipe should be pushed fully into the coupler/socket or fitting until it reaches the end stop.

a) By hand (DN150):

For smaller pipe sizes it may be possible to push the coupler or fitting on by hand.

b) Using a lever (DN225 and DN300):

If it is not possible to assemble by hand, then place a suitable piece of timber across the end of the pipe to spread the load and prevent damage, and then carefully lever the pipe home.

c) Using mechanical assistance (DN375 and up):

If it is not possible to assemble by hand or lever, then place a suitable piece of timber across the end of the Pipe to spread the load and prevent damage, and then carefully use a digger or machine to push the Pipe home.

Alternatively pull the pipe and coupler/socket together using a sling.

Ensure the pipe and coupler/socket or fitting are aligned correctly and that there is no excessive angular deflection.

Note: lifting the pipe at the non-jointing end will help locate, joint the pipe and avoid dragging the bedding into the sealing area.

5.1.3 - Backfilling

Backfill over the new joint in order to hold the joint in place as soon as possible. Joints should not be left for long periods without backfilling, as the pipe may creep out of the coupler/socket and/or fitting causing a gap.

It may be necessary to leave any mechanical assistance in place, holding the pipe down whilst backfill is applied.

5.2 - Air Test / Pressure Test

This should be done in line with current highways specifications and using the correct test equipment e.g. 4 inch 'U' tube manometer.

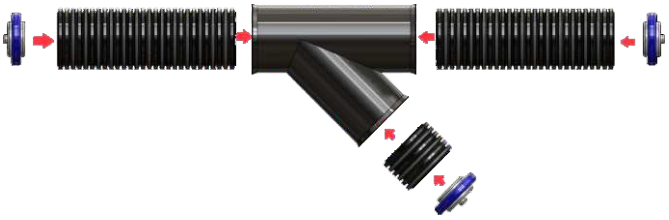
Before testing an installed line verify the testing equipment is working by completing a test on a single length of pipe. Bends and fittings always require a stub pipe for proper sealing.

All the stoppers intended for use in the final line test should be checked to ensure they will hold. The rubber should not be cracked and should be free from dirt.

5.2.1 - Inserting Stoppers:

Seal the open ends of the pipe and coupler/socket or fitting with expanding stoppers, leaving approximately 25mm between the stopper and the end of the pipe. Clean the inside of the pipe and the seal face of the stopper before fitting and ensure the stopper is tight and aligned with the pipe.

When testing fabricated fittings, they should have stub pipes fitted, and the stub pipes should be sealed with expanding stoppers.



5.2.2 - Setting U-tube manometer:

Fill the U-tube manometer with water to the required level, ensuring there are no trapped air bubbles.

Connect the manometer to the port of one of the sealed stoppers.

5.2.3 - Conducting Test:

1. Increase the pressure until 100mm of water is achieved (equivalent to 0.01 bar).
2. Let the pressure stabilise for 5 minutes, and increase the pressure to achieve 100mm head of water if it drops.
3. Record the pressure after 5 minutes.
4. The manometer should not drop below 75mm head of water (25%) without additional pumping.

Note: The larger MetroDrain™ diameter may require a longer test period – please refer to BS EN 1610 for details, clause 13.2 table 3.

Due to the large volume of air in the large diameter pipe, it will need to be left to settle and pressure increased several times before it stabilises enough to conduct the test.

Shield the pipe from direct sunlight as the pressure test is very sensitive to temperature fluctuations. As little as 1°C change in air temperature may cause the test to fail.

5.3 - Stub pipes for Fabricated fittings:

If the joint does not pass the above test please check the following:

1	Check that the stoppers are positioned correctly and secured squarely in the pipe.
2	Check that the expandable stoppers are correctly inflated.
3	Check the manometer is not damaged and is filled correctly with water to the zero mark.
4	Check the tubing and bellows are not damaged and are correctly connected to the manometer. Also check the bellows are correctly sealed off during the test with a suitable clip on the air line.
5	Check the pipes have not crept apart, this is also applicable when testing fittings with stub pipes. The stub pipe should not move during a test. If it does the stub should be propped to prevent movement.
6	Check the seals are not damaged, and have been correctly assembled in the correct position.
7	Check that adequate lubricant has been applied, otherwise the seals may roll over and move out of position during the jointing process.
8	Check that there is no dirt or damage around the seal or pipe end.
9	Check that there has been no sharp increase or decrease in temperature during the test. For example, sun exposure heating the pipe causing the air in it to expand.
10	Check that bends and fittings have a stub pipe for proper sealing.

If all the above checks have been completed, and a leak is suspected, then apply water with detergent around the various mating surfaces and increase the pressure until bubbles appear.

6.0 - Maintenance

Structured thermoplastic pipe systems do not require routine maintenance. Silt management may be required if the flow is not particularly sufficient. Generally, maintenance is limited to de-silting.

The system can be rodded using flexible drain rods. Toothed root cutter and rods with metal ferrules should not be used as this will damage the integrity of the pipe.

6.1 - Access

Access to the pipe should be provided by manholes, inspection chambers, rodding points and catchpits.

6.2 - Water Jetting

Naylor Drainage recommends using a low-pressure, high volume method of water jetting as set out in MCHW, Volume 1, Clauses 520 and 521. The maximum pressure that can be applied is 127 Bar, or 1900 PSI.

7.0 - Transport, Handling and Storage

7.1 - General

Handling should be done carefully and in accordance with the health and safety executive (HSE) guidelines. Operatives should not enter or climb on the delivery vehicle to offload.

MetroDrain™ pipes are lightweight and easy to handle onsite. The pipes are resistant to punctures and are robust, however pipes should not be thrown, dropped or dragged.

7.2 - Load Quantities

The standard delivery method for Naylor pipe is either via a standard length curtain sided or flatbed trailer.

