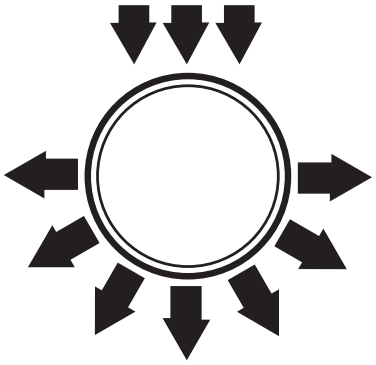
Hepworth

PLASTICS DRAINAGE AND SEWERAGE SYSTEMS

TECHNICAL / PRODUCT GUIDE

FLEXIBILITY



P.V.C.u. pipes and fittings are regarded as flexible under the stresses set up by backfill and surcharge loads. Properly installed in a suitable bed and surround, part of this load is transmitted to the side fill which is correspondingly consolidated.

The modulus of elasticity of P.V.C.u. varies from about 400,000 p.s.i. when new to about 200,000 p.s.i. after 50 years.

In the event of unforeseen excess loading which could cause fracture of pipes of rigid materials, the P.V.C.u. pipes merely take on a small, and generally temporary, increase in deformation.

PRECISION MANUFACTURE

The P.V.C.u. system has been based on the past usage and experience with pressure pipe for gravity purposes. Sewerdrain joints are made with the same precision as pressur there is no need to allow for it in design.

Connections at a later date can be done with equal confidence.

Precision joints together with longer pipe lengths reduce the risks of blockage and have a minimal effect on flow.

LIGHT WEIGHT

Handling costs reduced to a minimum. Easily stored, easily laid with fewer men and less machinery.

RUGGEDNESS

P.V.C.u. can reduce breakage dramatically because of its higher impact strength. Even pipes which have suffered some damage can be partially saved by removing the damaged section.

CORROSION RESISTANCE

Normal acid or alkali soil conditions have no adverse effect. Sewerdrain can be used for a wide range of industrial effluents. For more detailed information contact our technical department or consult BS code of practice CP.312, Part 1 : 1973.

EASILY WORKED

No special tools required and not unkind to the hands.

EXPERIENCE

P.V.C.u. pipes are a proven part of modern building and civil engineering and pressure pipes up to 24" diameter have for many years been used for gravity drainage schemes in all parts of the United Kingdom. They have been used on many major trunk roads and motorways, often with the original pipe design changed to make the most of the wider ranges of sizes available in P.V.C.u.

The crushing strength requirements of rigid material are not relevant to P.V.C.u. because of its flexibility. The wall thickness/diameter ratio of Sewerdrain has been selected so as to be comparable with class B "Pressure Pipes" to BS 3505. The outside diameters are in accordance with ISO/R161 recommendations.

PREFERRED METRIC RANGE

Because the SEWERDRAIN system has been designed to use a logical size progression from 110mm to 400mm with a single wall thickness to diameter ratio, a more accurate system using the extra available sizes can be designed, often resulting in considerable cost saving.

GENERAL INFORMATION

STANDARD LENGTHS

Pipes are normally available and supplied with integral joints in 6m or 9m lengths, but lengths of 3m can be produced if required. Colour, the metric Sewerdrain system is terracotta coloured. Imperial pipe to BS 3505/BS 3506 is grey.

FLOW

See Appendix III (Flow Charts), page 35. For the Colebrooke white formula the following co-efficients of friction should be used.

When new 0.003mm.

Mature 0.6mm (the normal accepted value for a mature sewer).

NOTE

Whilst it is difficult to claim the use of the lower value for a mature P.V.C.u. sewer it should be noted that because of the long lengths and precision joints, it is difficult to induce roughness by misalignment of joints. Stepping does not occur.

PHYSICAL PROPERTIES

Specific Gravity	1.42
Inflammability	Will not support combustion
Specific Heat	1.00kJ / kg / °C
Thermal Conductivity	0.180 J/m² /s/ °C/m
Co-efficient of Linear Expansion	0.06mm/m/ °C
Vicat Softening Point (5kg)	79 °C
Impact Strength	Complies with **EN 1401 - 1,3505**
Modulus of Elasticity	3000 MN / m² at 20 °C
Poisson's Ratio	1 : 3
Tensile Strength	In excess of 45 MN / m² at 20 °C
Elongation at Break	In excess of 80%

RELEVANT STANDARDS AND RECOMMENDATIONS

METRIC

110mm - 160mm pipe and fittings	EN 1401-1
200mm - 400mm pipe and fittings	EN 1401-1
Inspection Chamber	Agrement Certificate No. 76 / 367

IMPERIAL

18" - 24" pipe and fittings	BS 3505 : 1986
Rubber rings, rubber to	BS 2494/EN 681-1

It should be noted that Imperial Pipe to BS 3505 is to inch dimensions as I.S.O. / R / 330 and can only be jointed to Sewerdrain by means of adaptors.

SPECIFICATION

The most straightforward way to ensure a trouble free system is to SPECIFY SEWERDRAIN.

"P.V.C.u. gravity drainage pipes and fittings shall be SEWERDRAIN as marketed by Hepworth Industrial Plastics Ltd., Padiham, Burnley, Lancs."

"Sewerdrain P.V.C.u. gravity drainage system may be used as an alternative throughout. Flow requirements in the various sections will be provided on request and size reductions in keeping with the manufacturers flow charts will be considered."

PRODUCT DATA

PIPES metric

Nominal Size m.m.	*Min. O.D m.m.*	*Min. Wall Thickness m.m.*	*Weight Kg / M*
110	110.0	3.2	1.677
160	160.0	4.1	3.005
200	200.0	4.9	4.536
250	250.0	6.1	7.022
315	315.0	7.7	11.095
400	400.0	9.8	17.889

The above form the present Sewerdrain range.

For some time pipes to BS 3505 and 3506 have been supplied for gravity drainage. These are still available: fittings can be fabricated, but the normal Sewerdrain fittings are not suitable. For your information, we have included their dimensions and weights.

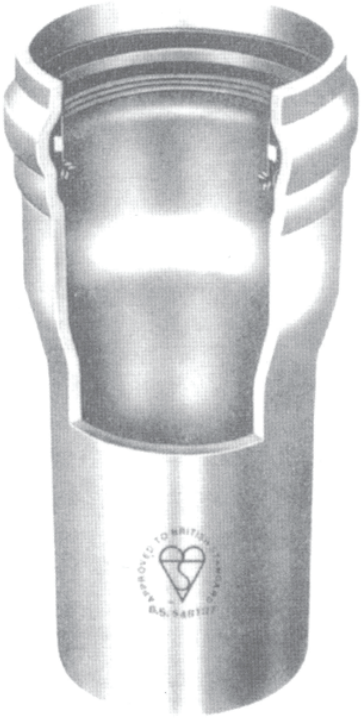
Imperial

Until our range is extended above 400mm, we recommend the use of 18", 20", 22" and 24" Class B pipes to BS 3506 - 1986

Class B P.V.C.u. to BS 3506 : 1986

Nominal Bore Size Inches.	*Min. O.D mm*	*Min. Wall Thickness mm*	*Weight Kg / m*
18	456.7	11.0	22.55
20	507.5	12.2	27.89
22	558.3	13.4	33.79
24	609.1	14.6	40.14

THE SEWERDRAIN LOC-RING INTEGRAL SOCKET



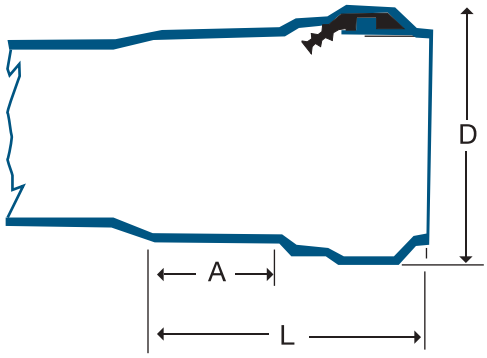
The patented Loc - Ring jointing system has been in widespread use by the Water Industry both in the United Kingdom and the Continent of Europe since 1963.

The socket is manufactured to the highest standard and provides a joint in accordance with EN 1401 - 1

Unique in design, the socket incorporates a triple compression rubber seal complying with British Standard Specification EN 681 - 1 and when jointed offers three-fold hydraulic security under both positive and negative pressure heads.

The rubber sealing gasket is seated and locked into position during manufacture as a safeguard against misuse. The socket is therefore delivered to the customer ready for immediate use and with maximum reliability already built-in.

Assembly of the Loc-Ring Integral Joint requires a minimum of skill and physical effort; it is only necessary to follow the simple jointing instruction. Both above and below ground-level assembly can be carried out with equal simplicity. The joint can be assembled with similar ease when laying under water.



INTEGRAL JOINT TO EN 1401-1

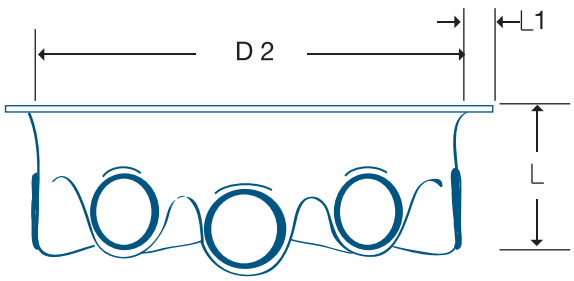
Pipe O.D.	*D*	*L*	*A*
160mm	184	101	69
200mm	235	112	75
250mm	290	129	85
315mm	365	151	100
400mm	460	183	120

INTEGRAL JOINT TO BS 3505

Nom. Dia	*D*	*L*	*A*
18”	559	297	153
20”	616	313	163
22”	670	338	173
24”	730	359	184

USE THE SEWERDRAIN INSPECTION CHAMBERS

INSPECTION CHAMBER BASE



A moulded one-piece unit in corrosion resistant G.R.P. (glass reinforced plastic) forming a quickly installed base for a manhole.

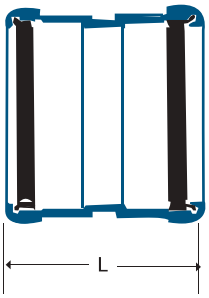
The required connections are made and the base is set in concrete. Flotation should be prevented until the concrete is set. The manhole may then be built up with concrete rings in the normal manner.

Pipe. Dia	*D2*	*L*	*L1*	*Weight Kg.*
160	750	300	37	15
200	1200	480	37	20
315	1200	600	37	24

FITTINGS

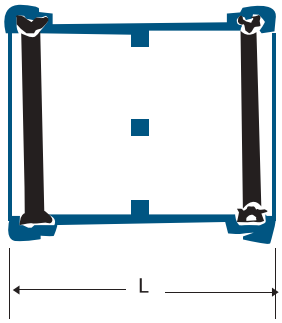
ALL DIMENSIONS GIVEN IN MILLIMETRES

COUPLER polypropylene



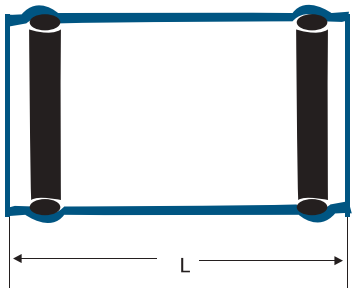
D	L	Weight Kg.
110	95	0.09
160	105	0.15

COUPLER P.V.C.



