NOTES:

1. This information should be used as guidance material only. Definitive assessment of native soil AHBP can be obtained through specialist geotechnical advice (refer to section 7.5.1 of WSA03).
2. Native soil strength has significance in the design of the following attributes:
   a. Pipeline selection (eg. Weaker ground requires stiffer pipes with greater hoop / flexural strength)
   b. Embedment & backfill design (eg. Weaker ground may lead to the pipeline requiring a stiffer embedment material).

PREPARING THE TEST AREA:

Conduct all native soil identification tests on a freshly exposed, damp, hand- trimmed area of the trench wall in the pipe zone. Take care that the soil in the exposed test area is not compacted or loosened during trench excavation. If the soil in the trench floor and wall is very dry at the time the trench is opened then flood the test area and allow time for the water to be absorbed by the soil before it is trimmed and tested.

IDENTIFYING CLAY SOILS:

A lump of clay soil will be difficult to break when dry. It will be sticky and need some effort to mould with the fingers when wet. Clay will not wash off easily. Individual clay particles are hard to see.

TESTING CLAY SOILS:

Clay soils are best tested at the wall of the trench. The fist, the thumb or the thumbnail may be used to determine the consistency (strength) of the clay (see table.)

IDENTIFYING CLEAN SAND SOILS:

The individual grains of sand will be visible to the eye. If a lump of sand is picked up, it will crumble with very little effort. Clean sand washes off easily.

TESTING CLEAN SAND SOILS:

Clean sand soils are best tested in the floor of the trench by pushing with the whole body weight on one foot. The depth of the depression left by the boot is related to the density of the sand (see table). Take care to ensure that the sand in the trench floor was not compacted or loosened during the excavation of the trench or the trimming of the test area.

TESTING ROCK:

The recommended field identification tests for rock rely on observing the ease with which the rock can be dug with a pick, and estimating the spacing of the joints in the rock. (joints are commonly called cracks or breaks). The spacing between joints is important because the allowable bearing pressure on rock is usually controlled by the joints in it, rather than the inherent strength of a fragment of rock. Joints may be tightly closed (like hairline cracks), but can also be open (filled with air) or filled with soft clay or other soil.

SOIL CLASSIFICATION		FIELD IDENTIFICATION TEST	AHBP kPa	SOIL MODULUS (MPa)
CLAY SOILS	VERY SOFT	EASILY PENETRATED 40 mm WITH FIST.	*< 50* *	*1*
	SOFT	EASILY PENETRATED 40 mm WITH THUMB.	*< 50* *	*2*
	FIRM	MODERATE EFFORT NEEDED TO PENETRATE 30 mm WITH THUMB.	*< 50* *	*3*
	STIFF	READILY INDENTED WITH THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.	50	6
	VERY STIFF	READILY INDENTED WITH THUMBNAIL.	100	9
	HARD	INDENTED WITH DIFFICULTY BY THUMBNAIL.	200	12
SANDS	LOOSE CLEAN SAND	TAKES FOOTPRINT MORE THAN 10 mm DEEP.	*< 50* *	*2*
	MEDIUM-DENSE CLEAN SAND	TAKES FOOTPRINT 3 mm TO 10 mm DEEP.	50	4
	DENSE CLEAN SAND OR GRAVEL	TAKES FOOTPRINT LESS THAN 3 mm DEEP.	100	7
ROCK	BROKEN OR DECOMPOSED ROCK	DIGGABLE. HAMMER BLOW "THUDS". JOINTS (BREAKS IN ROCK) SPACED AT LESS THAN 300 mm APART.	100	15
	SOUND ROCK	NOT DIGGABLE WITH PICK. HAMMER BLOW "RINGS" JOINTS (BREAK IN ROCK) SPACED MORE THAN 300 mm APART.	200	>15
UNCOMPACTED FILL REFUSE (TIP)		OBSERVATION AND KNOWLEDGE OF THE SITE HISTORY.	*< 50* *	*1*

NOTES:

* SPECIAL GEOTECHNICAL ASSESSMENT REQUIRED

ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE

REV	DESCRIPTION	DATE	APPROVED
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ

	NAME	DATE		NAME	DATE
DESIGNED:	R. JAGGER	1 JULY 2015			
DRAWN:	R. JAGGER	1 JULY 2015			
CHECKED: ☒ CWW	D. MOORE	01/09/15	APPROVED: ☒ CWW	R. CARRUTHERS	01/09/15
☒ SEW	C. PAXMAN	01/09/15	☒ SEW	D. O'DONOVAN	01/09/15
☒ YVW	K. DAWSON	01/09/15	☒ YVW	J. TOMASI	01/09/15
ISSUED 2015			VERSION 1		

MELBOURNE RETAIL WATER AGENCIES

City West Water™ · South East Water · Yarra Valley Water

MRWA SEWERAGE STANDARDS

SOIL CLASSIFICATION GUIDELINES AND ALLOWABLE HORIZONTAL BEARING PRESSURE

NOT TO SCALE

MRWA-S-200

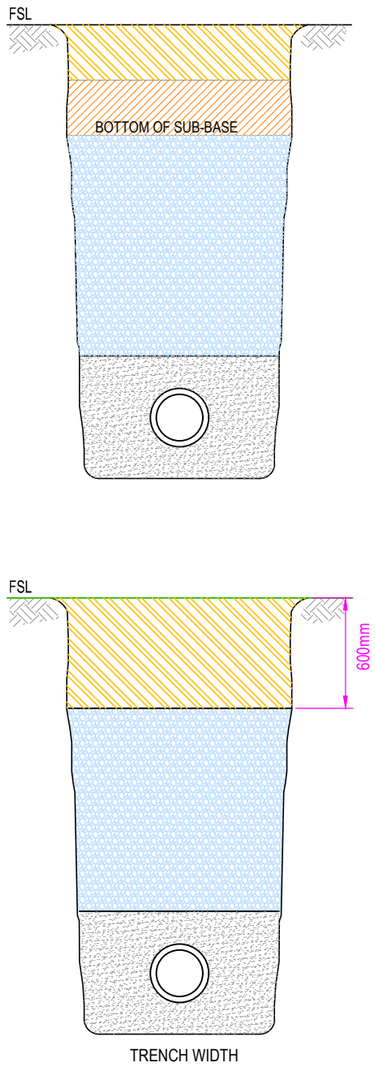
Planning	Design	Construction
	✓ ✓	

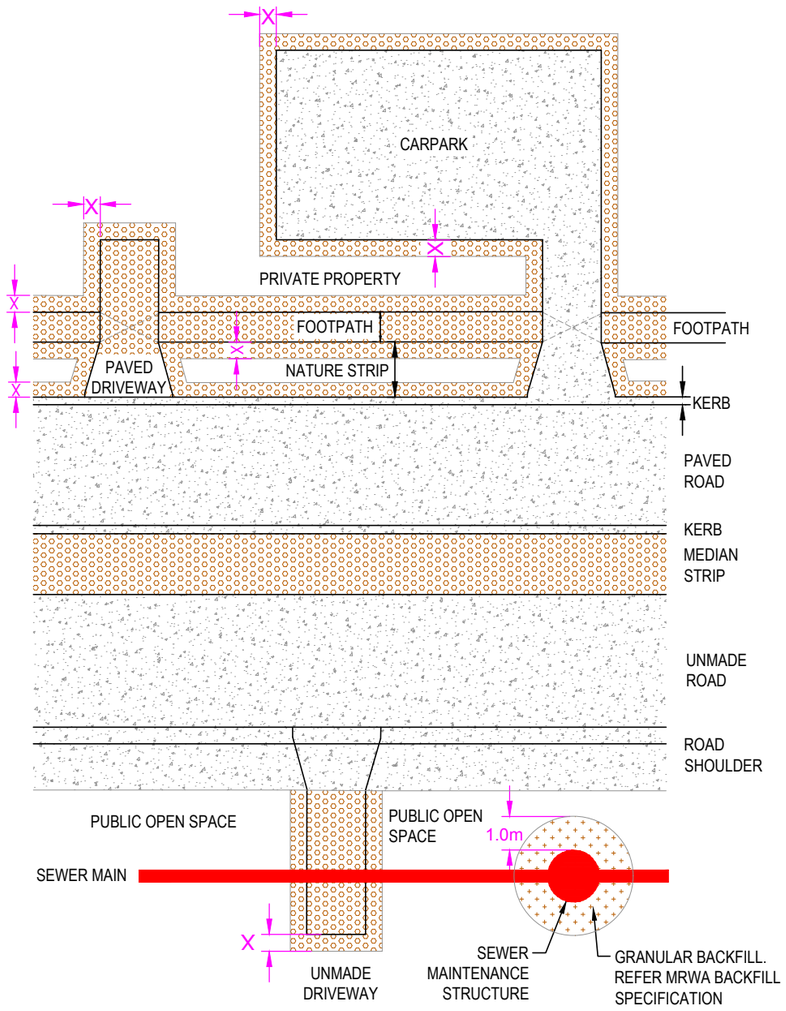
TABLE 201-A: TRAFFICABLE AREAS (TYPE R or F BACKFILL)