The responsibility for safely offloading product at the point of delivery rests with the contractor. Offloading must be in line with Health and Safety guidelines and take into account established site rules and local conditions at the point of unloading. A relevant risk assessment must be completed by a competent person.

DN	Pipes per Pack	Packs per Load	Pipes per Load
100	85	12	1020
150	33	12	396
225	14	12	168
300	9	12	108
375	5	12	60
450	4	12	48
600	N/A	N/A	28
750	N/A	N/A	18
900	N/A	N/A	8
1050	N/A	N/A	8

Table 7.1 – Load quantities

If standard delivery is not suitable due to site requirements, other delivery options are available.

Rigid vehicle - Load bed width of 2.9m by 7.5m length and maximum height of 3m.

Moffat - A trailer with a forklift truck carried on the rear for sites with no suitable offloading vehicles. There must be a suitable hard standing for forklift to use and for pipes to be offloaded onto.

Slinged - The recommended method for offloading 600 and above is via slings. Naylor Drainage can deliver pipes fitted with single use slings attached in the correct position.

Note: These options have an addition charge and vary according to your requirements and location- Contact Naylor Drainage sales office for information on the additional cost.

7.3 - Off Loading

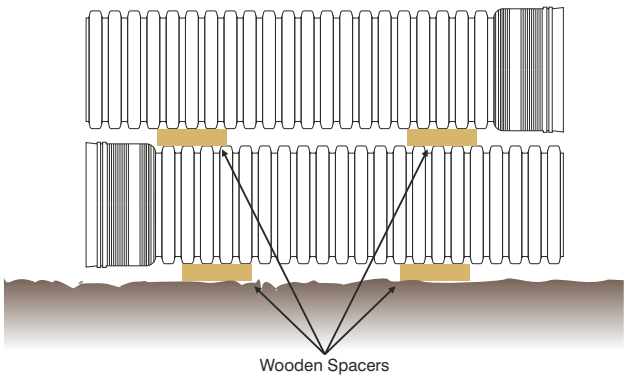
- Offloading should be done by a suitably competent person.
- No person should be required to work on the back of the trailer.
- Before removing any securing straps, check that the pipes have not shifted out of positioning boards and that the pipes can be removed safely one at a time.
- Pipes should be supported by at least 2 points during lifting. Care should be taken to avoid damage to the socket when moving the pipe.
- Pipes DN450 and below are delivered in wooden frames bound with plastic straps.
- Sizes DN600-1050 are supplied loose strapped directly to the trailer or palletised. We recommend that large pipes should be offloaded with slings in line with Health and safety guidelines. Call Naylor Drainage to specify your transportation.

7.4 - Storage

The following guidelines relate to the storage of Naylor Drainage pipe:

- All deliveries should be inspected thoroughly upon arrival and any damage, shortages or defects should be documented and reported immediately.
- Pipe should be stacked on a firm flat ground with the pipe lifted off the ground sufficiently to prevent distortion.
- For safety, the pipes should be transported and stored in their packaging.
- The maximum stacking height for pipes is 3 meters, pipes should not be stored in open areas or areas with high winds.
- MetroDrain™ pipes are not UV stabilised, so should not be stored in direct sunlight for more than 3 months. (If a UV stabilised pipe is needed contact Naylor Drainage)
- Rubber seals and lubricant should be stored out of direct sunlight and heat sources when unused, preferably indoors.
- Use Timber spacers to ensure loads are evenly distributed and chocked to prevent stack/pipes from rolling and to keep sockets spaced apart.

  If stacking socketed pipe, ensure the pipes are rotated 180° to the pipes above and below ensuring no sockets are pressed into each other. Care should be taken during laying of first layer as proper spacing and chocking as this will dictate spacing and layout of additional layers.



Chemical Resistance Tables

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Ratings: **A** Excellent **B** Good **C** Fair **D** Poor
1: Satisfactory to 72°F (22°C) **2**: Satisfactory to 120°F (48°C)

Chemical	Compatibility		
	PP	HDPE	EPDM
Acetaldehyde	A1	C	A
Acetamide	A1	A	A
Acetate Solvent	B1	A	A
Acetic Acid	B	A	A
Acetic Acid 20%	A	A	A
Acetic Acid 80%	A	A	A
Acetic Acid, Glacial	A1	A	B
Acetic Anhydride	B1	C	B
Acetone	A	D	A
Acetyl Bromide	N/A	N/A	N/A
Acetyl Chloride (dry)	D	N/A	D
Acetylene	A1	N/A	A
Acrylonitrile	A1	A	D
Adipic Acid	B2	A	A2
Alcohols:Amyl	B1	A	A
Alcohols:Benzyl	A	B	B
Alcohols:Butyl	A	N/A	A2
Alcohols:Diacetone	B2	A	A
Alcohols:Ethyl	A	A	A
Alcohols:Hexyl	N/A	N/A	C
Alcohols:Isobutyl	A1	A	A
Alcohols:Isopropyl	A2	A	A
Alcohols:Methyl	A2	A	A
Alcohols:Octyl	N/A	N/A	A
Alcohols:Propyl	A	N/A	A
Aluminum Chloride	A	A	A
Aluminum Chloride 20%	A	A	A
Aluminum Fluoride	A	A	A
Aluminum Hydroxide	A	A	A
Aluminum Nitrate	A2	N/A	A2
Aluminum Potassium Sulfate 10%	A	A	A
Aluminum Potassium Sulfate 100%	A	A	A
Aluminum Sulfate	A	A	A
Alums	A	N/A	A1
Amines	B2	B	B
Ammonia 10%	A2	A	A
Ammonia Nitrate	A	N/A	A
Ammonia, anhydrous	A	A	A
Ammonia, liquid	A2	A	A
Ammonium Acetate	A	A	A
Ammonium Bifluoride	A	N/A	A2
Ammonium Carbonate	A	B	A
Ammonium Caseinate	N/A	N/A	N/A
Ammonium Chloride	A	A	A
Ammonium Hydroxide	A	A	A
Ammonium Nitrate	A	A	A
Ammonium Oxalate	A	A	A
Ammonium Persulfate	A	A	B