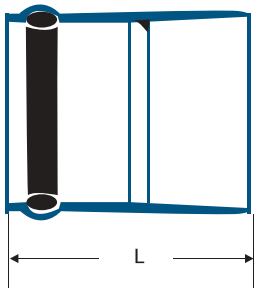
D	L	Weight Kg.
110	140	0.38

COUPLER P.V.C. repair



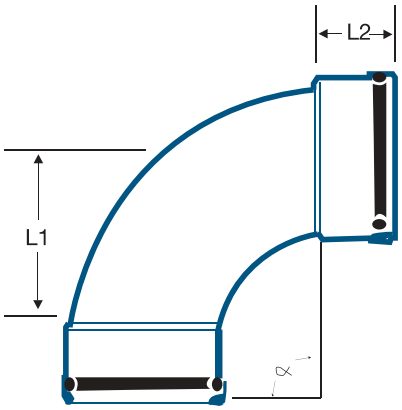
D	L	Weight Kg.
110	183	0.35
160	258	0.82
200	318	1.50
250	378	3.30
315	456	6.60
400	546	12.90

LOOSE SOCKET
(for solvent welding to pipe)



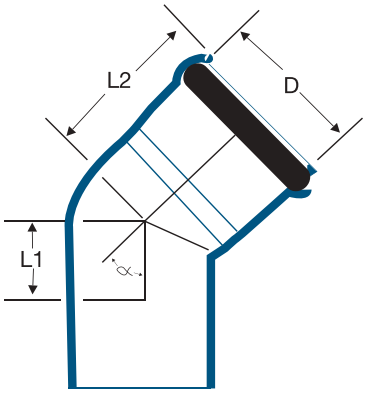
D	L1	L	Weight Kg.
200	88	220	1.11

BEND double socket



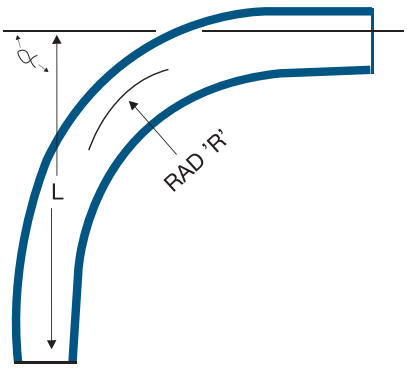
a	D	L1	L2	Weight Kg.
11.25º	110	20	60	0.31
22.5º	110	35	60	0.41
45º	110	30	60	0.32
87.5º	110	147	60	0.44
15º	160	20	100	1.00
30º	160	30	100	1.00
45º	160	48	100	1.10
87.5º	160	122	100	1.50

BEND single socket



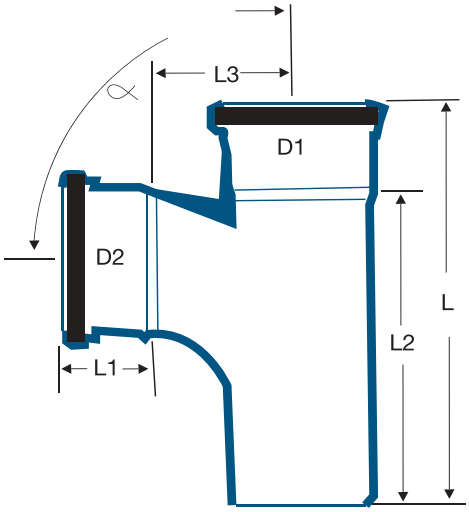
a	D	L1	L2	Weight Kg.
15°	110	33	96	0.35
15°	160	31	126	0.74
15°	200	44	154	1.40
15°	250	48	168	2.30
15°	315	100	198	4.48
30°	110	45	108	0.37
30°	160	51	144	0.84
30°	200	66	176	1.60
45°	110	58	120	0.41
45°	160	67	162	0.97
45°	200	89	199	1.80
45°	250	110	225	3.00
45°	315	135	283	6.00
87.5°	110	106	169	0.55
87.5°	160	138	233	1.40
87.5°	200	177	287	2.50

BEND long radius



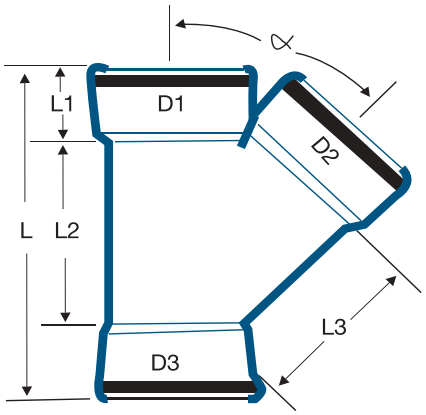
a	D	Min. R	L	Weight Kg.
90°	110	350	600	1.26
90°	110	450	680	1.96
90°	160	600	840	5
90°	200	905	1219	11
90°	250	1130	1473	21
90°	315	1425	1994	42
90°	400	1805	2032	83

JUNCTION swept two sockets



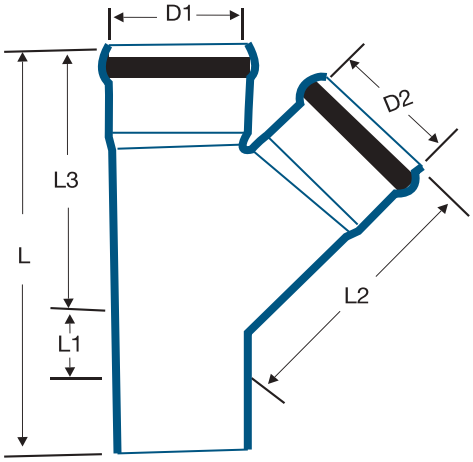
α	D1	D2	L1	L2	L3	L	Weight Kg.
87.5°	110	110	75	250	112	325	0.95
87.5°	160	110	55	250	145	345	1.60
87.5°	160	160	95	295	135	390	2.10

JUNCTION three sockets



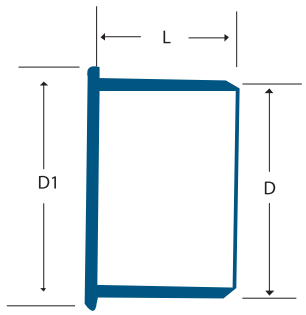
α	D1 / 2 / 3	L1	L2	L3	L	Weight Kg.
45°	110	60	152	132	272	0.76
45°	160/110	95	180	180	365	1.60
87.5°	160/110	95	155	-	345	1.60
87.5°	160/160	95	200	-	390	2.10

JUNCTION two sockets



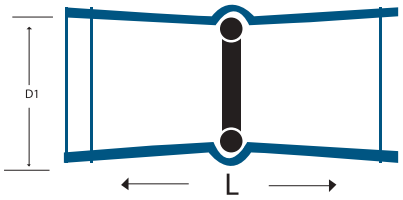
α	D1	D2	L1	L2	L3	L	Weight Kg.
45°	160	110	35	254	269	304	1.4
45°	160	160	76	303	303	379	2.0
45°	200	110	17	281	311	328	2.1
45°	200	160	59	331	346	405	2.8
45°	200	200	93	375	375	468	3.9
45°	250	200	56	425	427	483	6.4
45°	250	250	98	468	468	566	8.7
45°	315	200	24	479	502	526	10.8
45°	315	315	119	592	592	711	17.0

STOPPER male



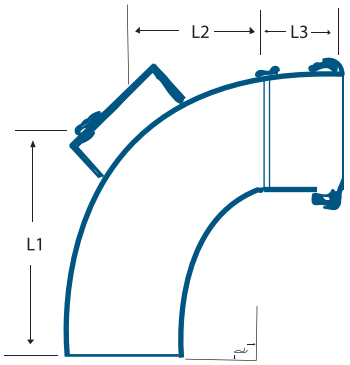
D	D1	L	Weight Kg.
110	126	71	0.16
160	180	66	0.36
200	224	89	0.62
250	326	135	2.50
315	326	195	4.00

WALL PROTECTION SLEEVE



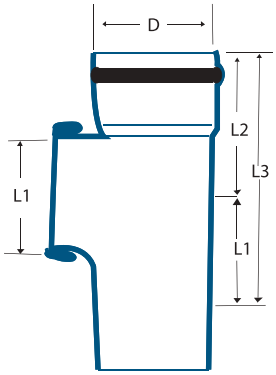
Pipe D	D1	L	Weight Kg.
110	129	240	0.50
160	180	240	0.92
200	219	240	1.20
250	272	240	1.60
315	338	240	1.80
400	428	240	2.30

ACCESS BEND



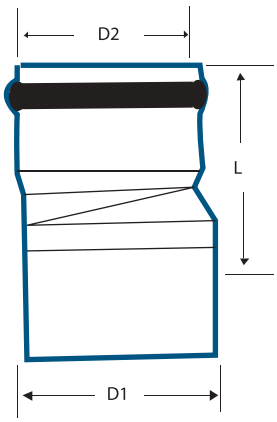
a	D	L1	L2	L3	Weight Kg.
87.5	110	206	130	75	0.92

ACCESS PIPE with cap



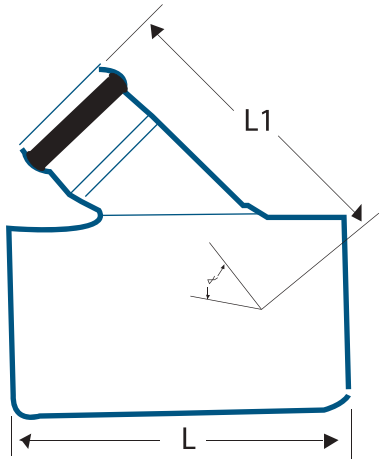
D	L1	L2	L3	D1	Weight Kg.
110	100	150	250	100	0.52
160	132	187	319	144	1.70
200	137	238	375	144	3.20

REDUCER

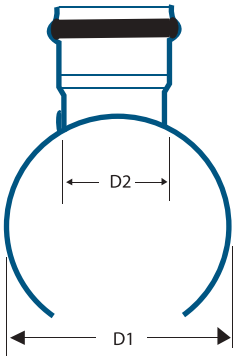


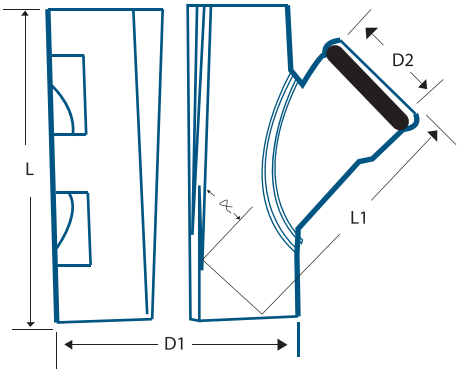
D1	*D2*	*L*	*Weight Kg.*
160	110	151	0.59
200	160	157	1.10
250	200	203	2.50
315	250	233	4.10

SADDLE JUNCTION



Type S



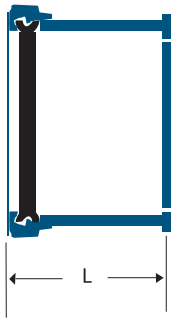


Type M

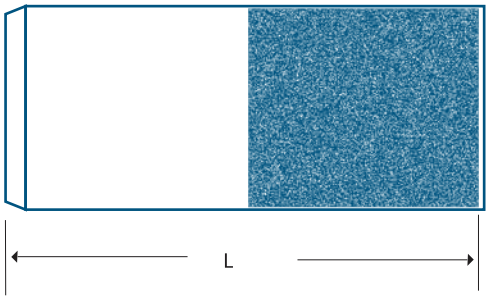
a	*D1*	*D2*	*L1*	*L*	*Weight Kg.*	*Type*
45°	160	110	267	315	1.0	s
45°	200	110	278	340	1.9	m
45°	200	160	328	340	2.2	m
45°	250	110	334	334	2.2	s
45°	250	160	440	370	3.7	m
45°	315	110	380	335	2.3	s
45°	315	160	427	432	3.2	s
45°	315	200	479	488	4.6	s
45°	400	110	440	369	4.4	s
45°	400	160	488	437	5.6	s
45°	400	200	539	494	6.0	s

N.B. OTHER SIZES ARE AVAILABLE TO SPECIAL ORDER

ADAPTOR
to clayware socket



110mm

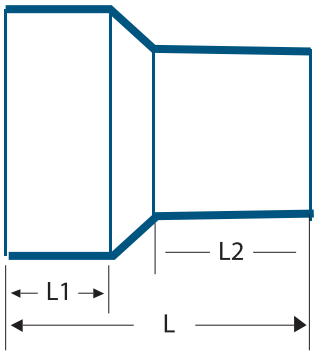


160mm

D	*L*	*Weight Kg.*
110	95	0.25
160	380	1.14

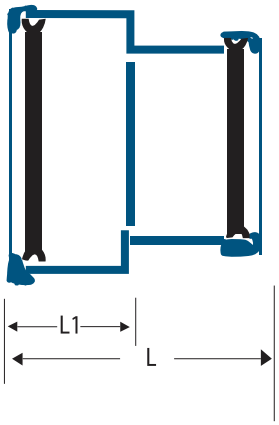
ADAPTOR
to clayware spigot

D	*D1*	*L1*	*L2*	*L*	*Weight Kg.*
110	157	73	95	197	0.39

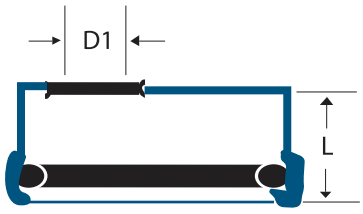


ADAPTOR TO HEPSLEVE

D	*L1*	*L*	*Weight Kg.*
110	52	110	0.12
160	67	124	0.30

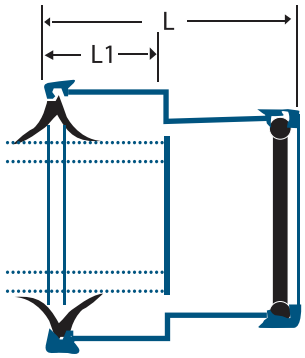


ADAPTOR to rain and waste



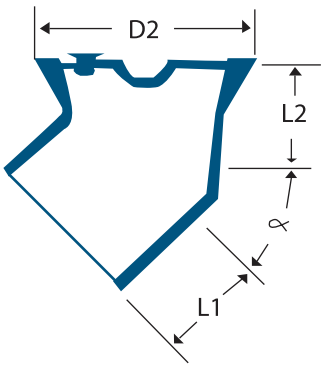
D	D1 inches	L	Weight Kg.
110	1.25	42	0.23
110	1.5	42	0.23
110	2.0	42	0.23
110	2.5	42	0.23
110	3.0	42	0.23

ADAPTOR to w.c.