TRENCH ZONE	PREFERRED MATERIALS	PRODUCT SPEC. No.	METHOD OF PLACEMENT	MINIMUM COMPACTION
PAVEMENT ZONE	REFER TO ROAD OWNERS SPECIFICATION			98% R_D TOP 100mm
SUB-BASE ZONE	REFER TO ROAD OWNERS SPECIFICATION			
BACKFILL ZONE	Refer to road owners specification, if not available: comply with MRWA backfill spec - MRWA spec 04.03, summarised as follows: A. For trenches <1.5 m deep in Type R situation: the backfill shall be 20mm Class 3 plant wet mixed crushed rock, for the full depth. B. For trenches > 1.5 m in Type R situation: • 20mm class 3 plant wet mixed crushed rock above the sub-base level. • 20mm class 4 (or better) crushed rock for the remainder. C. In Type F situations: • the backfill shall be 20mm Class 4 (or better) crushed rock.	VIC ROADS SPECS 812 FOR CLASS 3 & 4 FCR. 818 FOR CLASS 4 CRUSHED SCORIA. 820 FOR CLASS 4 CRUSHED CONCRETE.	Backfill material shall be placed and compacted in layers and moisture conditioned as required to achieve the required density. Where hand held or walk behind compaction equipment is used on the backfill zone, avoid compaction within 300mm of top of pipe. Where heavier compaction is used in the backfill zone, avoid compaction within 1200mm of top of pipe.	95% R_D
EMBED-MENT ZONE	• Refer to MRWA-S-202. • All nominated embedment is satisfactory in Type R situations, however, it is critical that embedment have the correct moisture content and be properly placed to achieve adequate compaction. • Selected materials shall be worked around the pipe to ensure all voids at haunches are filled and the pipe is provided with good support along its entire length. • Embedment to be placed under the haunches by shovel and compacted using hand tampers or vibrating probes or plates. • Risk of pipeline deflection may be further reduced by: •• increasing the depth of the overlay (to up to 1m), or •• cement stabilising the top surface of the embedment (hand distributed cement at 2 kg per square metre, worked into the top surface by shovel).			70% i_D

TABLE 201-B: NON TRAFFICABLE AREAS

TRENCH ZONE	PREFERRED MATERIALS	METHOD OF PLACEMENT	COMPACTION REQUIRED
BACKFILL ZONE	Refer to Backfill Specification - MRWA specification 04.03. • For backfill < 1.5m deep, selected or ordinary fill. A. Selected Fill. Material that is free from organic or other deleterious material, obtained from excavation or imported, with a particle size of rock not greater than 20mm, or for other than rock not greater than 75mm (refer AS2566.2-2002). B. Ordinary Fill. Material obtained from excavation or imported that contains not more than 20% by mass of rock fragments with size between 75mm and 150mm, with no rock or clay fragments greater than 150mm (refer AS2566.2-2002). • For backfill > 1.5m deep, as per project specific backfill specification.	Refer to Backfill Specification - MRWA specification 04.03. • For backfill < 1.5m deep, selected or ordinary fill placed as required to meet the nominated compaction density. • For backfill > 1.5m deep, place as specified in the project specific backfill specification. Place and compact in layers and moisture condition as required. Where hand held or walk behind compaction equipment is used in the backfill zone, avoid compaction within 300mm of top of pipe. Where heavier compaction is used in the backfill zone, avoid compaction within 500mm from the top of pipe.	95% R_D TOP 600mm 90% R_D
EMBED-MENT ZONE	• Refer to MRWA-S-202. • The embedment proposed is satisfactory in non trafficable situations, however, it is critical the embedment have the correct moisture content and be properly placed to achieve maximum compaction. • Selected materials shall be worked around the pipe to ensure all voids at haunches are filled and the pipe is provided with good support along its entire length. Embedment to be placed under the haunches by shovel or fork and compacted to the required density.		60% i_D





X IS A DISTANCE EQUIVALENT TO THE MAINS DEPTH TO A MAXIMUM OF 1m

TYPE R TRAFFICABLE AREA

TYPE F TRAFFICABLE AREA

FIGURE 201-B: TYPE R AND TYPE F LOCATIONS

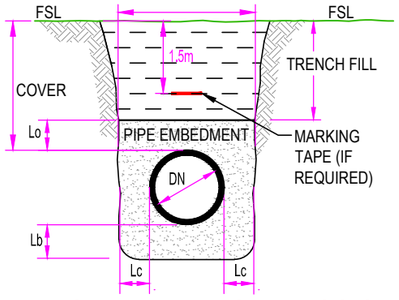


FIGURE 201-A: TRENCH DIMENSIONS

NOTES Regarding Figure 201-A:

A. Sides of excavation to be kept vertical to at least 150 above the pipe.
B. All rock intrusions out of trench wall must be removed prior to any pipe laying operations.
C. Any foreign matter such as vegetation or litter shall be removed from the trench prior to pipe laying and backfill.
D. Marker tape is required where the sewer is **not** the deepest service.
E. Place marker tape at 1.5m deep or on first backfill layer, whichever is shallower.

TABLE 201-C: MINIMUM COVER

LOCATION	MINIMUM COVER
NON TRAFFICABLE	600
TYPE F TRAFFICABLE	750
TYPE R TRAFFICABLE (LOCAL ROADS)	900
TYPE R TRAFFICABLE (MAJOR & ARTERIAL ROADS)	1200

NOTES Regarding Table 201-C:

a. Location definitions are provided in the MRWA backfill spec 04.03.
b. Major and arterial roads are vicroads declared main roads.
c. All other roads can be considered as local roads.

TABLE 201-D: TRENCH DIMENSIONS

SEWER SIZE (DN)	L_B :BEDDING DEPTH MINIMUM	L_B :BEDDING DEPTH MAXIMUM[1]	L_O :OVERLAY (MINIMUM)	L_C :SIDE SUPPORT MINIMUM	L_C :SIDE SUPPORT MAXIMUM
100 / 150	75	150	100^2 / 300^3	100	350
225 / 300	100	200	150^2 / 300^3	150	400
375 / 450	100	200	150^2 / 300^3	200	450
525 - 900	150	250	150^2 / 300^3	250	500
> 900	150	250	200^2 / 300^3	300	550

NOTES Regarding Table 201-D:

1. If maximum bedding depth is exceeded, fill over excavation with special embedment as per drawing MRWA-S-202.
2. The first minimum overlay figure is the minimum overlay required when walk behind trench backfill compaction equipment is to be used.
3. The second minimum overlay figure is the minimum overlay required when:
   3.1. Ride on trench backfill compaction equipment is to be used, or
   3.2. The sewerage pipe is in the road carriageway.
   3.3. This assumes that the first trench fill layer will be at least 200 thick (when compacted) so that there is a total cover > 500 during mechanical compaction.

ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE

REV	DESCRIPTION	DATE	APPROVED
3	CHANGE TO TYPE R BACKFILL & DRIVEWAYS	01/07/16	RJ / CP / JT
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ

		NAME	DATE
DESIGNED:		R. JAGGER	1 JULY 2015
DRAWN:		R. JAGGER	1 JULY 2015
CHECKED:	☒ CWW	D. MOORE	01/09/15
	☒ SEW	C. PAXMAN	01/09/15
	☒ YVW	K. DAWSON	01/09/15
APPROVED:	☒ CWW	R. CARRUTHERS	01/09/15
	☒ SEW	D. O'DONOVAN	01/09/15
	☒ YVW	J. TOMASI	01/09/15

ISSUED 2015

VERSION 1

MELBOURNE RETAIL WATER AGENCIES

City West Water™

South East Water

Yarra Valley Water

MRWA SEWERAGE STANDARDS

TRENCHING AND TRENCHFILL

NOT TO SCALE

MRWA-S-201

Planning	Design			Construction			
	✓			✓	✓	✓	✓

TABLE 202-A: EMBEDMENT SYSTEM SELECTION

SITUATION	DESCRIPTION	WHEN TO USE
TYPE A	GRADED	NO STRUCTURAL ISSUES OR GROUND WATER
TYPE B	CEMENT STABILISED	ASSET PROTECTION REQUIRED. eg: SEWERS UNDER MAJOR CROSSINGS
TYPE C	CONCRETE ENCASED	HIGH RISK OF THIRD PARTY DAMAGE
TYPE D	SINGLE SIZED AGGREGATE	SIGNIFICANT GROUND WATER IS PRESENT OR MAY BE COMMON
TYPE E	CEMENT STABILISED BASE	WHERE UNINTENTIONAL OVER EXCAVATION OCCURS DURING TRENCH EXCAVATION
TYPE F	CONCRETE BASE	UNSTABLE GROUND AND NO SIGNIFICANT RISK OF THIRD PARTY DAMAGE

NOTES Regarding Table 202-A:

1. The designer shall specify the appropriate embedment system(s) for all pipelines.
2. All embedment systems nominated are suitable for all pipe types.
3. Where the contractor finds that the ground conditions are different to that expected by the designer (eg: when ground water is observed and Type A embedment proposed), the designer shall be consulted regarding the embedment system selection.