Chemical	Compatibility		
	PP	HDPE	EPDM
Ammonium Phosphate, Dibasic	A	N/A	A
Ammonium Phosphate, Monobasic	A	N/A	A
Ammonium Phosphate, Tribasic	A	N/A	A
Ammonium Sulfate	A	A	A
Ammonium Sulfite	A2	B	A1
Ammonium Thiosulfate	N/A	N/A	A1
Amyl Acetate	B1	N/A	A
Amyl Alcohol	B1	A	A
Amyl Chloride	D	B	D
Aniline	A1	B	B
Aniline Hydrochloride	D	N/A	B
Antifreeze	D	N/A	A
Antimony Frichloride	A	B	B1
Aqua Regia (80% HCl, 20% NHO3)	B1	D	C
Arochlor 1248	D	N/A	B
Aromatic Hydrocarbons	D	N/A	D
Arsenic Acid	A	B	A2
Arsenic Salts	N/A	N/A	N/A
Asphalt	B1	N/A	D
Barium Carbonate	A	N/A	A
Barium Chloride	A	B	A
Barium Cyanide	D	N/A	A
Barium Hydroxide	B	N/A	A
Barium Nitrate	A	N/A	A
Barium Sulfate	B1	B	A
Barium Sulfide	B	A	A
Beer	A1	A	A
Beet Sugar Liquids	A1	N/A	A
Benzaldehyde	D	B	A
Benzene	D	D	D
Benzene Sulfonic Acid	D	A	D
Benzoic Acid	B1	A	D
Benzol	B	N/A	D
Benzonitrile	N/A	N/A	N/A
Benzyl Chloride	C	N/A	D
Bleaching Liquors	A1	N/A	A
Borax (Sodium Borate)	B	A	A
Boric Acid	A	A	A
Brewery Slop	N/A	N/A	N/A
Bromide	D	D	D
Butadiene	C	D	C
Butane	A1	N/A	D
Butanol (Butyl Alcohol)	A1	N/A	A2
Butter	N/A	N/A	A
Buttermilk	A1	N/A	A1
Butyl Amine	B1	N/A	N/A
Butyl Ether	D	N/A	D
Butyl Phthalate	B2	A	B2

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1: Satisfactory to 72°F (22°C) **2**: Satisfactory to 120°F (48°C)

Chemical	Compatibility		
	PP	HDPE	EPDM
Butylacetate	B1	B	B
Butylene	N/A	N/A	D
Butyric Acid	B1	D	B
Calcium Bisulfate	N/A	A	A
Calcium Bisulfide	A	N/A	C
Calcium Bisulfite	A	N/A	D
Calcium Carbonate	A	N/A	A
Calcium Chlorate	N/A	N/A	A
Calcium Chloride	A2	N/A	A
Calcium Hydroxide	A2	A	A
Calcium Hypochlorite	A1	A	B1
Calcium Nitrate	A2	B	A2
Calcium Oxide	A	N/A	A
Calcium Sulfate	A	N/A	A
Calgon	A	N/A	A
Cane Juice	C1	N/A	A
Carbolic Acid (Phenol)	B	N/A	B
Carbon Bisulfide	D	N/A	D
Carbon Dioxide (dry)	A2	N/A	B
Carbon Dioxide (wet)	A2	N/A	B
Carbon Disulfide	D	D	D
Carbon Monoxide	A	N/A	A
Carbon Tetrachloride	D	C	D
Carbon Tetrachloride (dry)	D	C	A1
Carbon Tetrachloride (wet)	D	C	D
Carbonated Water	B	N/A	N/A
Carbonic Acid	A	B	B
Catsup	A	N/A	A
Chloric Acid	N/A	N/A	N/A
Chlorinated Glue	N/A	N/A	B
Chlorine (dry)	D	B	A
Chlorine Water	D	C	C
Chlorine, Anhydrous Liquid	D	C	B
Chloroacetic Acid	C1	A	B
Chlorobenzene (Mono)	C1	D	D
Chlorobromomethane	A	N/A	B
Chloroform	C1	D	D
Chlorosulfonic Acid	D	D	D
Chocolate Syrup	A2	N/A	A
Chromic Acid 10%	D	A	C
Chromic Acid 30%	D	A	B
Chromic Acid 5%	D	A	A
Chromic Acid 50%	D	A	B
Chromium Salts	N/A	N/A	N/A
Cider	A	N/A	A
Citric Acid	A	A	A
Citric Oils	A	B	B
Cloroxr (Bleach)	D	N/A	B

Chemical	Compatibility		
	PP	HDPE	EPDM
Coffee	A	N/A	A
Copper Chloride	A	N/A	A
Copper Cyanide	A	N/A	A
Copper Fluoborate	N/A	N/A	N/A
Copper Nitrate	A	N/A	N/A
Copper Sulfate >5%	A	A	A
Copper Sulfate 5%	A	A	A
Cream	A	N/A	N/A
Cresols	D	D	D
Cresylic Acid	A1	N/A	D
Cupric Acid	A2	N/A	A2
Cyanic Acid	N/A	N/A	N/A
Cyclohexane	D	D	D
Cyclohexanone	D	B	D
Detergents	A	A	A
Diacetone Alcohol	A1	A	A
Dichlorobenzene	A1	N/A	D
Dichloroethane	D	C	N/A
Diesel Fuel	A1	D	D
Diethyl Ether	A1	D	D
Diethylamine	A1	D	B
Diethylene Glycol	A2	A	A2
Dimethyl Aniline	D	B	B2
Dimethyl Formamide	A	A	B
Diphenyl	D	N/A	D
Diphenyl Oxide	D	N/A	D
Dyes	N/A	N/A	N/A
Epsom Salts (Magnesium Sulfate)	A	N/A	A
Ethane	D	N/A	D
Ethanol	A	A	A
Ethanolamine	D	N/A	B
Ether	D	D	C
Ethyl Acetate	A1	A	B
Ethyl Benzoate	B1	B	N/A
Ethyl Chloride	D	C	A
Ethyl Ether	D	D	D
Ethyl Sulfate	N/A	N/A	N/A
Ethylene Bromide	D	N/A	C
Ethylene Chloride	C1	C	D
Ethylene Chlorohydrin	D	N/A	B
Ethylene Diamine	N/A	B	A
Ethylene Dichloride	D	D	C
Ethylene Glycol	A	A	A
Ethylene Oxide	D	B	C
Fatty Acids	A	A	D
Ferric Chloride	A	D	A
Ferric Nitrate	A	N/A	A
Ferric Sulfate	A	N/A	A