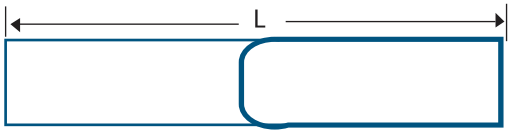
D	L	L1	Weight Kg.
110	110	52	0.32

ALUMINIUM RODDING EYE



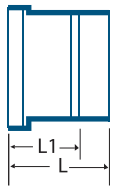
a	D	L1	L2	D2	Weight Kg.
45°	110	70	60	145	0.77

MANHOLE CONNECTOR



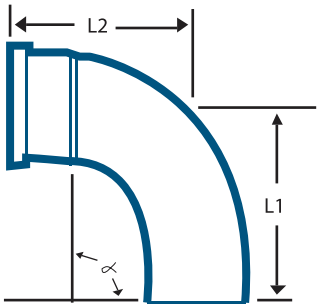
D	L	Weight Kg.
110	635	0.84
160	635	1.48
200	635	3.38

CHANNEL COUPLING



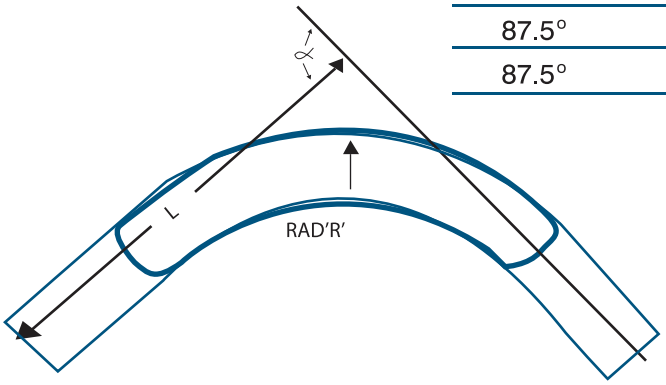
D	L1	L	Weight Kg.
10	73	104	0.11

CHANNEL BEND
left or right hand



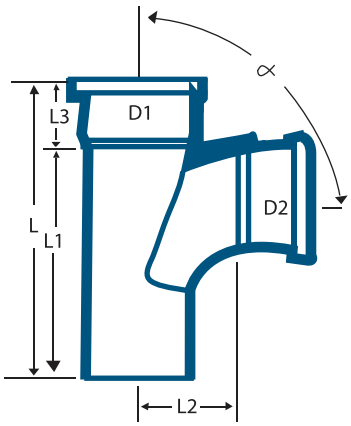
a	D	L1	L2	Weight Kg.
87.5°	110	206	195	0.32
45°	110	115	117	0.20

CHANNEL BEND
long radius



a	D	R	L	Weight Kg.
87.5°	110	350	600	0.88
87.5°	110	450	680	1.37
87.5°	160	600	840	3.18

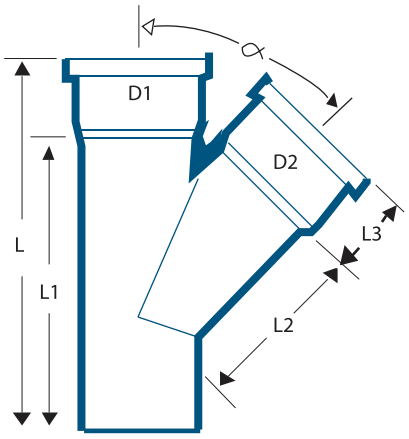
CHANNEL JUNCTION
left or right hand



a	D1	D2	L1	L2	L3	L	Weight Kg.
87.5°	110	110	250	115	75	325	0.42

CHANNEL JUNCTION left or right hand

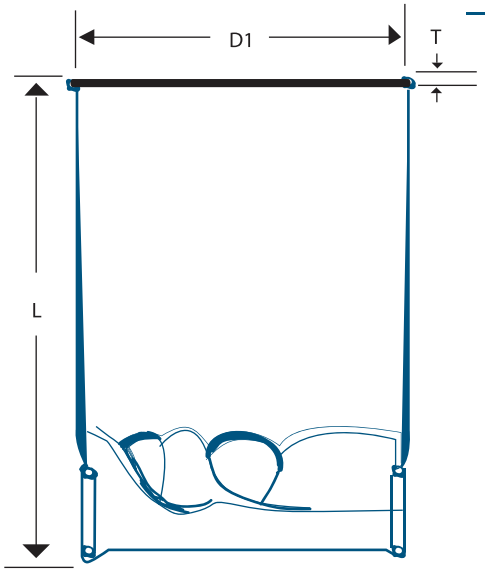
a	*D1*	*D2*	*L1*	*L2*	*L3*	*L*	*Weight Kg.*
45°	110	110	260	162	75	335	0.35

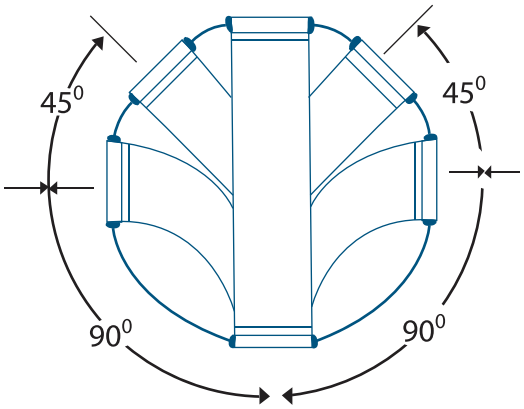


For diameters larger than 110mm, the standard fittings are cut to form channel fittings and weights are approximately half those recorded in the relevant tables.

INSPECTION CHAMBER

D	*D1*	*L*	*T*	*Weight Kg.*
110	463	610	30	5.90
110	463	915	30	8.16





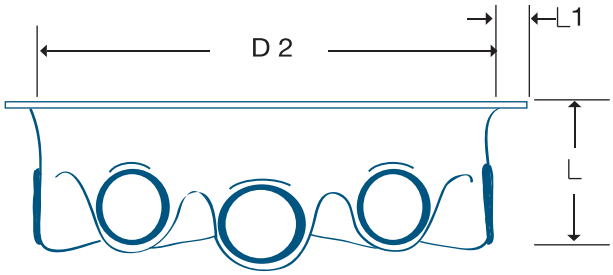
CAST IRON COVER and FRAME

To suit 110mm inspection chamber.

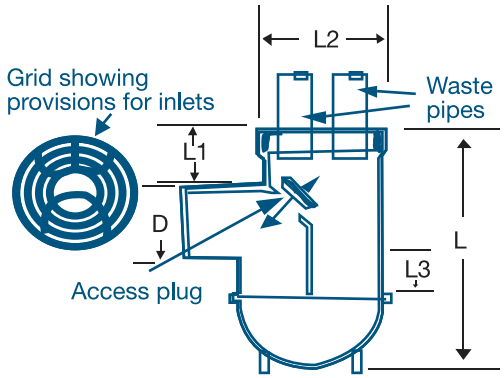
Weight Kg 21.0

INSPECTION CHAMBER base

Pipe Dia.	*D2*	*L*	*L1*	*Weight Kg.*
160	750	300	37	15
200	1200	480	37	20
315	1200	600	37	24

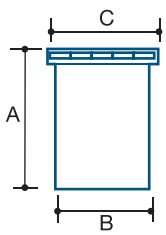


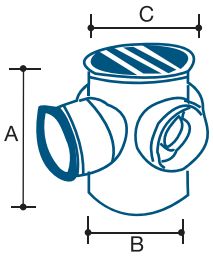
ACCESS GULLEY polypropylene



D	*L1*	*L2*	*L3*	*L*	*Weight Kg.*
110	80	170	115	370	0.92

Bottle Gully including Grid and Rodding Eye





Size	*Angle*	*Code*	*A*	*B*	*C*
110mm	$87_{1/2}^{o}$	DS46	264	185	148

Raising Piece for DS46

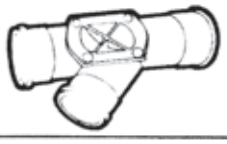
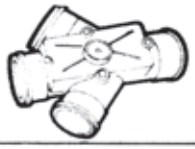
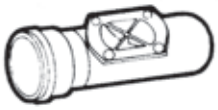
Size	*Code*	*A*	*B*	*C*
160mm	DS48	300	160	180

INSPECTION CHAMBERS, GULLIES AND ADAPTORS

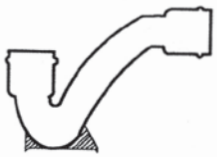
Description	Length/Type	Sizes (mm) 110	Sizes (mm) 160
HDP Gully Plain Outlet	375×750 mm 510×840 mm		G03A G04A
HDP Gully Trapped Outlet	375×750mm 510×840mm		G06A G07A
Supersleve Adaptor (Not illustrated)		M05B	

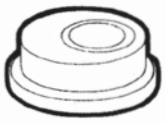
Description	Length/Type	Sizes (mm) 110	Sizes (mm) 160
Road Gully Trap Adaptor – 160 mm (Not illustrated)			6A08B
Adaptor to 160mm Plastidrain (Not illustrated)			6A18A
Rodding Eye	Vertical		4A20A

PIPES AND FITTINGS

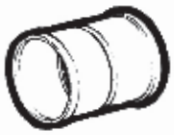
Description	Length/Type	Sizes (mm) 82	110	160	200	250	315	400	450	500	610
Access Junction – Triple Socket 	45°L.H.	–	4A13BL	6A13BL	–	–	–	–	–	–	–
	45°R.H.	–	4A13BR	6A13BR	–	–	–	–	–	–	–
	45°L.H.×110	–	–	6A13EL	–	–	–	–	–	–	–
	45°R.H.×110	–	–	6A13ER	–	–	–	–	–	–	–
Double Access Junction c/w Screw Cap 	4 Sockets	–	4A13C	–	–	–	–	–	–	–	–
Access Pipe c/w Bolt Down Cover 		–	4A13A	6A13A	–	–	–	–	–	–	–
Access Plug c/w Screw Cap		–	4A21A	6A21A	8A21A	–	–	–	–	–	–
Expanding Pipe Stopper		–	4P30A	6P30A	8P30A	10P30A	12P30A	15P30A	18P30A	20P30A	24P30A

PIPES AND FITTINGS

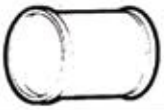
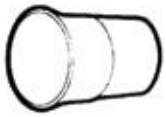
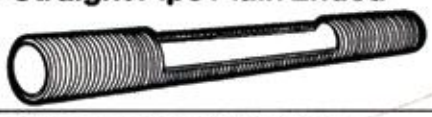
Description	Length/Type	Sizes (mm)	
		110	160
Square Hopper c/w Grid	2 No Boss Inlets	4H10A	
Rectangular Hopper c/w Grid		4H11A	
Grid		4H11B	
Cover Plate		4H11E	
Sealed Hopper c/w Blanking Plate		4H12A	
Lowback Trap 		4T10	
Inspection Chamber 315 mm dia	600 mm deep	M08A	
Inspection Chamber 450 mm dia	910 mm deep 110/160 tapered channel	M07A	
Inspection Chamber base 475 dia (Not illustrated)	230mm deep	M09D	

Description	Length/Type	Sizes (mm)	
		110	160
Rainwater Pipe Adaptor Double Socket 	68mm Rnd–82mm 65mm Sq–82mm 50mm Rnd 68mm Rnd 82mm Rnd	3A06A 3A06S 4A05A 4A06A 4A07A	
Round Access Gully Back Inlet		4A16A	
Grid		4H11B	
Cover Plate		4H11E	
Gully Socket – Waste Adaptor	32 mm & 40 mm	4A16B	
Horizontal Inlet Grommet	32mm 40mm	4A12C 4A12D	
Boss Adaptor Push fit/Solv/Copper	1¼"–32mm 1½"–40mm	S420 S421	
Inspection Chamber 475 mm dia	900mm deep 550mm deep	M09A M09B	
Lifting Handle		M08E	
Cast Iron Cover & Plastic Frame		M04A	
Extension Piece	180mm deep	M09C	
Concrete Cover 315 mm dia		M08B	