Type B: Use premixed cement stabilised class 3 FCR in high risk situations, eg:

- where minimum cover cannot be achieved.
- major crossings (rail, tram, river, freeway) where requested by the authority.
- where sewer at grade > 1 in 20.

Type C: Requires Water Agency approval. Pipes may be susceptible to third party damage where excavators will likely operate near the sewer main, eg: the sewer main crosses an open waterway which may be excavated.

Type F: Unstable ground can exist where:

- ground susceptible to land slip.
- highly reactive clays to the depth of the sewer main.
- old refuse sites.
- decomposing soils high in organic content.
- un-compacted ground.

TABLE 202-B: EMBEDMENT MATERIALS

ITEM	DESCRIPTION	WSAA PRODUCT SPECIFICATION	PARTICLE SIZE MAX.	SIZE DISTRIBUTION	MODULUS (WET) MPa
a	EMBEDMENT SAND	WSA PS 360	10	GRADED	5
b	5mm MINUS CRUSHED ROCK	WSA PS 361	5	GRADED	3
c	7mm CRUSHED ROCK	WSA PS 361 SEW	7	GRADED	5
d	RECYCLED GLASS SAND	WSA PS 368	4	GRADED	5
e	10mm WELL GRADED CRUSHED ROCK	WSA PS 362	10	GRADED	3
f	20mm WELL GRADED CRUSHED ROCK	WSA PS 362	20	GRADED	5
g	5 / 7mm SINGLE SIZED AGGREGATE	WSA PS 351	7	SINGLE SIZED	10
h	10mm SINGLE SIZED AGGREGATE	WSA PS 351	10	SINGLE SIZED	10
i	10 / 14mm SINGLE SIZED AGGREGATE	WSA PS 351	14	SINGLE SIZED	7
j	14mm SINGLE SIZED AGGREGATE	WSA PS 351	14	SINGLE SIZED	7
k	20mm SINGLE SIZED AGGREGATE	WSA PS 351	20	SINGLE SIZED	7
l	20mm CEMENT TREATED CLASS 3 FCR	WSA PS 352	20	GRADED	10

NOTES Regarding Table 202-B:

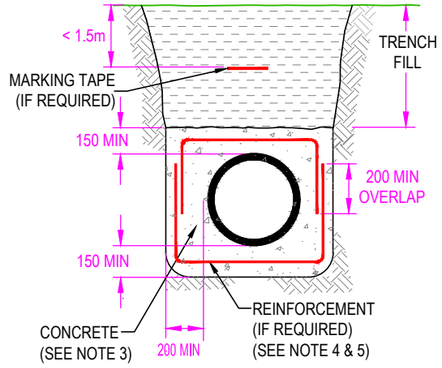
- Approved embedment materials are listed in the MRWA products portal.
- All material shall be installed with a moisture within 3% of optimum.
- Moisture conditioned embedment material shall be ordered in dry conditions.
- Moisture has a large impact on the ease with which compaction can be achieved and therefore a large impact on the ability of the embedment zone to resist pipe deflection.
- Item g. 5 / 7mm aggregate containing any distribution of particles between 2 and 7mm in size accepted.
- Item l. Shall be plant mixed with 3% cement.

TABLE 202-C: EMBEDMENT MATERIAL SELECTION

EMBEDMENT SYSTEM	PVC / PE / GRP (DN)	100 & 150	225 to 450	> 450
	PP (DN)	150 to 300	375 & 450	> 450
TYPE A, E & F		a, b, c, d	a, b, c, d, e	a, b, c, d, e, f
TYPE B		l	l	l
TYPE D		g	g, h	g, h, i, j

NOTES Regarding Table 202-B & C:

- Embedment material does not need to be specified as part of the design unless the structural integrity of the pipe is dependent on the modulus of the embedment material. In such cases, suitable embedment material(s) shall be specified in the design. Refer MRWA-S-203 and MRWA-S-204..
- Unless particular embedment materials are specified in the design, the Contractor may choose any of the materials nominated in Table 202-C which are suitable for the embedment system(s) selected by the Designer.

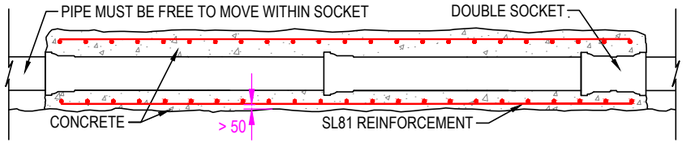


TYPE C: CONCRETE ENCASED EMBEDMENT

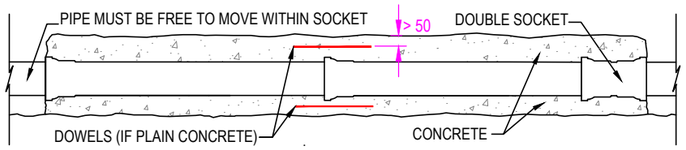
NOTES Regarding Type C:

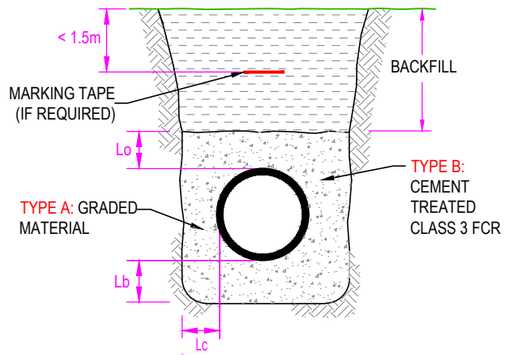
1. Use this support where authorised by the Water Agency.
2. Use minimum grade N20 concrete.
3. Plain concrete acceptable means of asset protection.
4. Steel reinforcement required if ground also unstable.
   - 4.1. Reinforcement to consist of min SL81 grade mesh (AS/NZS 4671).
   - 4.2. Steel reinforcement shall have >50 clear cover of concrete.
6. Where concrete is not reinforced, provide 300 long N10 dowel pins at 150 spacing around each pipe joint (to prevent the pipe shearing at joints).
7. Pipes will require a restraint system to prevent movement and/or floatation during encasing process.
8. Finish concrete at edge of RRJ at both ends (if RRJ pipe).
   Double socket connector may be required at one end.

TYPE C1: CONCRETE ENCASED EMBEDMENT (REINFORCED)



TYPE C2: CONCRETE ENCASED EMBEDMENT (DOWELLED)





TYPE A: STANDARD EMBEDMENT SYSTEM

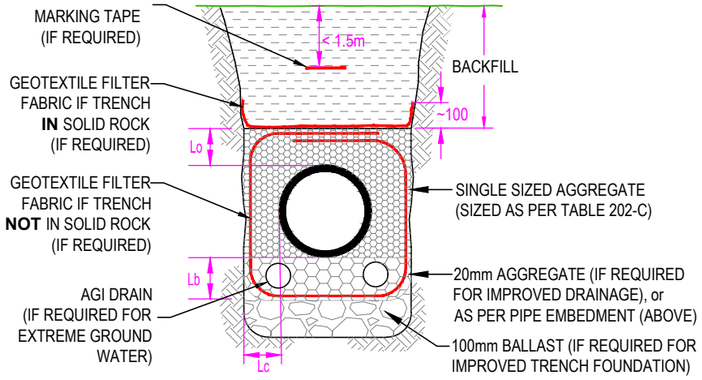
NOTES Regarding Type A:

A. Graded material (Types A to E) may only be installed when:
   A.A. The trench is not wet.
   A.B. The pipe sits above the normal groundwater level.
B. If significant groundwater is observed during excavation but embedment System A is nominated in the design, the designer shall be consulted to reconsider embedment system selection.