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Chemical	Compatibility		
	PP	HDPE	EPDM
Ferrous Chloride	A	A	N/A
Ferrous Sulfate	A	N/A	A
Fluoboric Acid	A	A	A2
Fluorine	D	D	A1
Fluosilicic Acid	A	B	A2
Formaldehyde 100%	C	A	A
Formaldehyde 40%	A	A	A
Formic Acid	A1	A	A
Freon 113	D	N/A	D
Freon 12	A2	N/A	B
Freon 22	B	N/A	A
Freon TF	D	B	D
Freonr 11	A	N/A	D
Fruit Juice	C	N/A	N/A
Fuel Oils	A	C	D
Furan Resin	D	N/A	C
Furfural	D	A	D
Gallic Acid	A	A	B
Gasoline (high-aromatic)	A	B	D
Gasoline, leaded, ref.	B	B	D
Gasoline, unleaded	C1	B	D
Gelatin	A	A	A
Glucose	A	A	A
Glue, P.V.A.	N/A	A	A
Glycerin	A	A	A
Glycolic Acid	A	N/A	A
Gold Monocyanide	N/A	N/A	N/A
Grape Juice	N/A	N/A	A
Grease	N/A	B	D
Heptane	C	N/A	D
Hexane	B	C	D
Honey	A	N/A	A
Hydraulic Oil (Petro)	D	A	D
Hydraulic Oil (Synthetic)	D	A	A
Hydrazine	C	D	A
Hydrobromic Acid 100%	C	D	A
Hydrobromic Acid 20%	A	D	A
Hydrochloric Acid 100%	B	D	D
Hydrochloric Acid 20%	B	A	A
Hydrochloric Acid 37%	C	A	C
Hydrochloric Acid, Dry Gas	B	D	N/A
Hydrocyanic Acid	A	A	B
Hydrocyanic Acid (Gas 10%)	A	A	A
Hydrofluoric Acid 100%	C	D	D
Hydrofluoric Acid 20%	A	A	D
Hydrofluoric Acid 50%	A	A	D
Hydrofluoric Acid 75%	C	B	C
Hydrofluosilicic Acid 100%	A	C	A

Chemical	Compatibility		
	PP	HDPE	EPDM
Hydrofluosilicic Acid 20%	A	B	A
Hydrogen Gas	A	A	A
Hydrogen Peroxide 10%	A	A	A
Hydrogen Peroxide 100%	B1	A	D
Hydrogen Peroxide 30%	B1	A	B
Hydrogen Peroxide 50%	B1	A	B
Hydrogen Sulfide (aqua)	A1	A	B
Hydrogen Sulfide (dry)	A1	A	B
Hydroquinone	A	N/A	D
Hydroxyacetic Acid 70%	N/A	N/A	A
Ink	N/A	N/A	N/A
Iodine	C	B	B
Iodine (in alcohol)	N/A	B	A
Iodoform	N/A	N/A	A
Isooctane	A2	B	D
Isopropyl Acetate	B1	B	B
Isopropyl Ether	B	D	D
Isotane	D	N/A	N/A
Jet Fuel (Jp3, Jp4, Jp5)	A1	D	D
Kerosene	B	B	D
Ketones	C	D	A
Lacquer Thinners	D	D	D
Lacquers	D	D	D
Lactic Acid	B	A	A
Lard	B1	A	D
Latex	A2	N/A	A
Lead Acetate	A1	A	A
Lead Nitrate	A2	A	A2
Lead Sulfamate	A2	N/A	A
Ligroin	A2	N/A	D
Lime	N/A	N/A	D
Linoleic Acid	B1	N/A	D
Lithium Chloride	A2	D	A1
Lithium Hydroxide	N/A	D	N/A
Lubricants	A1	B	D
Lye: Ca(OH)2 Calcium Hydroxide	A2	B	A
Lye: KOH Potassium Hydroxide	A	B	A2
Lye: NaOH Sodium Hydroxide	A	B	B1
Magnesium Bisulfate	A2	N/A	N/A
Magnesium Carbonate	A	N/A	A
Magnesium Chloride	A2	A	A
Magnesium Hydroxide	A	B	A
Magnesium Nitrate	A	B	A
Magnesium Oxide	N/A	N/A	N/A
Magnesium Sulfate (Epsom Salts)	A	A	A
Maleic Acid	A	A	D
Maleic Anhydride	D	A	D
Malic Acid	A1	N/A	D