ULTRA-RIB PIPES AND FITTINGS

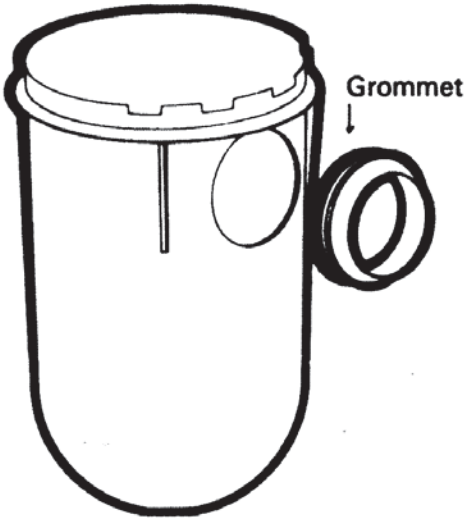
Description	Length/Type	Sizes (mm)		
		180	225	300
Pipe – Spigot and Socket	3.0m 6.0m	U6SSP3 U6SSP6	U9SSP3 U9SSP6	U12SSP3 U12SSP6
Pipe – Plain Ended	3.0 m 6.0 m	U6EP3 U6EP6	U9EP3 U9EP6	U12EP3 U12EP6
Coupler – Double Socket 		U6DSCO	U9DSCO	U12DSCO
Coupler – Double Socket Repair		U6DSCR	U9DSCR	U12DSCR
Short Radius Bends – Double Socket	90° 45° 30° 15°	U6SB90 U6SB45 U6SB30 U6SB15	U9SB90 U9SB45 U9SB30 U9SB30	U12SB90 U12SB45 U12SB30 U12SB30
45° Junction – Triple Socket	×110 ×160 ×180 ×225 ×300	U6SJX4 U6SJX6 U6SJEQ	U9SJX4 U9SJX6 U9SJX7 U9SJEQ	U12SJX4 U12SJX6 U12SJX7 U12SJX9 U12SJEQ
Long Radius Bend – Plain Ended	5° 10°	U6LB5 U6LB10	U9LB5 U9LB10	U12LB5 U12LB10

ULTRA-RIB PIPES AND FITTINGS

Description	Length/Type	Sizes (mm)		
		180	225	300
Wall Protection Sleeve 		U6WAPS	U9WAPS	U12WAPS
Level Invert Reducer to BS4660 Spigot to Ultra-Rib Spigot	×110 ×160 ×180 ×225	U6REX4 U6REX6	U9REX7	U12REX9
Socket Plug		U6SOPL	U9SOPL	U12SOPL
Adaptor – to Supersleve 150	Push Fit	U6ACM1		
Adaptor – to Clay & Concrete Spigot	Mortar Joint ×225 ×300		U9ACM9	U12ACM1
Adaptor – to PVC-U BS5481 Spigot	Push Fit ×200 ×250 ×315	U6APM8	U9APMA	U12APM1
Adaptor – to PVC-U BS5481 Socket 	Push Fit ×200 ×250 ×300	U6APF8	U9APF0	U12APF2
Channel Fitting – Straight Pipe Plain Ended 	2.0 m	U6CHST	U9CHST	U12CHST
Channel Bend Double Socket ½ Section	45° 30° 15°	U6SRC45 U6SRC30 U6SRC15	U9SRC45 U9SRC30 U9SRC15	U12SRC45 U12SRC30 U12SRC15
Channel Bend Plain Ended ¾ Section	L.H. R.H.	U6CBUNL U6CBUNR	U9CBUNL U9CBUNR	U12CBUNL U12CBUNR
Testing Stopper		U6STOP	U9STOP	U12STOP
Sealing Ring		U6SEAL	U9SEAL	U12SEAL
Lubricant		S264		

PLASTIC ROAD GULLEYS

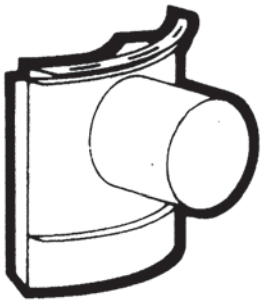
ROAD GULLEY BODY
CAT. NO. G01A



Untrapped body moulded in one piece polypropylene (price includes rubber grommet)

Diameter : 568mm Depth : 920mm

ROAD GULLEY TRAP
CAT. NO. G02A



Converts Gully Body (above) into Trapped Road Gully.

185mm outlet

This improved version of our well proven Polypropylene Road Gully is moulded in two parts; The Road Gully Body and the Road Gully Trap. Both parts are supplied and priced separately.

The depth of the gully has been increased to 920mm so providing an increase of 28% in capacity over the old 838mm version.

A Rubber Grommet supplied with the Gully Body provides the means by which the trap is sealed to the body. When untrapped gullies are required, the grommet provides the seal between the Gully Body and the connecting pipework.

The requirement to stock both trapped and untrapped gullies has traditionally required a large floor area. This new concept of supplying the trap as a separate item drastically reduces the space necessary for storage since :

- only one type of body is needed to meet either requirement, and
- the gully body can be nested to a high density due to the lack of external trap or outlet.

PLASTIC ROAD GULLEYS

SPECIFICATION

For export, shipping costs are materially reduced by the high density of nesting possible. An order for trapped gullies requires no more shipping space than untrapped gullies, since the trap is accommodated within the base of the nesting body.

The Trap comes complete with a 100mm diameter rodding eye fitted with a removable stopper attached to a retaining cord. The position of the internal trap greatly improves the accessibility for rodding.

Material

Polypropylene Copolymer having high impact strength even at 0°C.

Dimension

Body	510mm diameter
	920mm deep
Trap Outlet	185mm

Capacity

Trapped	97 litres
Untrapped	115 litres

Water Seal

Trapped	100mm

Weight

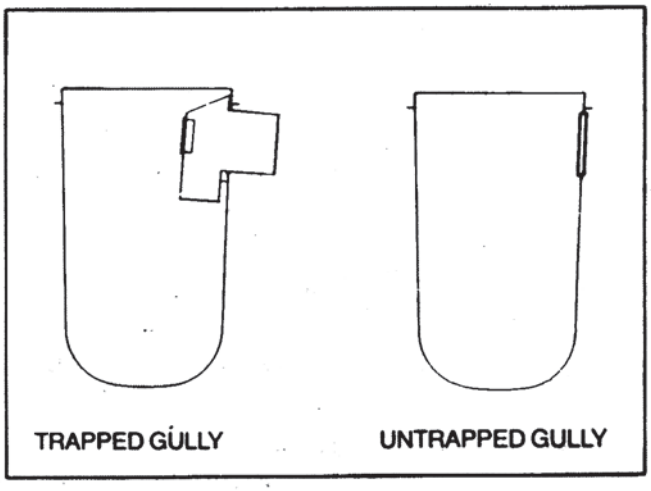
Body	6.10kg
Trap	1.10kg

CONNECTIONS

Trapped Gully to	160mm uPVC (Plastidrain adaptor 6A08A)
	150mm Clay (Hepsleve coupling or standard pipe socket)
Untrapped Gully to	160mm uPVC (Plastidrain adaptor 6A08B)
	150mm Hepsleve (Direct)

Installation

Refer to Plastidrain "GOOD PRACTICE GUIDE"



Sitework Instructions

Transport

Generally, pipes are delivered pre-packed in standard quantities. These pipe bundles are held by nylon straps and timber supports and are usually mechanically handled.

Loose pipes are hand-loaded and care should be taken before loading to check the vehicle's load carrying area for nails and other projections. The pipes must be evenly supported throughout their length, but where this is not possible, timber supports of at least 75 mm bearing width should be placed no more than 2 m apart. When loading socket and spigot pipes, place the sockets at alternate ends of each layer, and allow the sockets to protrude so that the pipes are evenly supported.

The pipes should be loaded so as not to overhang the vehicle by more than one metre. The vehicle should have side supports at centres of no more than 2 m and the inner upright surface should be flat with no sharp edges.

When a mixed load of pipes (i.e. varying diameters) is to be transported, the larger, thicker-walled and thus heavier pipes should be placed at the bottom of the load with the small diameters on top.

Fittings are supplied in cardboard boxes or plastic bags.

The complete load should be correctly secured prior to commencement of the journey.

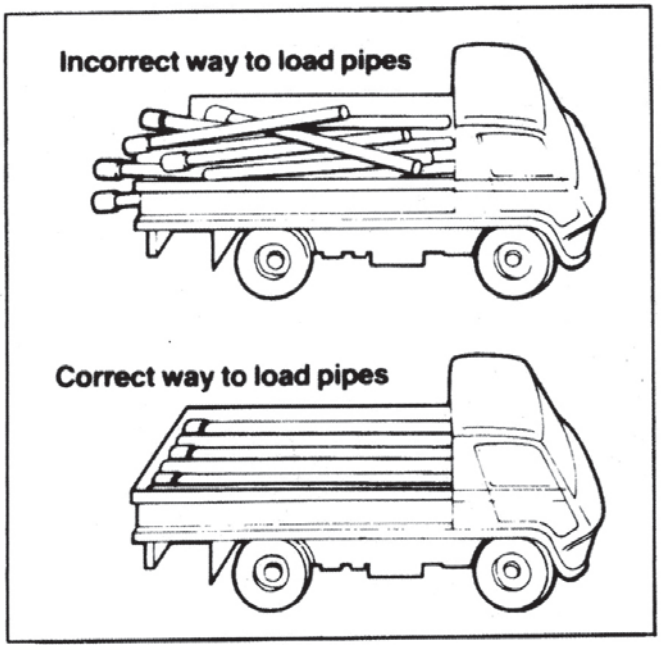
Handling

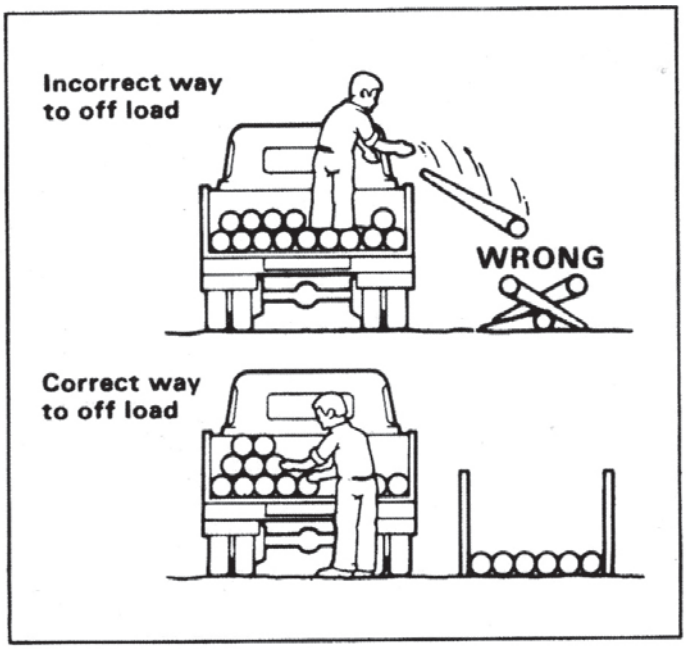
One man can easily handle 6 m lengths up to 250 mm diameter, two men can handle up to 400 mm diameter. Mechanical aid will be required for larger sizes and pipe bundles. Because they are so easily handled, care should be taken, especially when pipes are being unloaded for stacking or distribution on site. Pipes should never be thrown from lorries.

When pipes are mechanically lifted, web or rope slings should be used. Metal slings, hooks or chains must not come into contact with the pipes.

When loose pipes have been transported one inside the other, always remove the inner pipe first.

Do not drop or drag pipes.





Storage

Loose Pipes

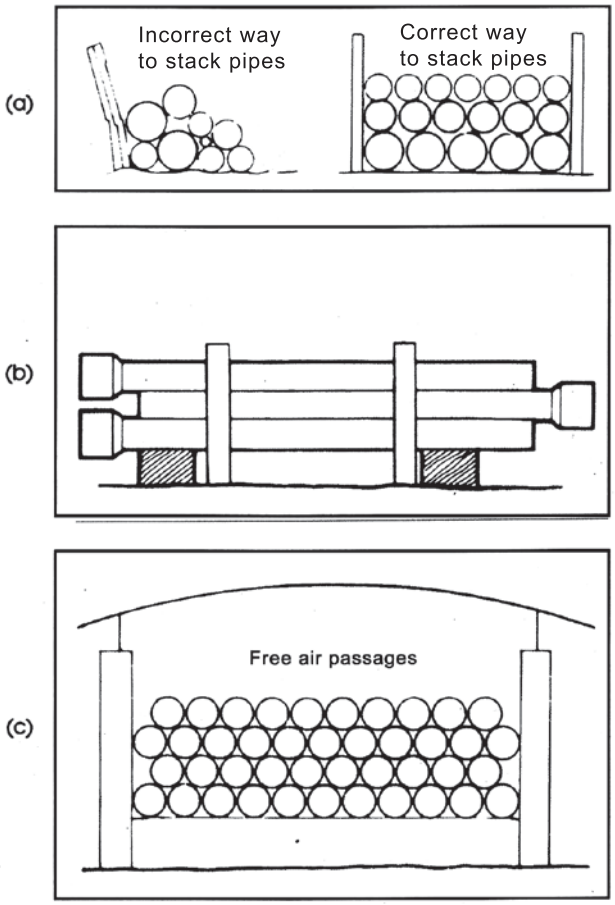
The pipes should be laid on a reasonably flat surface free from large stones or sharp projections, if this is not possible, place the pipes on transverse bearers of at least 75 mm width and spaced at centres not exceeding 1m. Side support should have a minimum bearing width of at least 75 mm and placed at intervals of 1.5 m or less.