TYPE B: CEMENT STABILISED EMBEDMENT

NOTES Regarding Type B:

A. Use Item l from Table 202-B only.



TYPE D: AGGREGATE (SINGLE SIZED) EMBEDMENT

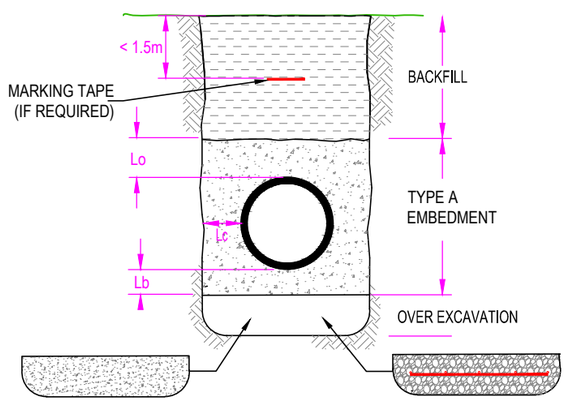
NOTES Regarding Type D:

1. Where ground water volumes are substantial, use 20mm aggregate as embedment under the pipe.
2. Where ground water volumes are extreme, install AGI drain as shown.
3. Where the trench floor is soft (ie: boots sink into the floor under a person's weight), press 100 ballast into the trench floor until it is solid and can take a persons weight without significant movement.
4. Provide trench stops / bulkheads and trench drainage (if required) as per MRWA-S-205 & 206.

NOTES Regarding Geotextile Wrapping:

a. 5 / 7 mm aggregate shall be geotextile wrapped **unless**:
   - Sewer grade < 1 in 60, **and**
   - Embedment is not subject to tidal ground water, **and**
   1. Trench sidewall consists of particles which satisfy the conditions of Appendix I of AS2566.2 (ie: coarse sand or gravel), **or**
   2. Trench sidewall consists of non dispersive clay which is not subject to drying out (ie: is generally below the water table).
      Non dispersive clay shall be:
   - determined by a NATA accredited geotechnical laboratory,
   - be crumb test grade 1 or 2, or
   - emerson test class 4, 5 or 6.

b. The designer shall nominate whether 5 / 7 mm aggregate requires geotextile wrapping.
c. Aggregate > 7mm shall always be wrapped in geotextile fabric.
d. Lay geotextile fabric against the trench floor and wall such that it fully encases the embedment, **unless**:
e. There is solid rock on both sides and underneath, in which case only the top surface requires geotextile filter fabric.
   In this case, fold >100 of fabric up sides of trench prior to backfill placement.
f. Provide min of 250 lap at all filter fabric joints.



TYPE E: OVEREXCAVATION. CEMENT STABILISED

NOTES Regarding Type E:

a. Use where there is little or no ground water.
A. Appropriate when unintentional over excavation occurs.
B. Cement stabilised material to consist of Item l from Table 202-B.
C. Place dry.

TYPE F: OVEREXCAVATION. CONCRETE

NOTES Regarding Type F:

1. Use N20 concrete or better.
2. Steel reinforcement is to consist of min SL81 grade mesh and N10 grade bar (as per AS/NZS 4671).
3. Steel reinforcement shall have >50 clear cover.

REV	DESCRIPTION	DATE	APPROVED
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ

ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE

		DATE
DESIGNED:	R. JAGGER	1 JULY 2015
DRAWN:	R. JAGGER	1 JULY 2015

CHECKED:	NAME	DATE	APPROVED:	NAME	DATE
☒ CWW	D. MOORE	01/09/15	☒ CWW	R. CARRUTHERS	01/09/15
☒ SEW	C. PAXMAN	01/09/15	☒ SEW	D. O'DONOVAN	01/09/15
☒ YVW	K. DAWSON	01/09/15	☒ YVW	J. TOMASI	01/09/15

ISSUED 2015 VERSION 1

MELBOURNE RETAIL WATER AGENCIES

City West Water™ South East Water Yarra Valley Water

MRWA SEWERAGE STANDARDS

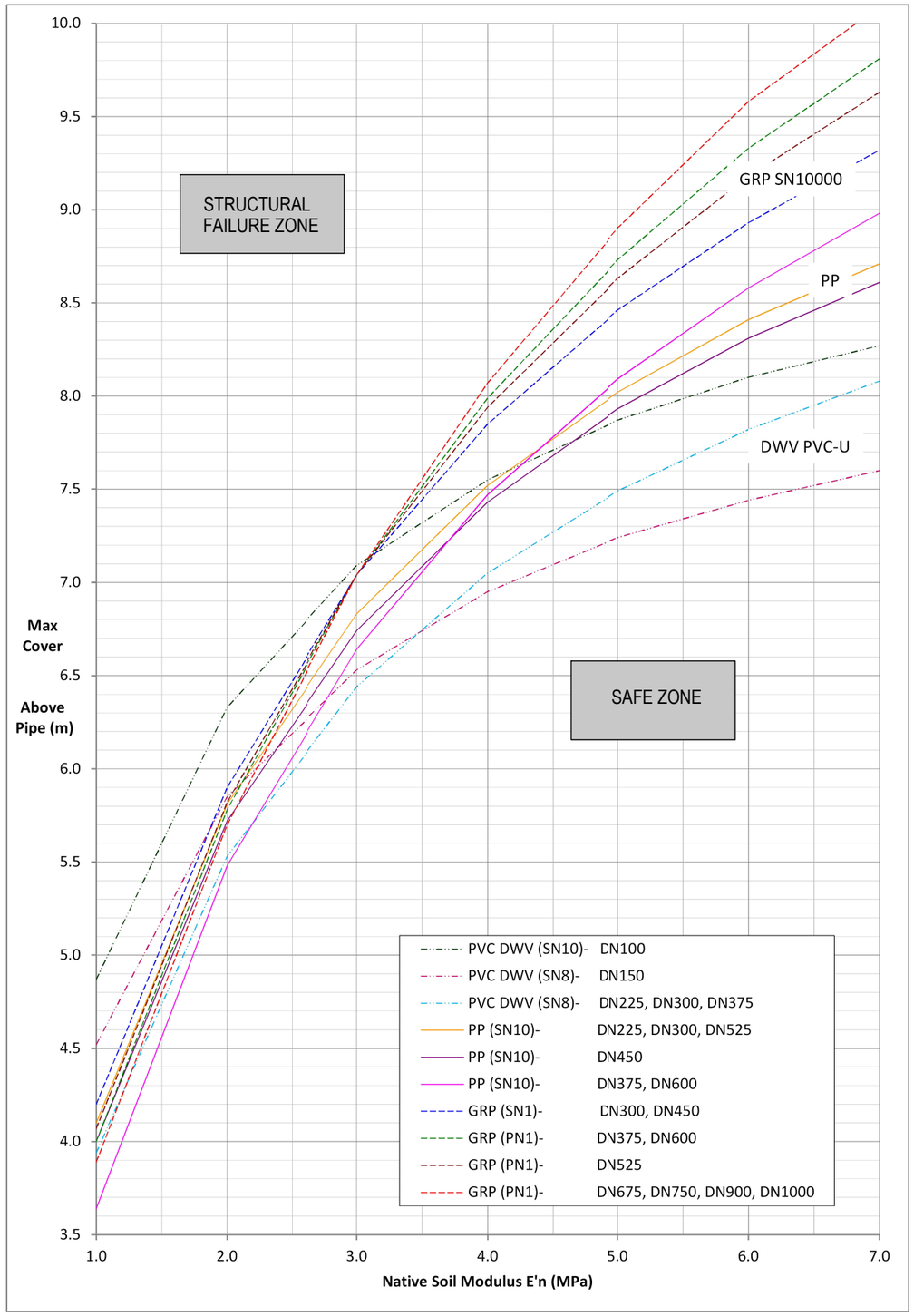
EMBEDMENT

NOT TO SCALE

MRWA-S-202

Planning	Design	Construction
	✓ ✓	✓ ✓ ✓ ✓

FIGURE 203-A: 3 MPa EMBEDMENT MODULUS- PIPE STRUCTURAL LIMITS



NOTES Re Figures 203-A & B:

Refer Table 202-B for the modulus values of different embedment materials.

Where sewers are to be > 5m deep, Native Soil Modulus should be estimated from bore log data.

Where the pipeline is subject to long term elevated water table, the depth limit will likely be in the order of 1 to 3m less than that indicated in these charts and these charts will **not** be suitable.