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Chemical	Compatibility		
	PP	HDPE	EPDM
Manganese sulfate	N/A	N/A	N/A
Mash	N/A	N/A	N/A
Mayonnaise	N/A	N/A	N/A
Melamine	A	N/A	A
Mercuric Chloride (dilute)	B	A	B
Mercuric Cyanide	B	N/A	B
Mercurous Nitrate	A	N/A	A
Mercury	B	A	B
Methane	A	N/A	A
Methanol (Methyl Alcohol)	A2	A	A2
Methyl Acetate	D	C	D
Methyl Acetone	N/A	N/A	N/A
Methyl Acrylate	D	N/A	D
Methyl Alcohol 10%	A2	A	A2
Methyl Bromide	C	N/A	C
Methyl Butyl Ketone	D	N/A	D
Methyl Cellosolve	B	N/A	B
Methyl Chloride	D	N/A	D
Methyl Dichloride	D	N/A	D
Methyl Ethyl Ketone	B	D	B
Methyl Ethyl Ketone Peroxide	N/A	N/A	N/A
Methyl Isobutyl Ketone	A	D	A
Methyl Isopropyl Ketone	N/A	N/A	N/A
Methyl Methacrylate	D	N/A	D
Methylamine	A2	N/A	A2
Methylene Chloride	B1	D	B1
Milk	B	N/A	B
Mineral Spirits	B	D	B
Molasses	B	A	B
Monochloroacetic Acid	N/A	A1	N/A
Monoethanolamine	B	A	B
Morpholine	B2	A1	B2
Motor oil	A1	A2	A1
Mustard	A	A	A
Naphtha	B	A	B
Naphthalene	B	A	B
Natural Gas	A	A	A
Nickel Chloride	A	C	A
Nickel Nitrate	A2	B2	A2
Nickel Sulfate	A	B1	A
Nitrating Acid (<15% HNO3)	C	D	C
Nitrating Acid (>15% H2SO4)	C	C	C
Nitrating Acid (S1% Acid)	C	A	C
Nitrating Acid (S15% H2SO4)	C	C	C
Nitric Acid (20%)	A2	A	A2
Nitric Acid (50%)	B	A1	B
Nitric Acid (5-10%)	A	A	A
Nitric Acid (Concentrated)	D	A1	D

Chemical	Compatibility		
	PP	HDPE	EPDM
Nitrobenzene	B1	B	B1
Nitrogen Fertilizer	N/A	N/A	N/A
Nitromethane	B2	A1	B2
Nitrous Acid	A	B	A
Nitrous Oxide	D	B	D
Oils: Aniline	A	A	A
Oils: Anise	N/A	A	N/A
Oils: Bay	N/A	A	N/A
Oils: Bone	A	A	A
Oils: Castor	A	A	A
Oils: Cinnamon	D	A	D
Oils: Citric	A	A	A
Oils: Clove	N/A	A	N/A
Oils: Coconut	A1	A	A1
Oils: Cod Liver	A1	A	A1
Oils: Corn	A2	A	A2
Oils: Cottonseed	A	A	A
Oils: Creosote	C	B	C
Oils: Diesel Fuel (20, 30, 40, 50)	A1	A	A1
Oils: Fuel (1, 2, 3, 5A, 5B, 6)	B	A	B
Oils: ginger	N/A	D	N/A
Oils: Hydraulic Oil (Petro)	D	A	D
Oils: Hydraulic Oil (Synthetic)	D	A	D
Oils: Lemon	N/A	A	N/A
Oils: Linseed	A	A	A
Oils: Mineral	A	A	A
Oils: Olive	A	A	A
Oils: Orange	A	A	A
Oils: Palm	N/A	A	N/A
Oils: Peanut	D	A	D
Oils: Peppermint	N/A	A	N/A
Oils: Pine	B	A	B
Oils: Rapeseed	D	A	D
Oils: Rosin	A2	A	A2
Oils: Sesame Seed	A	A	A
Oils: Silicone	A	A	A
Oils: Soybean	A1	A	A1
Oils: Sperm (whale)	N/A	A	N/A
Oils: Tanning	N/A	A	N/A
Oils: Transformer	B	A	B
Oils: Turbine	B1	A	B1
Oleic Acid	B1	A	B1
Oleum 100%	D	A	D
Oleum 25%	D	B	D
Oxalic Acid (cold)	A2	A	A2
Ozone	B	A	B
Palmitic Acid	B1	A1	B1
Paraffin	A1	A	A1