Different sizes are best stacked separately, if this is not practical, then stack with the largest pipes at the base (see (a)).

Pipes should not be nested for long periods and stacks should not exceed seven layers or 2 m in height.

When socketed pipes are stacked, the bottom layer of sockets should be prevented from being in direct contact with the ground, either by excavating under the socket, or by use of transverse supports (see (b)).

Alternate layers should have the sockets protruding from and opposite to the previous layer. In warm climates stacks should be limited to 1 m in height and be shaded if practicable (see (c)).



Product Properties

Approvals

"Hepworth has a declared company objective to design and manufacture products to the highest standards of quality and technical excellence, to satisfy all appropriate standards, customer requirements and company specifications.

To achieve this objective, the policy of the Board of Directors is to establish, maintain and continually imporove through regular review, an effective and efficient quality management system. The quality system provides a framework for control based on the ISO 9000 series of Quality System Standards.

Where appropriate, this policy is endorsed through third party certification such as BAI Kitermark Licence schemes. In certain circumstances, where recognised national/international technical product standards do not exist, or are considered insufficient, third party approval/quality system certification is obtained through British Board of Agrement."

Physical Properties

Specific Gravity	1.41
Inflammability	Will not support combustion
Specific Heat	1.00 KJ/Kg ^{O}C
Thermal Conductivity	1600 W/m ^{O}C
Coefficient of Linear Expansion	0.05 mm/m ^{O}C
Vicat Softening Point (5 Kg)	79 ^{O}C
Impact Strength	Complies with BS4660, BS5481, BS3506, WIS 4-31-05:1988
Modulus of Elasticity	2800 MN/m² at 20 ^{O}C
Poisson's Ratio	1:3
Colour	
Plastidrain to BS4660	Terracotta
Sewerdrain to BS5481	Terracotta
Ultra-Rib	Terracotta
Sewerdrain to BS3505/6	Grey

British Standards

110 mm and 160 mm pipe and fittings	EN 1401-1 - specification for unplasticized PVC underground drain pipe and fittings
200-400 mm pipe and fittings	EN 1401-1 -specification for unplasticized PVC pipe and fittings for gravity sewer
450-610 mm pipe	BS3506: 1969 - specification for unplasticized PVC pipe for industrial uses
450-610 mm joints and bends	BS4346:Pt 2 1970 - mechanical joints and fittings, principally of unplasticized PVC
Rubber rings, rubber to:-	EN 681 - 1 -specification for elastomeric joint rings for pipework and pipelines

Water Industry Specifications

180-300 mm Ultra-Rib	WIS 4-31-05. 1988-specification for solid wall concentric external rib reinforced PVC-U sewer pipe

System Design

Structural Design

The structural performance of PVC-U pipes is assessed as the ability of the pipe to resist deformation under soil and traffic loads. The accepted long-term limit for deformation is 6% of the vertical diameter, and is determined for the particular pipe according to its loading and installation conditions.

Design Procedure

The soil and traffic loads should be determined from Table 1 for the particular pipe diameter, burial depth and traffic conditions. These values are based on a saturated bulk density of 2000 kg/m^3, should the site conditions indicate a different soil density then the soil load values can be adjusted on a pro rata basis. The total load (soil load + traffic load) should be determined according to the depth of cover and assumed traffic loading, and the corresponding deformation found by reference to chart number 1.

If the predicted deformation is less than 6 %, then the installation conditions are acceptable.

The design charts are based on the formula

Deflection, $$\Delta d = \frac{(Po\ D + Pt)\ Kx \times 10^3}{(8\ Si) + (0.061\ E')}$$ metres

and $$D = \frac{\Delta d}{\text{Pipe OD}} \times 100$$ %

assuming

Po = soil load (kN/m)

D_1 = Deflection lag factor = 1.5

Pt = traffic load (kN/m)

Kx = Bedding factor = 0.103

Si = Pipe Stiffness = 760N/m^2 (110, 160 dia)
650 N/m^2 (200, 250, 315, 400, 450, 500, 610 dia)
4000 N/m^2 (180, 225, 300 dia Ultra-Rib

E' = Soil Modulus = 7 x 10^{6}N/m^2

where different values from given above are to be applied, separate calculations will be necessary.

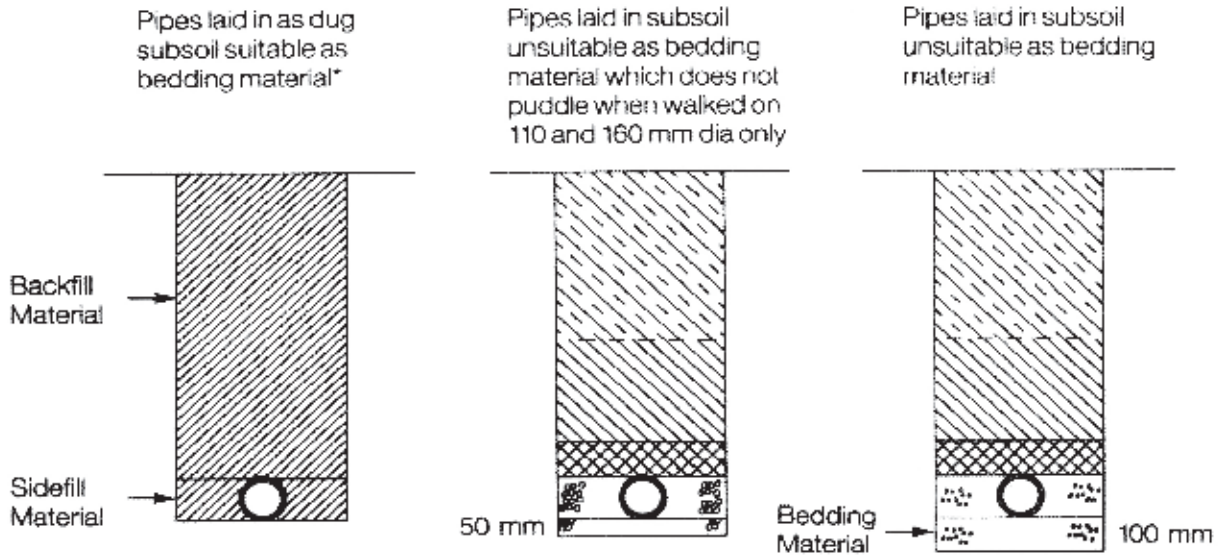
NB For pipes with depths of cover less than 0.6 m in fields and 0.9m in carrage ways special protection will be required (see Trench Construction Section).

Installation Below Ground

Trench Preparation

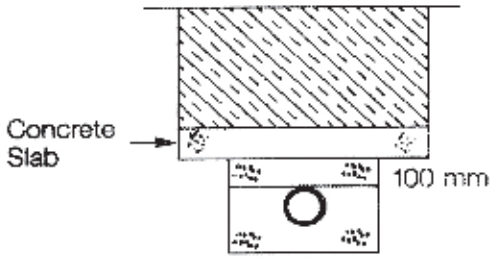
The trench should not be excavated too far in advance of pipe laying and should be backfilled as soon as possible. Trench widths should be as narrow as practicable but not less than the pipe OD plus 300 mm to enable proper compaction of sidefill. Trench sides should be correctly supported.

Pipes laid at depths greater than 900 mm cover in roads, 600 mm in fields



*Suitable material – granular material in accordance with BS5955 Part 6 : 1980 Appendix A maximum particle size – 10 mm (110 dia), 14 mm (160 dia), 20 mm (200 dia +)

Pipes laid at depths less than 900 mm cover in roads, 600 mm in fields



Note
Concrete surround.
Pipes may be protected at shallow depths using a 150 mm thick concrete surround with allowance for flexibility at pipe joints using compressible boards which should be equal in size to the concrete cross section

As dug backfill/sidefill maximum particle size 10 mm (110 dia) 14 mm (160 dia) 20 mm (200 dia and over)

10 mm single – sized aggregate (complying with BS882)

NB – Where backfill above pipe contains stones greater than 40 mm or cover to pipe exeeds 2 m in poor ground extend the bedding material to 100 mm above the pipe crown

300 mm backfill free from stones greater than 40 mm (unless granular material extends 100 mm above pipe – see above)

As dug backfill

Granular material in accordance with BS5955 part 6 1980 : table 2 –

Pipe dia (mm)	Material (complying with BS882) (mm)
110	10, single sized
160	10, 14 single sized, 14–5 graded
200+	10, 14, 20 single sized, 14–5, 20–5 graded

RECOMMENDED CONSTRUCTION AND BEDDING

The following recommendations should be adopted when laying in the situations listed.

LOCATION	*DEPTH TO CROWN OF PIPE*	*BEDDING MATERIAL*	*BEDDING DETAIL*
Fields, Gardens (elsewhere than under roads)	0.6 metres to 6.0 metres	Excavated material with C.F. value not greater than 0.3 or imported granular material	As Fig. 1, Fig. 2, or Fig. 3
Fields, Gardens (elsewhere than under roads)	Less than 0.6 metres	Construction as detailed in Fig. 4	Fig. 4
Under Roads	Less than 0.9 metres (below final surface)	Construction as detailed in Fig. 4	Fig. 4
Under Roads	0.9 metres to 1.2 metres (below final surface)	Excavated material with C.F. value not greater than 0.15 or imported granular material	Fig. 1, Fig. 2 or Fig. 3
Under Roads	1.2 metres to 6.0 metres (below final surface)	Excavated material with C.F. value not greater than 0.3 or imported granular material	Fig. 1, Fig. 2 or Fig. 3

These requirements apply to trenches in stable soils. In less stable soils, i.e. soft clays, silts or fine sands, it may be desirable to double the thickness of granular bedding and surround given in Figures 1 to 3 and extra care should be taken in compaction.

FLEXIBILITY

The pipes themselves are flexible. However, where part of the pipe is embedded in concrete (e.g. at a manhole) additional flexibility should be provided by the use of two joints placed close to the concrete face.

The pipes themselves will stand cold bending to a radius of 250 pipe diameters.

JOINTING

SPECIAL NOTE

Above 315mm, jointing tackle is available. Never cut a Sewerdrain bend, the curved portion is not designed to form a joint and leakproof jointing may be impossible to achieve. (See jointing instructions.)

APPENDIX III

FLOW CHARTS

The Charts have been designed and prepared by Peter Lamont, M.A., F.I.C.E., F.I.W.E., using Colebrook's well-known Transition Region formula, which he has transposed into the form:

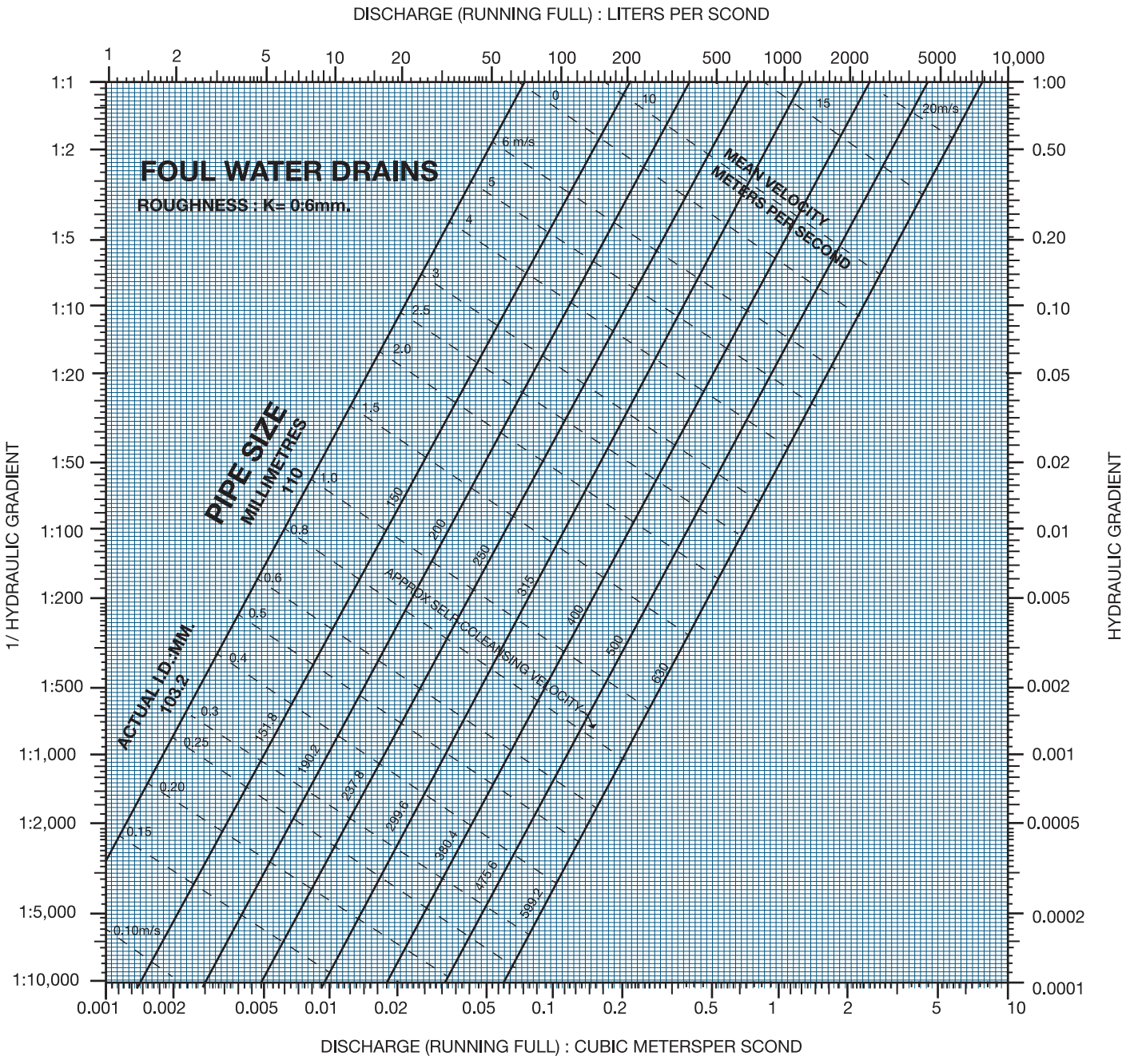
$$V = -2\sqrt{2gdi}\,\log\left(\frac{k}{3.7d} + \frac{2.51\nu}{d\sqrt{2gdi}}\right)$$