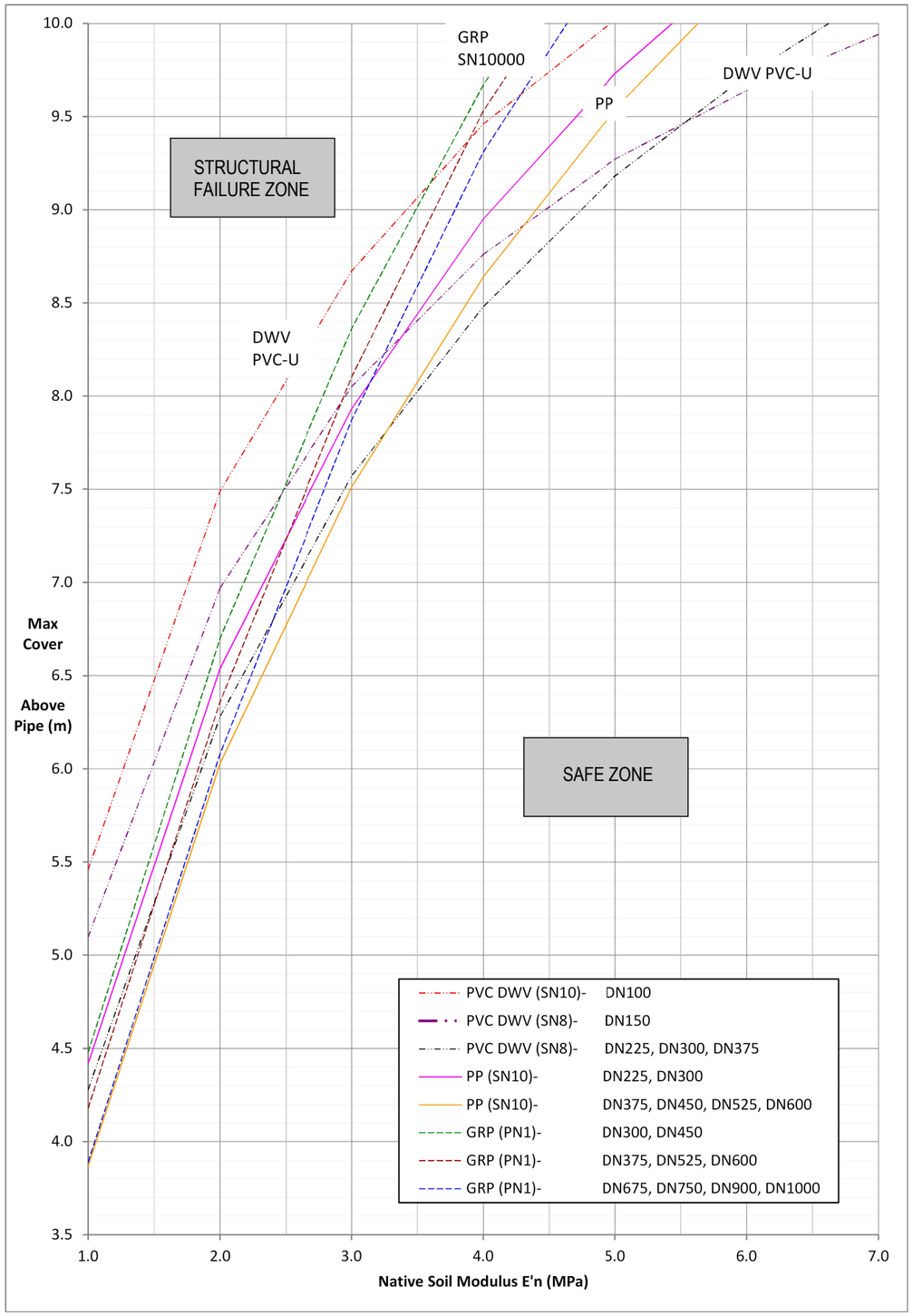
If the chart indicates that the pipeline may be at risk of structural failure, calculate the depth limit for the situation using more accurate values appropriate to the particular case.
If the calculations indicate that there is still a significant structural risk:

1. Specify a higher SN rating pipe (ie: SN15,000 GRP pipe), **or**
2. Specify a higher embedment modulus material, **or**
3. Do both 1 & 2.

Chart assumptions include:

- Traffic loads W7 and T44 live loads.
- No long term water charged ground conditions

FIGURE 203-B: 5 MPa EMBEDMENT MODULUS- PIPE STRUCTURAL LIMITS



ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE

REV	DESCRIPTION	DATE	APPROVED
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ

DESIGNED:	R. JAGGER	DATE: 1 JULY 2015			
DRAWN:	R. JAGGER	DATE: 1 JULY 2015			
CHECKED:	NAME	DATE	APPROVED:	NAME	DATE
☒ CWW	D. MOORE	01/09/15	☒ CWW	R. CARRUTHERS	01/09/15
☒ SEW	C. PAXMAN	01/09/15	☒ SEW	D. O'DONOVAN	01/09/15
☒ YVW	K. DAWSON	01/09/15	☒ YVW	J. TOMASI	01/09/15
ISSUED 2015			VERSION 1		

MELBOURNE RETAIL WATER AGENCIES
City West Water™
South East Water
Yarra Valley Water
WITH ACKNOWLEDGEMENT TO DON TASEVSKI FROM IPLEX PIPELINES

MRWA SEWERAGE STANDARDS

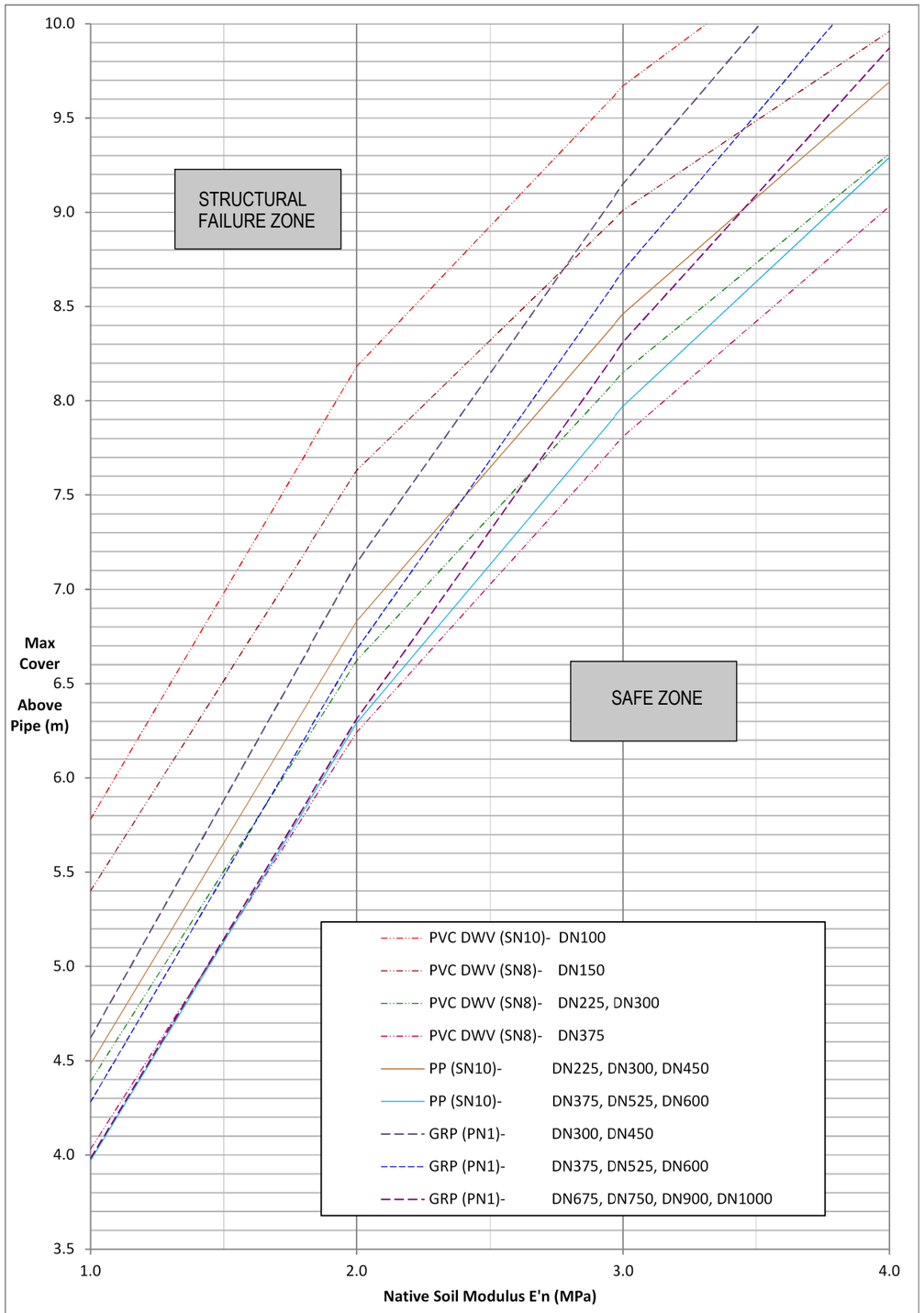
PIPELINE STRUCTURAL DESIGN
3 MPa AND 5 MPa EMBEDMENT MODULUS

NOT TO SCALE

MRWA-S-203

Planning	Design	Construction
	✓ ✓ ✓	

FIGURE 203-A: 7 MPa EMBEDMENT MODULUS- PIPE STRUCTURAL LIMITS



NOTES Re Figures 204-A & B:

Refer Table 202-B for the modulus values of different embedment materials.