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Chemical	Compatibility		
	PP	HDPE	EPDM
Pentane	D	C	D
Perchloric Acid	C	C	C
Perchloroethylene	D	A1	D
Petrolatum	D	A	D
Petroleum	B1	A1	B
Phenol (10%)	B1	B	B
Phenol (Carbolic Acid)	B	B	B
Phosphoric Acid (>40%)	A2	D	A2
Phosphoric Acid (crude)	B2	B	B2
Phosphoric Acid (molten)	D	C	D
Phosphoric Acid (S40%)	A2	C	A2
Phosphoric Acid Anhydride	A	N/A	A
Phosphorus	A	A2	A
Phosphorus Trichloride	N/A	A2	N/A
Photographic Developer	A	A	A
Photographic Solutions	A2	N/A	A2
Phthalic Acid	A	A	A
Phthalic Anhydride	D	A	D
Picric Acid	B1	B	B
Plating Solutions, Antimony Plating 130°F	A	A	A
Plating Solutions, Arsenic Plating 110°F	A	A	A
Plating Solutions, Brass Plating: High-Speed Brass Bath 110°F	A	A	A
Plating Solutions, Brass Plating: Regular Brass Bath 100°F	A	A	A
Plating Solutions, Bronze Plating: Cu-Cd Bronze Bath R.T.	A	A	A
Plating Solutions, Bronze Plating: Cu-Sn Bronze Bath 160°F	A	A	A
Plating Solutions, Bronze Plating: Cu-Zn Bronze Bath 100°F	A	A	A
Plating Solutions, Cadmium Plating: Cyanide Bath 90°F	A	A	A
Plating Solutions, Cadmium Plating: Fluoborate Bath 100°F	A	A	A
Plating Solutions, Chromium Plating: Barrel Chrome Bath 95°F	A	D	A
Plating Solutions, Chromium Plating: Black Chrome Bath 115°F	A	C	A
Plating Solutions, Chromium Plating: Chromic-Sulfuric Bath 130°F	A	C	A
Plating Solutions, Chromium Plating: Fluoride Bath 130°F	A	D	A
Plating Solutions, Chromium Plating: Fluosilicate Bath 95°F	D	C	D
Plating Solutions, Copper Plating (Acid): Copper Fluoborate Bath 120°F	A	D	A
Plating Solutions, Copper Plating (Acid): Copper Sulfate Bath R.T.	A	D	A
Plating Solutions, Copper Plating (Cyanide): Copper Strike Bath 120°F	A	A	A
Plating Solutions, Copper Plating (Cyanide): High-Speed Bath 180°F	A	A	A
Plating Solutions, Copper Plating (Cyanide): Rochelle Salt Bath 150°F	A	A	A
Plating Solutions, Copper Plating (Misc): Copper (Electroless)	A	N/A	A
Plating Solutions, Copper Plating (Misc): Copper Pyrophosphate	A	A	A
Plating Solutions, Gold Plating: Acid 75°F	A	C	A
Plating Solutions, Gold Plating: Cyanide 150°F	A	A	A
Plating Solutions, Gold Plating: Neutral 75°F	A	C	A
Plating Solutions, Indium Sulfamate Plating R.T..	A	C	A
Plating Solutions, Iron Plating: Ferrous Am Sulfate Bath 150°F	A	C	A
Plating Solutions, Iron Plating: Ferrous Chloride Bath 190°F	C	D	C
Plating Solutions, Iron Plating: Ferrous Sulfate Bath 150°F	A	C	A
Plating Solutions, Iron Plating: Fluoborate Bath 145°F	A	D	A
Plating Solutions, Iron Plating: Sulfamate 140°F	A	D	A
Plating Solutions, Iron Plating: Sulfate-Chloride Bath 160°F	A	D	A
Plating Solutions, Lead Fluoborate Plating	A	C	A
Plating Solutions, Nickel Plating: Electroless 200°F	D	N/A	D
Plating Solutions, Nickel Plating: Fluoborate 100-175°F	A	C	A
Plating Solutions, Nickel Plating: High-Chloride 130-160°F	A	C	A
Plating Solutions, Nickel Plating: Sulfamate 100-140°F	A	C	A
Plating Solutions, Nickel Plating: Watts Type 115-160°F	A	C	A
Plating Solutions, Rhodium Plating 120°F	A	D	A
Plating Solutions, Silver Plating 80-120°F	A	A	A
Plating Solutions, Tin-Fluoborate Plating 100°F	A	C	A
Plating Solutions, Tin-Lead Plating 100°F	A	C	A
Plating Solutions, Zinc Plating: Acid Chloride 140°F	A	D	A
Plating Solutions, Zinc Plating: Acid Fluoborate Bath R.T.	A	C	A
Plating Solutions, Zinc Plating: Acid Sulfate Bath 150°F	A	C	A
Plating Solutions, Zinc Plating: Alkaline Cyanide Bath R.T.	A	A	A
Potash (Potassium Carbonate)	A	B	A
Potassium Bicarbonate	A	B	A
Potassium Bromide	A	B	A
Potassium Chlorate	A	B	A
Potassium Chloride	A	A1	A
Potassium Chromate	A	B1	A
Potassium Cyanide Solutions	A	B1	A
Potassium Dichromate	A	B1	A
Potassium Ferricyanide	A2	B1	A2
Potassium Ferrocyanide	A	B	A
Potassium Hydroxide (Caustic Potash)	A	A1	A
Potassium Hypochlorite	N/A	B	N/A

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Chemical Resistance Tables

MetroDrain™ pipe system shows excellent resistance to chemical contaminants commonly found in ground and storm water. The following table provides guidance, contact Naylor Drainage if clarification is required.

Ratings: **A** Excellent **B** Good **C** Fair **D** Poor
1: Satisfactory to 72°F (22°C) **2**: Satisfactory to 120°F (48°C)

Chemical	Compatibility		
	PP	HDPE	EPDM
Potassium Iodide	A2	A1	A
Potassium Nitrate	A	B	A
Potassium Oxalate	N/A	B1	N/A
Potassium Permanganate	A	B	A
Potassium Sulfate	A	A	A1
Potassium Sulfide	A	B	A
Propane (liquefied)	A	A	D
Propylene	N/A	A1	D
Propylene Glycol	A2	B	A
Pyridine	A2	A	B
Pyrogallic Acid	A	B	B
Resorcinal	A2	N/A	B1
Rosins	A2	A1	N/A
Rum	A	A	A
Rust Inhibitors	A	A	N/A
Salad Dressings	A	A	N/A
Salicylic Acid	A1	B2	A
Salt Brine (NaCl saturated)	A	A2	A
Sea Water	A	C	A2
Shellac (Bleached)	A	A	A2
Shellac (Orange)	A	A	A
Silicone	A	A	A
Silver Bromide	N/A	D	N/A
Silver Nitrate	A1	B	A
Soap Solutions	A	A1	A
Soda Ash (see Sodium Carbonate)	A	A	A2
Sodium Acetate	A	B1	A
Sodium Aluminate	N/A	A	A
Sodium Benzoate	A2	N/A	A
Sodium Bicarbonate	A	A1	A2
Sodium Bisulfate	A	C1	A2
Sodium Bisulfite	A	B1	A2
Sodium Borate (Borax)	A2	B	A
Sodium Bromide	N/A	C	A
Sodium Carbonate	A	A	A2
Sodium Chlorate	A	B1	A
Sodium Chloride	A	B	A
Sodium Chromate	N/A	B	N/A
Sodium Cyanide	A	B1	A2
Sodium Ferrocyanide	A	B	A
Sodium Fluoride	A	D	A
Sodium Hydrosulfite	N/A	N/A	B
Sodium Hydroxide (20%)	A	B2	B
Sodium Hydroxide (50%)	A	B1	B1
Sodium Hydroxide (80%)	A	B1	B1
Sodium Hypochlorite (<20%)	A	C	B
Sodium Hypochlorite (100%)	B	D	B1
Sodium Hyposulfate	N/A	A	N/A