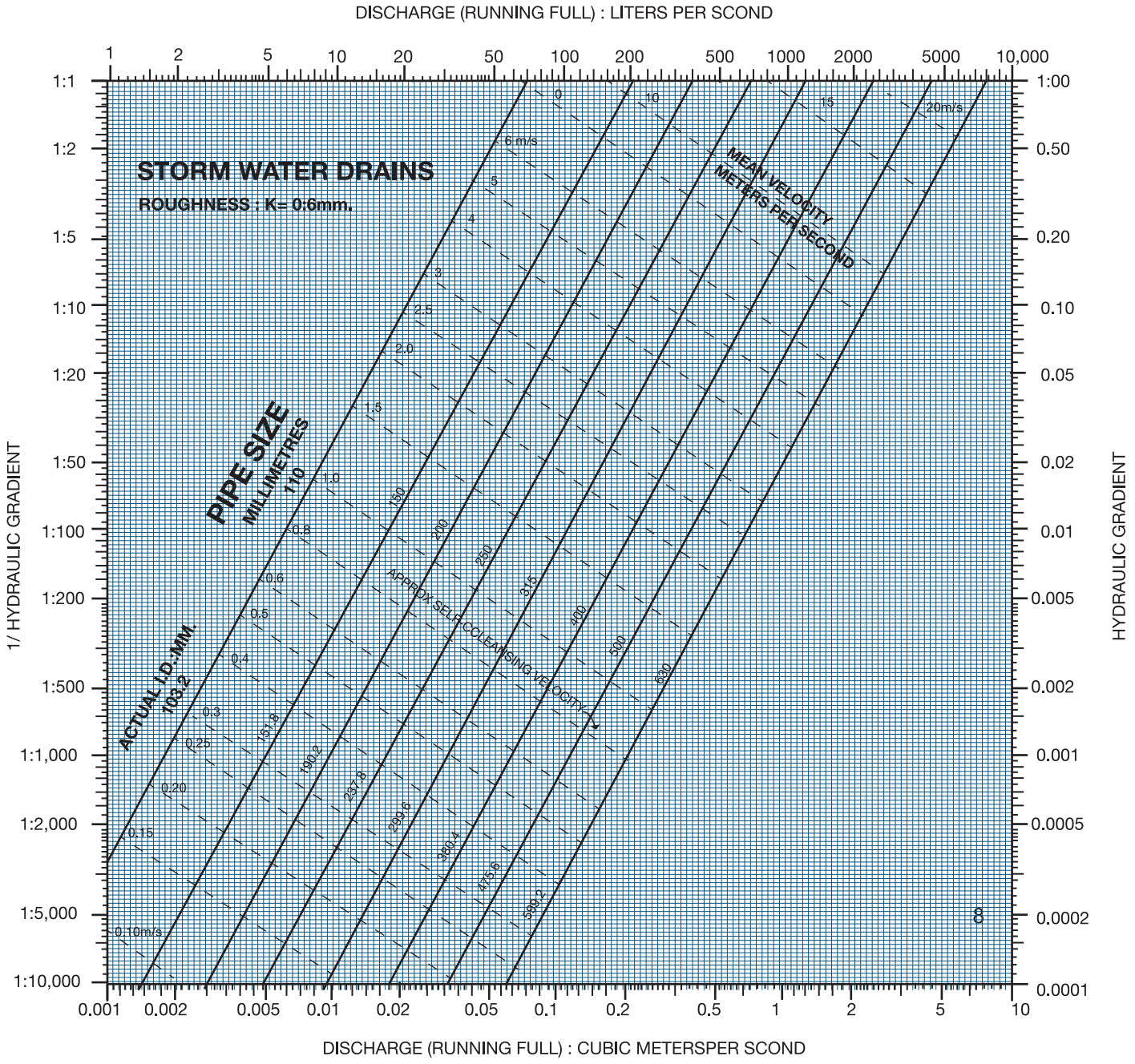
where
- V = velocity
- g = gravitational acceleration
- i = hydraulic gradient (dimensionless)
- ν = kinematic viscosity of fluid
- d = internal diameter
- k = a linear measure of effective roughness

Roughness values of 0.6mm and 0.003mm have been assumed for pipes carrying foul water and storm water respectively.

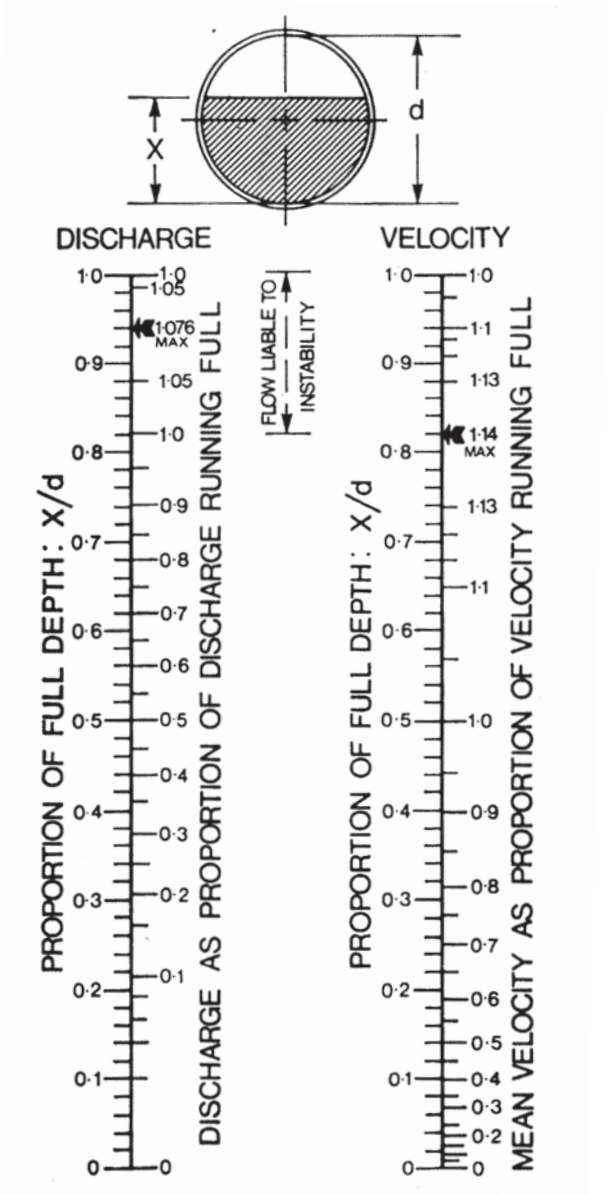
Diagrams have also been prepared for the proportionate discharge and velocity in circular pipes flowing partly full.

These have been based on velocity proportional to (hydraulic radius) $^{0.667}$ and may be used in conjunction with the values of discharge and velocity obtained from the Foul Water and Storm Water Diagrams.




DISCHARGE (RUNNING FULL) : LITERS PER SCOND
1
2
5
10
20
50
100
200
500
1000
2000
5000
10,000
1:1
1:2
1:5
1:10
1:20
1:50
1:100
1:200
1:500
1:1,000
1:2,000
1:5,000
1:10,000
1:00
0.50
0.20
0.10
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
1/ HYDRAULIC GRADIENT
HYDRAULIC GRADIENT
STORM WATER DRAINS
ROUGHNESS : K= 0.6mm.
PIPE SIZE
MILLIMETRES
1:0
0.8
0.6
0.5
0.4
0.3
0.25
0.20
0.15
0.10m/s
ACTUAL I.D.MM.
103.2
151.8
190.2
257.6
299.6
380.4
475.6
598.2
150
200
250
315
400
500
630
APPROX SELF CLEANSING VELOCITY
0
10
15
20m/s
6 m/s
5
4
3.5
3.0
2.5
2.0
1.5
MEAN VELOCITY
METERS PER SECOND
8
0.001
0.002
0.005
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
DISCHARGE (RUNNING FULL) : CUBIC METERSPER SCOND

SEWERDRAIN FLOWING PARTLY FULL



USE OF DIAGRAMS

The line diagrams above (based on V proportional to $d^{0.667}$) may be used to determine the discharge, velocity and/or depth of flow of **SEWERDRAIN** flowing partly full.

Example 1: A 315mm stormwater sewer (actual I.D.=299.6mm) at a gradient of 1 :300, has an estimated discharge when full of 85 l/s at a velocity of 1.2 m/s according to the stormwater chart.

Calculate discharge and velocity when running 2/3 full (i.e. x/d=0.667).

From discharge diagram: Proportional discharge=0.79.
Hence discharge=0.79 × 85=67 l/s.
From velocity diagram: Proportional velocity=1.108.
Hence velocity=1.108 × 1.2=1.3 m/sec.

Example 2: A 500mm foul water sewer (actual I.D.=475.6mm) at a gradient of 1 :400 has an estimated discharge when full of 180 l/s at a velocity of 1.05 m/s according to the foul water chart.

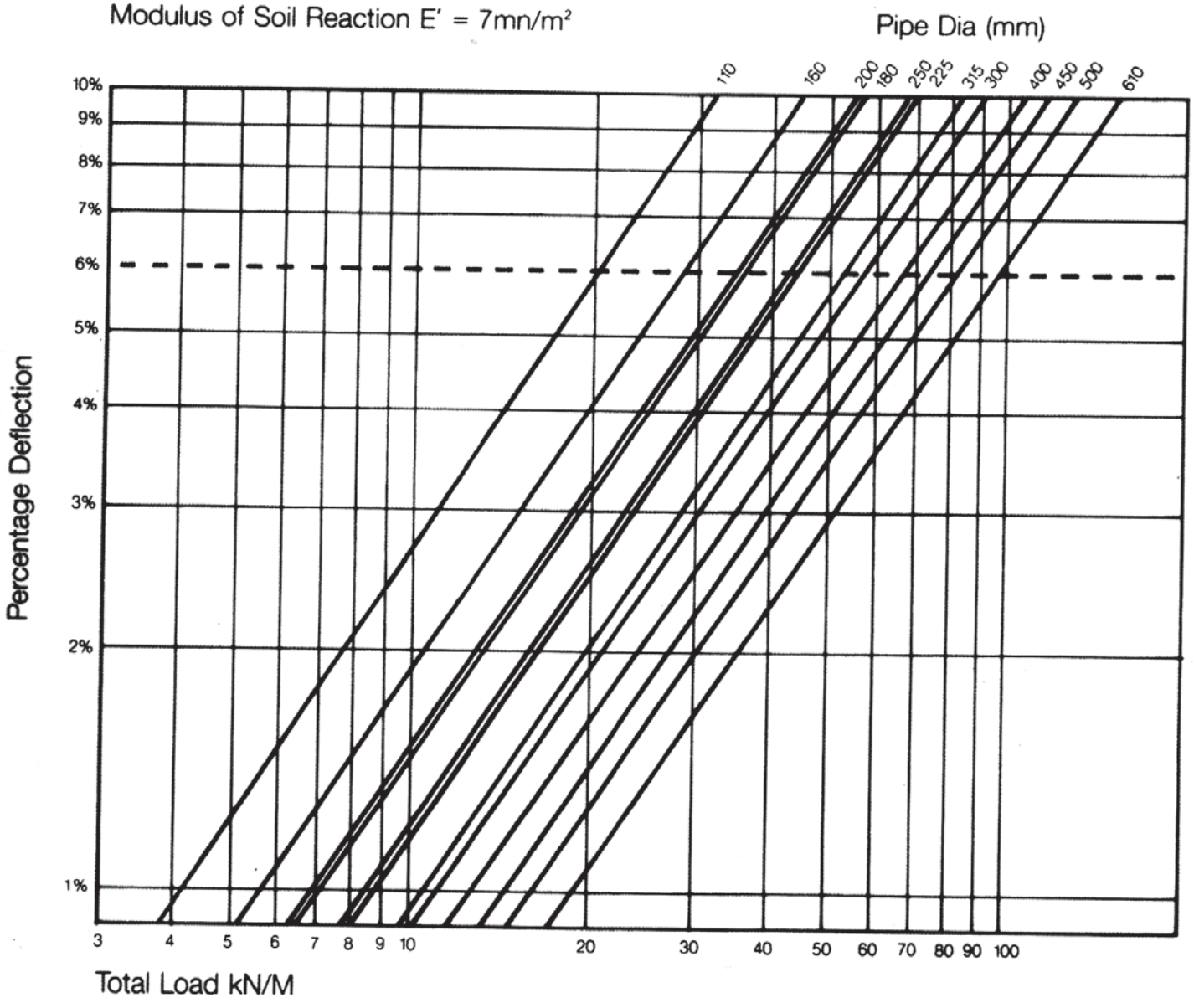
Calculate depth of flow and velocity for a discharge of 60 l/s.