Where sewers are to be > 5m deep, Native Soil Modulus should be estimated from bore log data.

Where the pipeline is subject to long term elevated water table, the depth limit will likely be in the order of 1 to 3m less than that indicated in these charts and these charts will **not** be suitable.

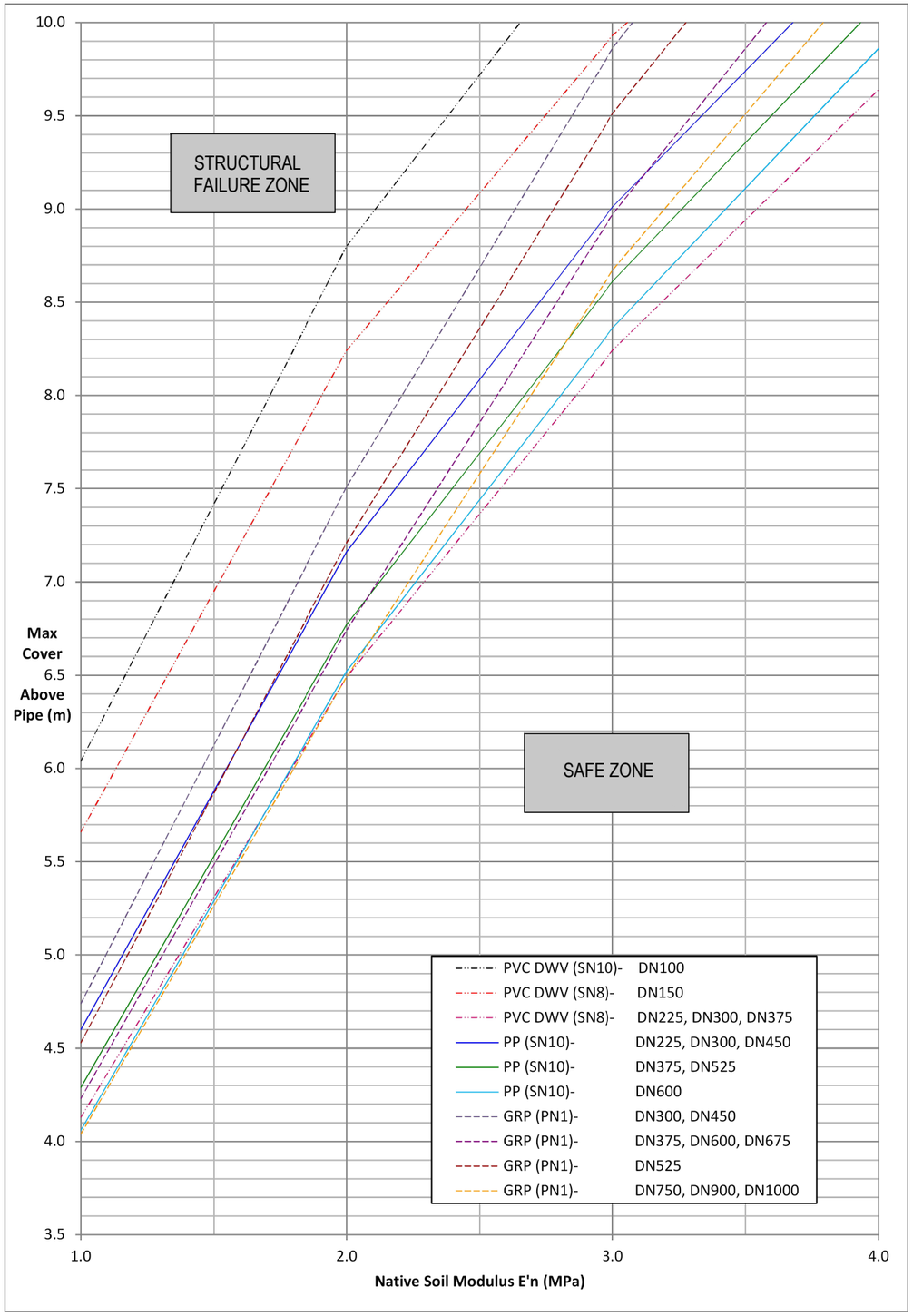
If the chart indicates that the pipeline may be at risk of structural failure, calculate the depth limit for the situation using more accurate values appropriate to the particular case.
If the calculations indicate that there is still a significant structural risk:

1. Specify a higher SN rating pipe (ie: SN15,000 GRP pipe), **or**
2. Specify a higher embedment modulus material, **or**
3. Do both 1 & 2.

Chart assumptions include:

- Traffic loads W7 and T44 live loads.
- No long term water charged ground conditions

FIGURE 203-B: 10 MPa EMBEDMENT MODULUS- PIPE STRUCTURAL LIMITS



ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE

REV	DESCRIPTION	DATE	APPROVED
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ

DESIGNED: R. JAGGER DATE: 1 JULY 2015
DRAWN: R. JAGGER DATE: 1 JULY 2015

CHECKED:	NAME	DATE	APPROVED:	NAME	DATE
☒ CWW	D. MOORE	01/09/15	☒ CWW	R. CARRUTHERS	01/09/15
☒ SEW	C. PAXMAN	01/09/15	☒ SEW	D. O'DONOVAN	01/09/15
☒ YVW	K. DAWSON	01/09/15	☒ YVW	J. TOMASI	01/09/15

ISSUED 2015 VERSION 1

MELBOURNE RETAIL WATER AGENCIES

City West Water™ South East Water Yarra Valley Water

WITH ACKNOWLEDGEMENT TO DON TASEVSKI FROM IPLEX PIPELINES

MRWA SEWERAGE STANDARDS

PIPELINE STRUCTURAL DESIGN
7 MPa AND 10 MPa EMBEDMENT MODULUS

NOT TO SCALE

MRWA-S-204

Planning	Design	Construction
	✓ ✓ ✓	

TABLE 205-A: TRENCHSTOP & BULKHEAD PLACEMENT AND PIPELINE SELECTION CRITERIA

	MAXIMUM TRENCHSTOP SPACING			
SLOPE	< 1 in 20	> 1 in 20	> 1 in 15	> 1 in 10
SOC MAIN (RRJ PVC / PP / GRP)	NOT REQUIRED	100m	75m	50m
WELDED MAIN (PE / SCJ PVC)	NOT REQUIRED	200m	150m	100m

NOTES Regarding Trenchstops:

A. Mains at < 1 in 20 slope do not typically require trenchstops or bulkheads.
B. Where welded PE mains are used for steep slopes, these shall be constructed in accordance with Figure 205-A.
C. When socketed mains are laid at >1 in 20 slope in areas that are likely to have high ground water, cement stabilized embedment shall be used as per MRWA-S-202.
D. For details of trenchstop design, refer to MRWA-S-206.
E. Where the sloped main is less than the spacing nominated, a trenchstop or bulkhead is only required at the bottom of the slope.
F. Where the slope length is < $\frac{1}{2}$ the spacing nominated, no trenchstop is required.
G. Trenchstops are required on both sides of any road crossing where there is a slope > 1 in 20 slope on either side of the road.
H. Where trenchstops or bulkheads are to be used, Type B embedment system shall be used as per MRWA-S-202.

TABLE 205-B: SAFE MAXIMUM GRADES

PIPE DN	100 & 150	225	300	375	450	525	600	750	900	> 900
MAXIMUM SAFE GRADE	1 in 10	1 in 15	1 in 30	1 in 40	1 in 45	1 in 55	1 in 60	1 in 75	1 in 90	1 in Ø /10

NOTES Regarding Table 205-B:

a. Velocities shall be kept to below 3 m/s.
b. The nominated grades are unlikely to lead to deterioration of the sewerage system through the formation of hydraulic jumps.
c. Where the grade nominated in Table 205-B is to be exceeded, supercritical and sub critical grades will need to be calculated.
d. Where supercritical / sub critical grade is exceeded, controls to limit the damage from hydraulic jumps shall be implemented.