Chemical	Compatibility		
	PP	HDPE	EPDM
Sodium Metaphosphate	A1	A	A
Sodium Metasilicate	A	A	A1
Sodium Nitrate	A	B1	A
Sodium Perborate	A	B	A
Sodium Peroxide	B	A	A
Sodium Polyphosphate	A	B	A
Sodium Silicate	A	B	A
Sodium Sulfate	A	B1	A
Sodium Sulfide	A	D	A2
Sodium Sulfite	A2	A	A
Sodium Tetraborate	N/A	A	A
Sodium Thiosulfate (hypo)	A2	B	A2
Sorghum	N/A	A	N/A
Soy Sauce	N/A	A	N/A
Stannic Chloride	A	D	A
Stannic Fluoborate	N/A	A	N/A
Stannous Chloride	A	A2	C
Starch	A2	A	A
Stearic Acid	A2	A	B
Stoddard Solvent	C	A	D
Styrene	N/A	A	D
Sugar (Liquids)	A	A	A
Sulfate (Liquors)	A	B	A
Sulfur Chloride	C1	D	D
Sulfur Dioxide	A1	A1	A2
Sulfur Dioxide (dry)	A1	A	A2
Sulfur Hexafluoride	N/A	N/A	B
Sulfur Trioxide	C	C	C2
Sulfur Trioxide (dry)	D	A	C1
Sulfuric Acid (<10%)	A2	B	A
Sulfuric Acid (10-75%)	A1	D	B2
Sulfuric Acid (75-100%)	C1	D	B1
Sulfuric Acid (cold concentrated)	A2	B	C
Sulfuric Acid (hot concentrated)	D	C	D
Sulfurous Acid	A	B	B
Sulfuryl Chloride	N/A	N/A	N/A
Tallow	A2	A	A
Tannic Acid	A	A	A
Tanning Liquors	A1	A2	B
Tartaric Acid	A	C2	B
Tetrachloroethane	C	A	D
Tetrachloroethylene	D	A	D
Tetrahydrofuran	C2	A	D
Tin Salts	A	D	B
Toluene (Toluol)	C1	A	D
Tomato Juice	A	A	A
Trichloroacetic Acid	A	C	B
Trichloroethane	C	B	D

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Ratings: A Excellent B Good C Fair D Poor
1: Satisfactory to 72°F (22°C) **2**: Satisfactory to 120°F (48°C)

Chemical	Compatibility		
	PP	HDPE	EPDM
Trichloroethylene	C[1]	B	D
Trichloropropane	N/A	A	N/A
Tricresylphosphate	A[1]	B	A
Triethylamine	D	A	A
Trisodium Phosphate	A	B	A
Turpentine	D	A	D
Urea	A	B	A
Uric Acid	N/A	B	N/A
Urine	A	A	A[1]
Varnish	A	A	D
Vegetable Juice	N/A	A	A
Vinegar	A	A	A
Vinyl Acetate	B[1]	B	B[2]
Vinyl Chloride	N/A	A[1]	C
Water, Acid, Mine	A	B	A
Water, Deionized	A[2]	A[2]	A[1]
Water, Distilled	A	A	A
Water, Fresh	A	A	A
Water, Salts	A	B	A
Weed Killers	N/A	A	N/A
Whey	N/A	A	N/A
Whiskey & Wines	A	A	A
White Liquor (Pulp Mill)	A[1]	A	N/A
White Water (Paper Mill)	A	A	N/A
Xylene	B	B	D
Zinc Chloride	A	B	A
Zinc Hydrosulfite	N/A	A	A
Zinc Sulfate	A	A	A

Before permanent installation, test the equipment with the chemicals and under the specific conditions of your application.