Proportional discharge=60/180=0.333.
From discharge diagram: Proportional depth x/d=0.4.
Hence depth of flow=0.40 × 475.6=190mm.
From velocity diagram: Proportional velocity at x/d 0.40=0.90.
Hence velocity=1.05 × 0.90=0.95 m/s.

CHART No. 1

Predicted Deformation of PVC-U Pipes

Modulus of Soil Reaction E' = 7mn/m²



NB

If E' value of the bedding material differs from the above then separate calculations will be necessary

Soil and Traffic Load (kN/m)

Type of Load	Pipe diameter (mm)											
	110	160	180*	200	225*	250	300*	315	400	450	500	610
Depth of Cover 0.9 m												
Wide Trench Soil	2.0	2.9	3.6	3.6	4.5	4.5	6.0	5.7	7.2	8.2	9.1	11.0
Main Traffic	11.4	14.3	18.2	18.2	23.8	23.8	28.5	28.1	35.5	40.2	44.3	53.5
Light Traffic	9.2	11.5	14.7	14.7	19.1	19.1	24.2	22.6	28.6	32.3	36.0	45.6
Field Traffic	5.3	6.7	9.0	9.0	14.0	14.0	14.1	14.7	16.7	18.9	20.8	25.0
Depth of Cover 1.2m												
Wide Trench Soil	2.6	3.8	4.8	4.8	6.0	6.0	8.0	7.6	9.6	11.0	12.2	14.6
Main Traffic	8.6	10.9	14.0	14.0	18.2	18.2	23.2	21.4	27.1	30.6	33.8	41.0
Light Traffic	6.2	7.8	10.0	10.0	12.9	12.9	16.5	15.2	19.3	21.7	23.9	29.0
Field Traffic	3.6	4.6	5.8	5.8	7.6	7.6	9.6	8.9	11.2	12.7	14.0	16.9
Depth of Cover 1.8 m												
Wide Trench Soil	4.0	5.8	7.2	7.2	9.0	9.0	12.1	11.3	14.4	16.5	18.3	22.0
Main Traffic	5.9	7.5	9.7	9.7	12.6	12.6	16.2	14.9	18.9	21.5	23.9	29.0
Light Traffic	3.3	4.1	5.2	5.2	6.8	6.8	8.8	8.1	10.3	11.8	12.8	15.6
Field Traffic	1.9	2.4	3.0	3.0	4.0	4.0	5.1	4.7	6.0	6.8	7.5	9.1
Depth of Cover 2.4 m												
Wide Trench Soil	5.3	7.7	9.6	9.6	12.0	12.0	16.1	15.1	19.2	21.9	24.3	29.3
Main Traffic	4.6	5.7	7.3	7.3	9.6	9.6	12.4	11.4	14.5	16.4	18.1	22.1
Light Traffic	1.9	2.5	3.2	3.2	4.1	4.1	5.3	4.9	6.3	7.1	7.8	9.5
Field Traffic	1.2	1.5	1.9	1.9	2.4	2.4	3.1	2.8	3.6	4.1	4.6	5.5
Depth of Cover 3.0 m												
Wide Trench Soil	6.6	9.6	12.0	12.0	15.0	15.0	20.1	18.9	24.0	27.4	30.4	36.6
Main Traffic	3.6	4.5	5.8	5.8	7.5	7.5	9.4	8.9	11.2	12.8	14.2	17.3
Light Traffic	1.3	1.7	2.2	2.2	2.9	2.9	3.7	3.4	4.2	4.6	5.1	6.4
Field Traffic	0.7	1.0	1.3	1.3	1.7	1.7	2.1	1.9	2.3	2.7	3.1	3.7
Depth of Cover 4.0 m												
Wide Trench Soil	8.8	12.8	16.0	16.0	20.0	20.0	26.8	25.1	32.0	36.6	40.6	48.8
Main Traffic	2.5	3.2	4.2	4.2	5.4	5.4	6.9	6.4	8.0	9.1	10.1	12.2
Light Traffic	0.8	0.1	1.4	1.4	1.7	1.7	2.2	2.0	2.5	2.9	3.2	3.9
Field Traffic	0.4	0.6	0.7	0.7	1.0	1.0	1.2	1.1	1.4	1.6	1.8	2.2
Depth of Cover 4.9 m												
Wide Trench Soil	10.8	15.7	19.6	19.6	24.5	24.5	32.8	30.9	39.2	44.8	49.7	59.8
Main Traffic	1.9	2.5	3.2	3.2	4.0	4.0	5.1	4.7	5.9	6.7	7.4	9.0
Light Traffic	0.5	0.7	0.9	0.9	1.2	1.2	1.5	1.3	1.7	1.9	2.1	2.6
Field Traffic	0.3	0.4	0.4	0.4	0.7	0.7	0.9	0.8	1.0	1.1	1.2	1.5
Depth of Cover 6.1 m												
Wide Trench Soil	13.4	19.5	24.4	24.4	30.5	30.5	40.9	38.4	48.8	55.8	61.9	74.4
Main Traffic	1.3	1.7	2.2	2.2	2.7	2.7	3.5	3.2	4.1	4.7	5.2	6.3
Light Traffic	0.3	0.5	0.6	0.6	0.7	0.7	0.9	0.8	1.1	1.2	1.3	1.7
Field Traffic	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.9

* NB 180 mm, 225 mm and 300 mm are Ultra-Rib internal diameters, the outside diameters are 200 mm, 250 mm and 335 mm respectively.

APPENDIX I

TESTS FOR SUITABILITY OF SOIL MATERIAL FOR SURROUNDING SEWERDRAIN

PARTICLE SIZE

The ideal is granular (no fines) material 10mm to 20mm.
The maximum particle size should generally not exceed 20mm but the presence of an occasional particle between 20mm and 40mm is acceptable, if the total quantity of such particles is only a very small fraction of the whole. If particles larger than 40mm are present, the material should be rejected.

In cases of doubt a representative sample of approximately 2 kg should be weighed and sieved using 20mm and 40mm sieves. If any particles are retained on the 40mm sieve or more than 5% by mass of the sample is retained on the 20mm sieve, the material is unsuitable; unless the whole is sieved before use, thus removing the larger particles.

TEST FOR COMPACTION (see British Standards CP 312)

Apparatus
(1) Open cylinder 250mm long and 150mm ± 6mm internal diameter (160mm Sewerdrain is suitable).
(2) Metal ram with striking face 40mm in diameter, weighing 1 to 1.25 kg.
(3) Rule.

Method

Obtain a representative sample more than sufficient to fill the cylinder (approximately 11 kg). It is important that the moisture content of the sample should not differ materially from that of the main body of material at the time of its use in the trench.

Place the cylinder on a flat firm surface and gently pour the sample material into it, loosely and without tamping. Strike off the top surface level with the top of the cylinder and remove the spilled material. Lift the cylinder clear of its contents and place on a fresh area of surface. Place about one quarter of the contents back in the cylinder and tamp vigorously with the metal ram until no further compaction can be obtained. Repeat with the second quarter, and so on with the third and fourth quarter, tamping the final surface as level as possible.

Measure down from the top of the cylinder to the surface of the compacted material.

This distance (in mm) divided by the height of the cylinder (in mm) is the compaction fraction.

RESULTS

Compaction Fraction	Suitability
0.15 or less	Material suitable.
0.15 to 0.3	Material suitable but requiring extra care in compaction. Not suitable if the pipe is subject to waterlogged conditions after laying.
Over 0.3	Material unsuitable.

APPENDIX II

CHEMICAL RESISTANCE

Sewerdrain is suitable for use with most acids, alkalis and aqueous solutions (strong oxidising agents excluded), aliphatic hydro-carbons, plating solutions and mineral oils.

Solvents such as ketones, aldehyds, ethers, esters, aromatic hydrocarbons and halogenated hydrocarbons attack Sewerdrain, even in low concentrations.

For more detailed information contact our Technical Department, or consult British Standard Code of Practice CP 312 Part 1 :1973.

Pipes and Fittings Jointing

Plastidrain Polypropylene Couplings 110 and 160mm diameter:

The polypropylene coupling incorporates an elastomeric sealing ring which is compressed by the pipe spigot to form an effective seal. Each joint permits 5° of angular deflection to facilitate installation and allow for ground movement.

Before making the joint ensure that both the pipe end and the sealing ring are clean. Lubricant should be applied to the pipe end which is then inserted into the coupling.

Should the pipe require cutting, the cut end should be chamfered to approximately 15° for half the pipe wall thickness and deburred with a sharp edged tool.

No special provision is necessary to accommodate thermal expansion, this is automatically achieved by the polypropylene coupling.

Plastidrain and Sewerdrain PVC-U couplings and single sockets :

Before making the joint ensure that both the pipe end and the sealing ring are clean, should cutting be necessary the pipe end should be chamfered as above. Lubricate both the pipe end and the sealing ring in the socket. Ensure that the components to be joined are correctly aligned, then push the spigot fully into the socket. The jointing of larger diameters is generally accomplished by applying leverage to the following socket end using a timber block to prevent damage.

To allow for expansion, mark the spigot at the socket face and then withdraw the spigot by a minimum of 12mm. If the spigot is already marked with the depth of entry, push the spigot home until the mark is just visible.

Ultra-Rib

The Ultra-Rib sealing ring is placed on the pipe spigot rather than being housed in the socket, hence there is no need to chamfer any cut ends. The spigot and socket should be cleaned, then the sealing ring positioned between the second and third ribs, ensuring that it is seated squarely without twisting. Lubricate the whole of the inside of the socket, align the components to be joined, and “feed” the spigot into the socket. Push the spigot home by applying leverage to the trailing pipe end, using a timber block to prevent damage. Mechanical aids should not be required. The pipe spigot is fully home when the pipe end meets the shoulder of the socket (ie when the fifth rib has entered the socket).

Trench Backfilling

Hand tamp the backfill fully at the sides of the pipe while tamping lightly over the crown. Hand tamping should continue until a minimum thickness of 300mm has been placed over the pipe.

“As dug” material may then be placed in 300mm layers and mechanically compacted. Dumpers or other vehicles must not be driven along the trench as a means of compaction.

Testing

All lengths of drains and sewers installed correctly using Hepworth PVC-U drainage systems will be capable of passing the appropriate air or water test specified. The former is usually more convenient but an excessive drop in pressure may be due to a change in temperature, defective apparatus or failure in the pipeline. It is therefore recommended that a water test follows an unsatisfactory air test so that the leakage can be assessed and located (seen (a) and (b) over page).

(a) **Air test**

(i) The length of drain or sewer to be tested including any connections should be effectively plugged.

(ii) Air is pumped into the test length by suitable means (e.g. hand pump) until a pressure of 100mm of water is indicated on a manometer connected to the system.

(iii) A suitable time should be allowed for stablilisation of air temperature.

(iv) The air pressure should not fall below 75mm of water during a period of five minutes, without further pumping.

(b) **Water test**

(i) Suitable strutted plugs are inserted at the lower end of the drain or sewer and at the head of any connections.

(ii) A suitable bend together with a vertical length of pipe is fitted at the head of the sewer or drain to provide the necessary test head. The system is then filled with water.

(iii) A test pressure of 1.50m head above the crown of the pipe is applied at the higher end of the drain or sewer ensuring that the resultant head at the lower end does not exceed 4.0m. Where gradients are steep, it may be necessary to test in sections to avoid exceeding this figure.