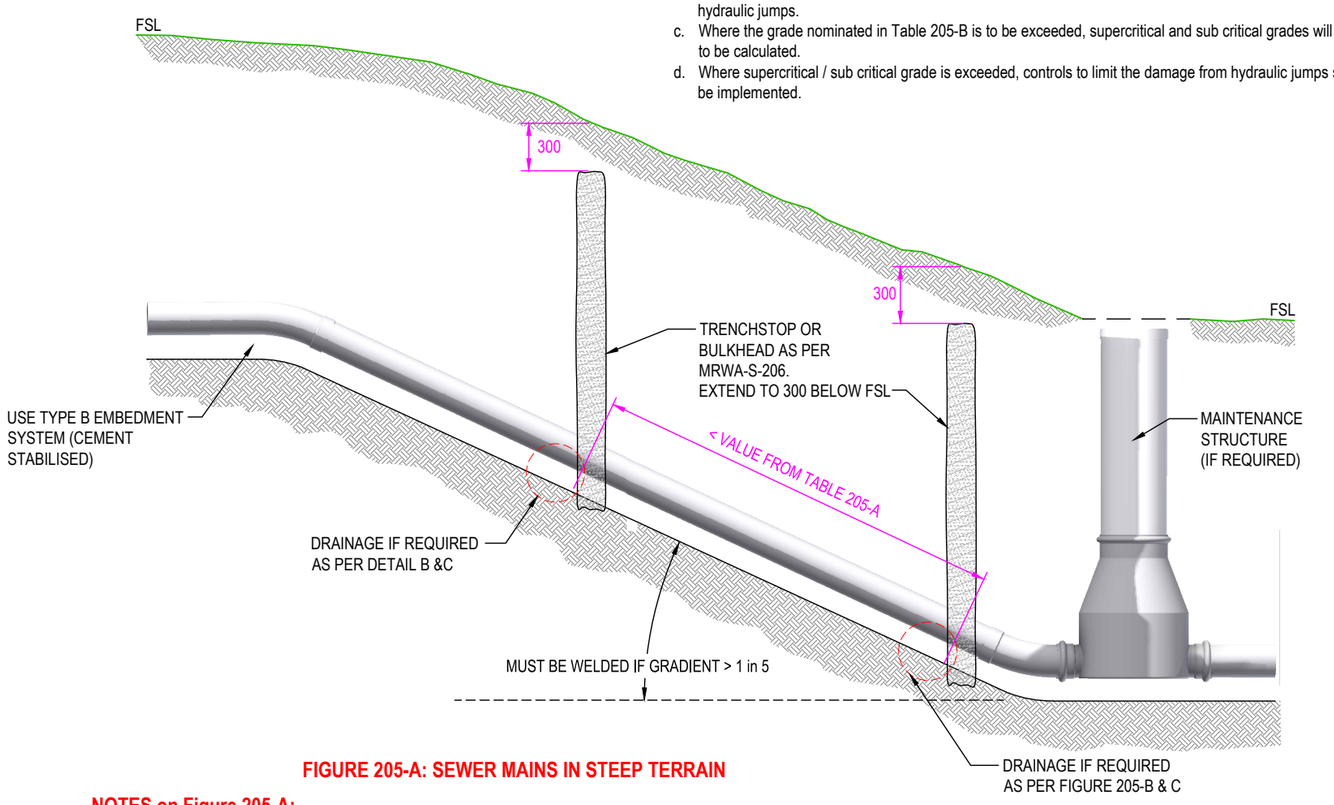


FIGURE 205-A: SEWER MAINS IN STEEP TERRAIN

NOTES on Figure 205-A:

If the main is welded PE, thrust restraints or maintenance hole connections to counteract shrinkage will be required at both ends of the PE main.
Refer to drawing MRWA-W-205-A or Figure 310-F for details.

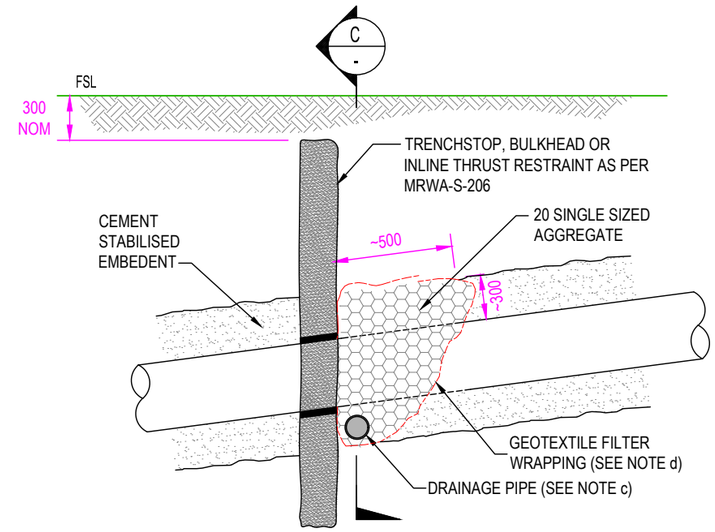


FIGURE 205-B: TRENCHSTOP WITH DRAIN (SECTION)

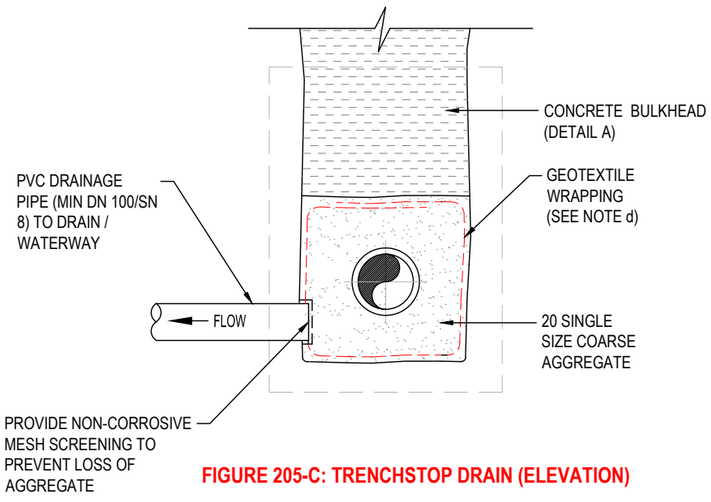


FIGURE 205-C: TRENCHSTOP DRAIN (ELEVATION)

Notes on Figures 205-B & C:

a. Trenchstops and bulkheads shall be drained as shown where the location is likely (or is known) to have high ground water or the surface water is not directed away from the sewer alignment.
The designer shall nominate all required drainage points and drainage arrangements.
b. Provide a restricted (to slow the flow of ground water) continuous drainage path between drainage points.
- through bulkheads and trenchstops.
- around maintenance structures.
- along embedment.

c. Drainage pipes to discharge ground water into authorised water discharge areas (as agreed by the drainage authority) shall be shown in the design drawings.
d. Lay geotextile filter fabric in trench such that it fully encapsulates the drainage material (coarse aggregate).
Provide minimum of 250 overlap at all filter fabric joints.

ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE

REV	DESCRIPTION	DATE	APPROVED
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ

DESIGNED: R. JAGGER DATE: 1 JULY 2015
DRAWN: R. JAGGER DATE: 1 JULY 2015

CHECKED:	NAME	DATE	APPROVED:	NAME	DATE
☒ CWW	D. MOORE	01/09/15	☒ CWW	R. CARRUTHERS	01/09/15
☒ SEW	C. PAXMAN	01/09/15	☒ SEW	D. O'DONOVAN	01/09/15
☒ YVW	K. DAWSON	01/09/15	☒ YVW	J. TOMASI	01/09/15

ISSUED 2015 VERSION 1

MELBOURNE RETAIL WATER AGENCIES
City West Water™ South East Water Yarra Valley Water

MRWA SEWERAGE STANDARDS

SLOPING MAINS
AND TRENCH DRAINAGE

NOT TO SCALE

MRWA-S-205

Planning	Design	Construction
	✓ ✓	✓ ✓

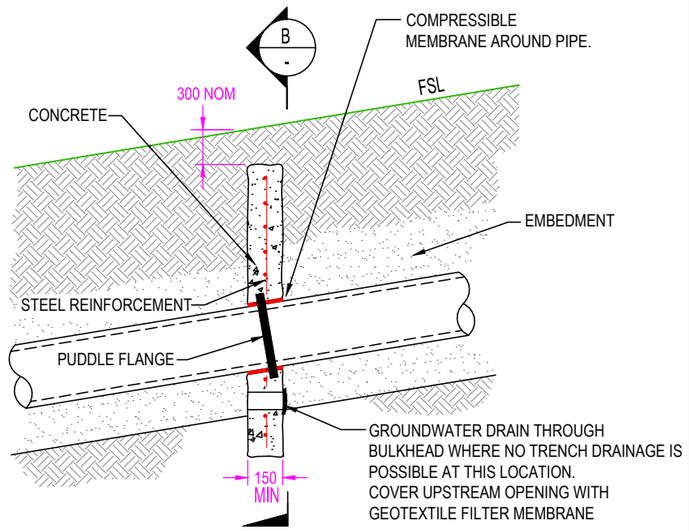


FIGURE 206-A: CONCRETE BULKHEAD (SECTION)