Data taken from http://www.coleparmer.com/chemical-resistance

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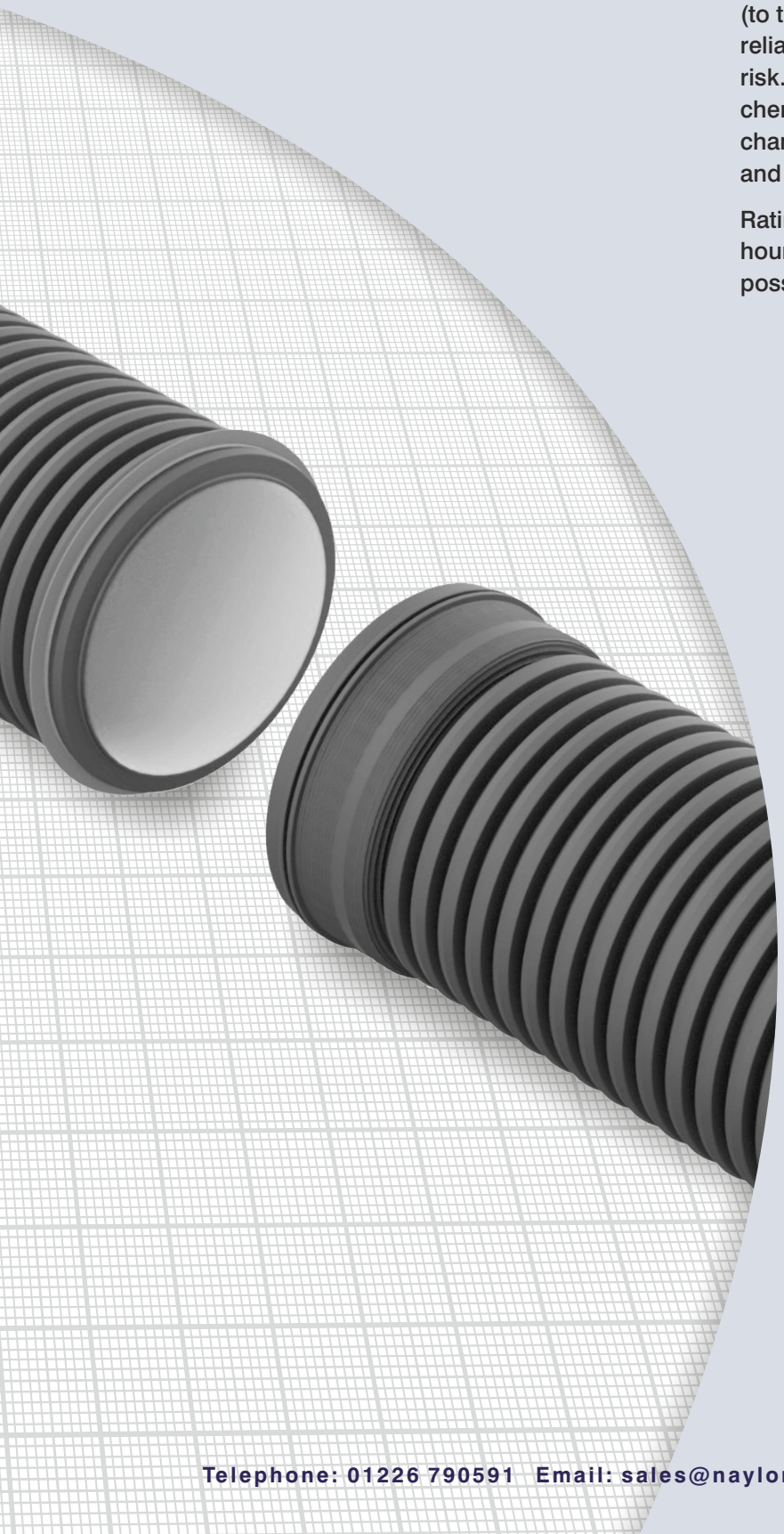
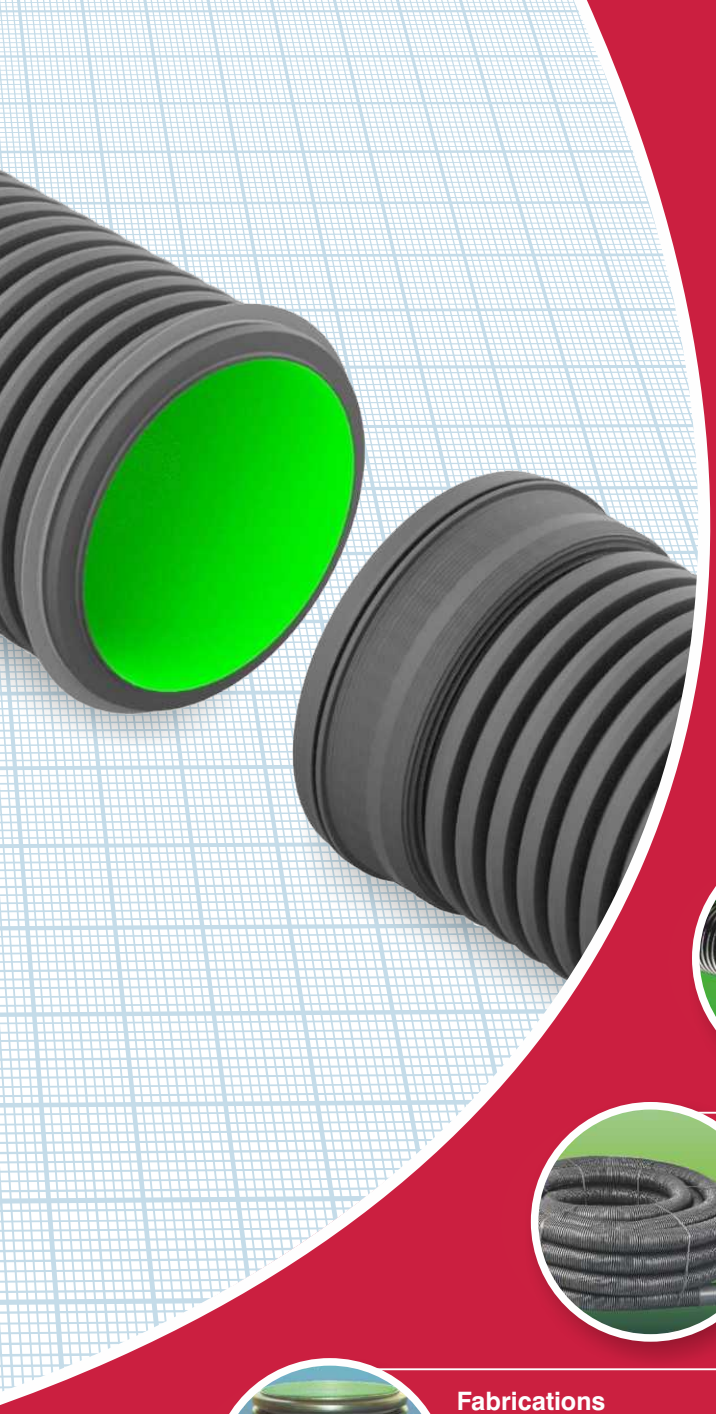
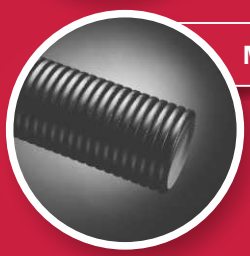
Ratings of chemical behavior listed apply to a 48 hour exposure period; we have no knowledge of possible effects beyond this period.





MetroDrain™

HDPE premium twin wall carrier/filter drainage system.



MetroDrain™ LC

Low Carbon HDPE twin wall carrier/filter drainage system.

MetroDuct™

twin wall cable ducting.

N-Drain™

HDPE agricultural twin wall carrier/filter drainage system.

Land Drainage

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