(iv) The sewer or drain under test should be left filled with water for 1-2 hours.

(v) The loss of water over a period of 30 minutes should be measured, by adding known quantities of water every 10 minutes to maintain the original level in the stand pipe. The loss of water should not exceed the equivalent 1 litre per hour, per linear metre, per metre of nominal diameter. The source of any leakage should be visible and the defective part of the work should be removed and made good.

(vi) During the water test, strutting precautions should be taken to prevent any movement of the drain or sewer.

Installation above ground

Frost:

PVC-U pipes become less resistant to impact at sub zero temperatures. The pipe should be protected accordingly in exposed conditions. Waterproof lagging should be carried out if the pipes are to stand full under no-flow conditions.

Thermal movement

Thermal expansion and contraction should be allowed for and sufficient freedom of movement allowed for at brackets. Change in length can be calculated from the formula :-

$$\Delta L = \alpha L \Delta T$$

where ΔL = change in length (mm)

α = coefficient of liner expansion = 0.05mm/m/°C

ΔL = change in temperature °C

Pipe Support Brackets :

These should be as wide as practicable with a minimum width of 75mm, with no sharp edges. Bare metal is not advisable, and should have a plastic coating or incorporate a rubber seal for protection.

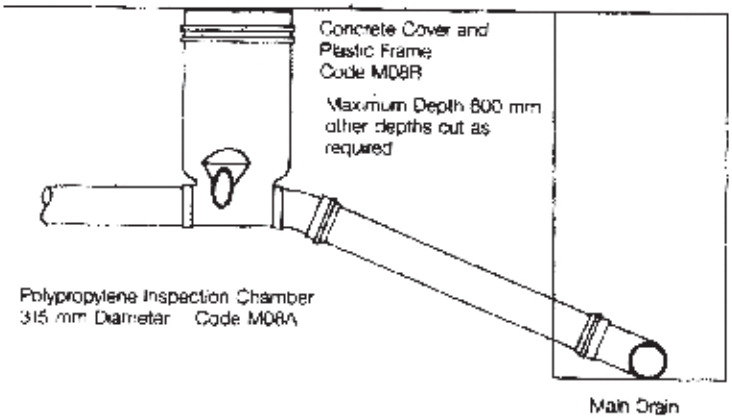
Pipe Support Centres :

These are dependent on the temperature of the contents and the weight. For normal conditions in horizontal pipework, the centres should not exceed :

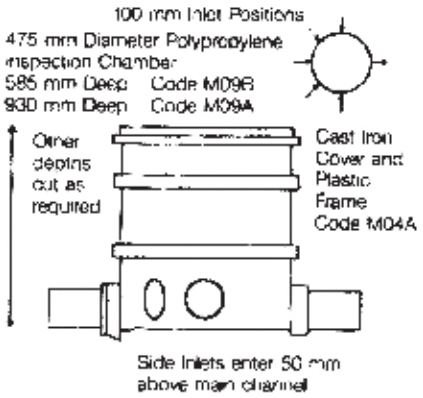
110	160	180/200	225/250	300/315	400	450	500	610 (mm)
1.0m	1.2m	1.5m	1.7m	1.8m	2.0m	2.1m	2.2m	2.5m

For vertical pipework, these distances may be doubled.

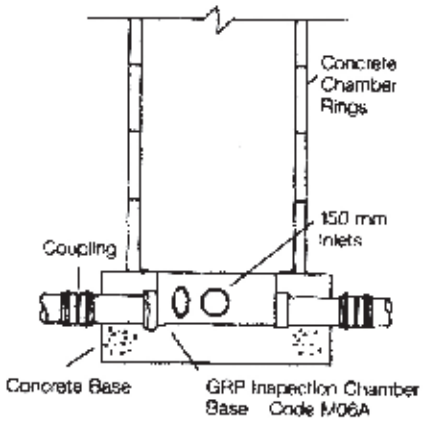
Application Details



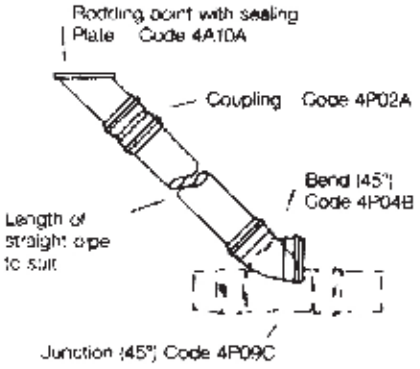
119 Polypropylene Inspection Chamber (Positioned off main drain run)



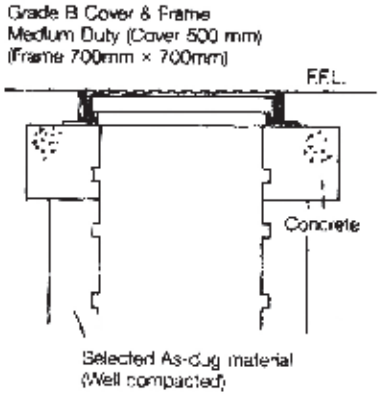
150 Polypropylene Inspection Chamber



154 GRP Inspection Chamber Base

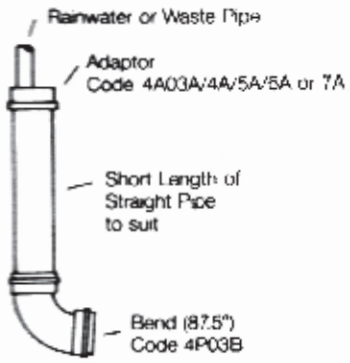


121 Rodding Point at head of drain
122 on branch drain

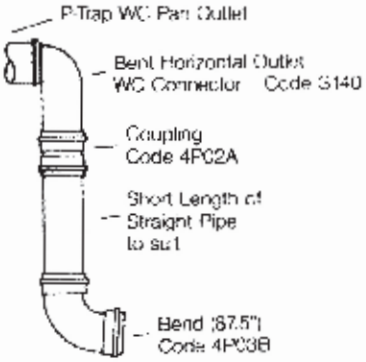


152 Chamber sited in Trafficked Area

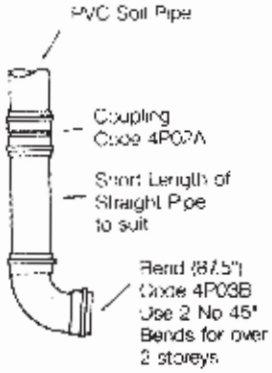
Application Details



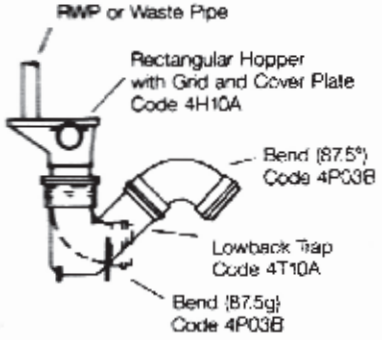
101 Connection for RWP or Waste Pipe



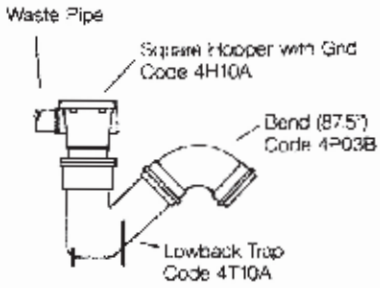
102 Connection for P-Trap WC



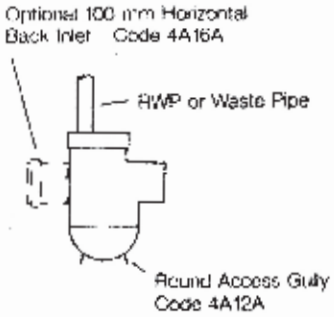
104 Connection for Soil & Vent Pipe



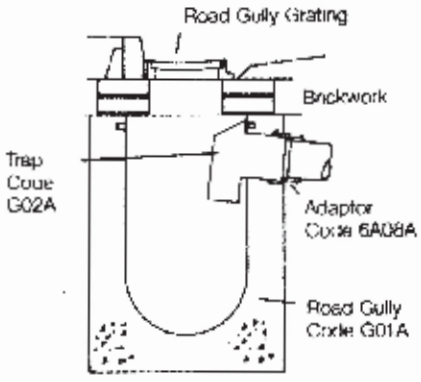
116 Vertical Inlet Trapped Gully
116A Untrapped Gully



113 Horizontal Inlet Trapped Gully

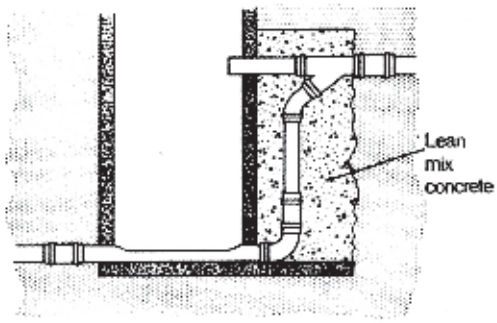


118 Vertical Inlet Access Gully
118A With Back Inlet



140 Polypropylene Road Gully

CONSTRUCTION OF MANHOLES AND BONDING TO CONCRETE



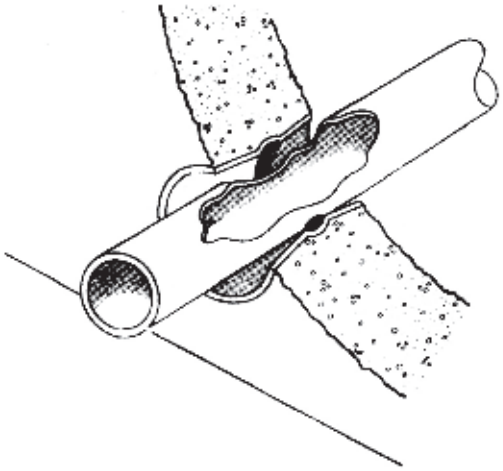
EXTERNAL BACKDROP MANHOLE

Manholes should be constructed in accordance with CP 301.1971. BS Code of Practice Building drainage and/or CP 2005 "Sewerage".

It is useful to consider the following :

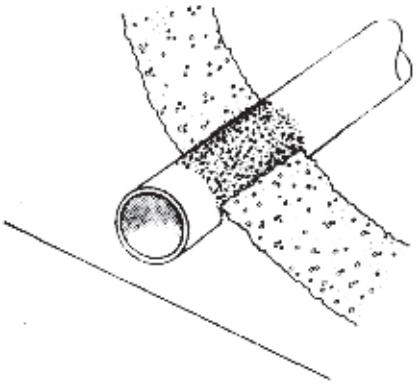
This provides a watertight seal, which gives a degree of flexibility, to take care of differential settlement.

WALL PROTECTION SLEEVE



BONDING TO CONCRETE

Since u.P.V.C. pipes are extremely smooth the surface needs treatment before a satisfactory bond can be produced. This is best achieved by painting the surface with solvent cement and, whilst it is still wet, sprinkling with *dry* coarse sand or grit. Once the surface has dried, it will bond directly to concrete.



USEFUL LITERATURE

BS Code of Practice 2005 "Sewerage".

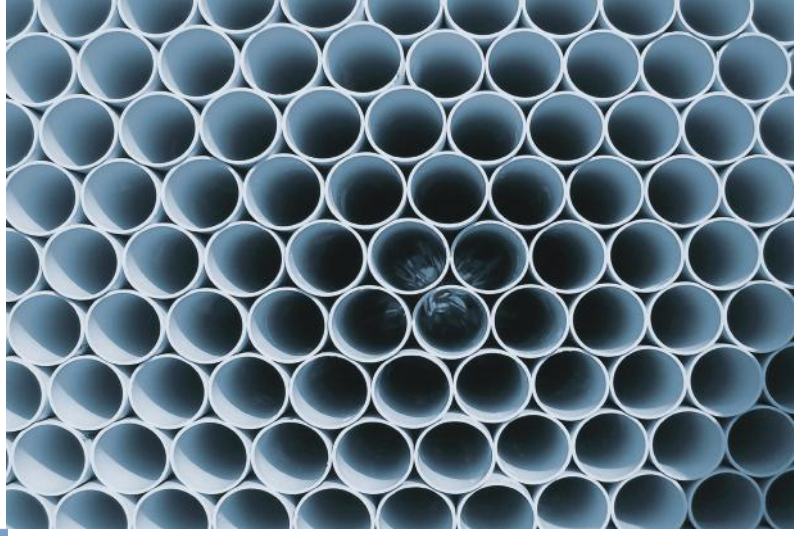
BS Code of Practice 301 :1971 "Building Drainage".

BS Code of Practice 312 Parts 1 and 2 1973 "Plastic Pipework".

"Note of Guidance on Practical Considerations in the Structural Design and in the Construction of Small Diameter Sewers and Drains" (HMSO : 1967).

NOTES

NOTES



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