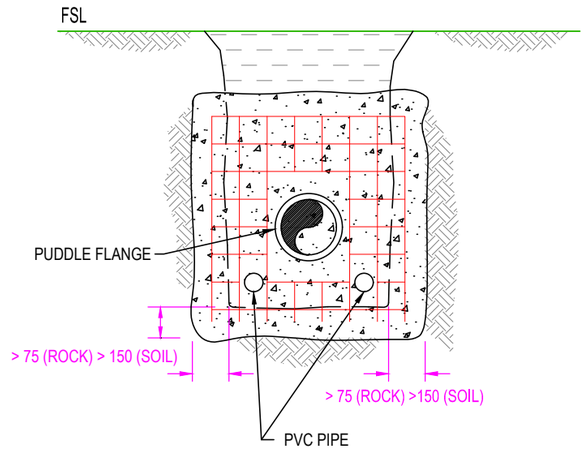


FIGURE 206-B: CONCRETE BULKHEAD (ELEVATION)

NOTES on Figures 206-A & B:

1. Bulkhead at a retaining wall to be under the wall.
2. Key concrete bulkheads into sides and bottom of trench against a bearing surface of undisturbed soil.
3. Concrete to be class N20.
4. Do not deform pipes during placement of concrete.
5. For bulkheads adjacent to kerbs, a polystyrene or neoprene membrane of at least 3mm thick shall be wrapped around the barrel of the pipe.
6. For bulkheads and trenchstops on slopes, an elastomeric membrane at least 3mm thick shall be used.
7. Concrete bulkhead reinforcement is to consist of min SL81 grade mesh and N10 grade bar (as per AS/NZS 4671).

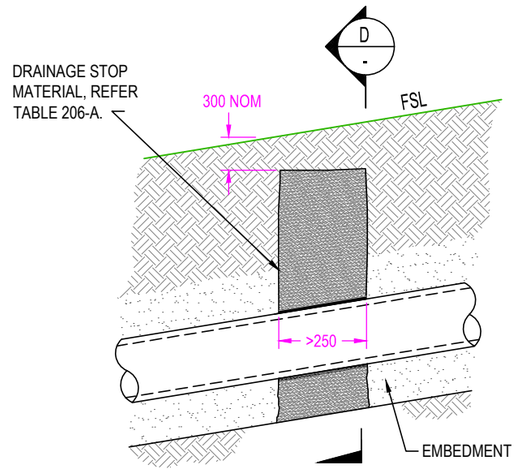


FIGURE 206-C: EARTHWORK TRENCH STOP (SECTION)

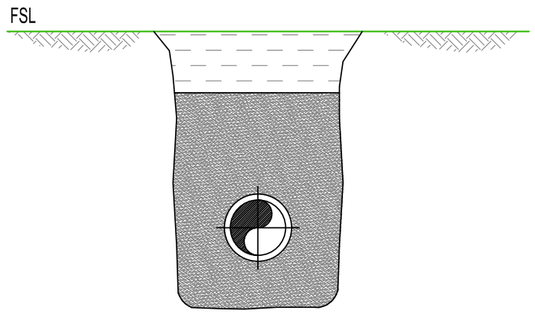


FIGURE 206-D: EARTHWORK TRENCHSTOP (ELEVATION)

TABLE 206-A: DRAINAGE STOP MATERIAL

MATERIAL	✳ PROPORTION
BENTONITE	1 (4%)
CEMENT	1 (4%)
CONCRETE SAND	23 (92%)
OR	
COMPACTED CLAY	95% R_D

✳ PROPORTION BY VOLUME OF DRY MATERIALS.

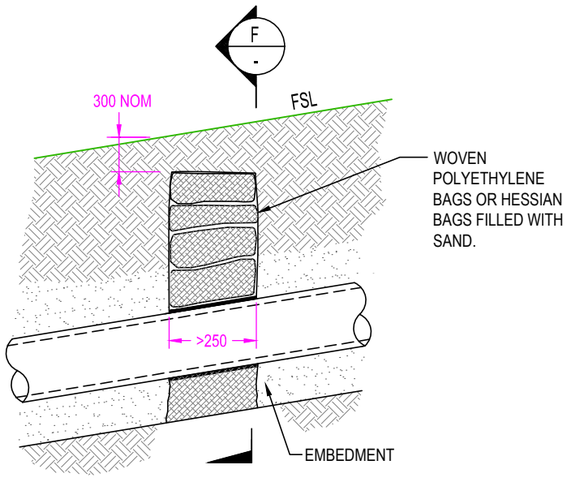


FIGURE 206-E: BAGGED TRENCH STOP (SECTION)

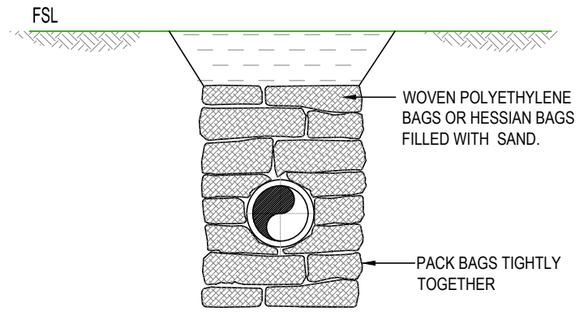


FIGURE 206-F: BAGGED TRENCHSTOP (ELEVATION)

GENERAL NOTES:

1. Construct concrete bulkheads and trench stops at locations specified in design drawings.
2. Trenchstops (either type) are preferred for slopes < 20%. Concrete bulkheads preferred for slopes > 20%.
3. Seal bags to prevent leakage of contained material.
4. For slopes > 5% refer to MRWA-S-205.

REV	DESCRIPTION	DATE	APPROVED
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ

ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE

DESIGNED: R. JAGGER DATE: 1 JULY 2015
DRAWN: R. JAGGER DATE: 1 JULY 2015

CHECKED:	NAME	DATE	APPROVED:	NAME	DATE
☒ CWW	D. MOORE	01/09/15	☒ CWW	R. CARRUTHERS	01/09/15
☒ SEW	C. PAXMAN	01/09/15	☒ SEW	D. O'DONOVAN	01/09/15
☒ YVW	K. DAWSON	01/09/15	☒ YVW	J. TOMASI	01/09/15

ISSUED 2015 VERSION 1

MELBOURNE RETAIL WATER AGENCIES

City West Water™ South East Water Yarra Valley Water

MRWA SEWERAGE STANDARDS

TRENCH BULKHEADS AND TRENCHSTOPS

NOT TO SCALE

MRWA-S-206

Planning	Design	Construction
		✓ ✓ ✓

TABLE 207-A: CROSSING REQUIREMENTS

CROSSING	COVER / CLEARANCE	OTHER AUTHORITY REQUIREMENTS	
		OPEN CUT	BORED
RAILWAY LINES	> 1600 BELOW RAIL LEVEL, > 600 BELOW FORMATION LEVEL (GROUND LEVEL IMMEDIATELY BELOW BALLAST), > 2000 BETWEEN RAIL LEVEL AND TOP OF TUNNELS	SLEEVED AS PER AS4799	SLEEVED AS PER AS4799. FULLY SUPPORTED BORE HOLE REQUIRED.
WATERWAYS	>1000 (OPEN CUT) >2000 (TRENCHLESS CONSTRUCTION)	CONCRETE ENCASED [E] (REF MRWA-S-202)	NONE
MELBOURNE WATER MAJOR DRAINS	> 300	NONE	NONE
FREEWAYS	> 1200	NONE [G]	NONE [G]
MAJOR ROADS	> 1200	NONE	NONE
TRAMWAYS	> 1200 (TOP OF RAIL TO TOP OF PIPE)	NONE	NONE

NOTES Regarding Major Crossings:

A. A crossing is considered "major" and shall be constructed in accordance with this drawing when a sewer is crossing a Freeway, Tollway, VicRoads designated road, Rail line, Melbourne Water trunk sewer or a waterway indicated in the Melways.
B. Sewers major crossings shall be one size larger than would otherwise be the case.
C. Microtunneling / HDD installations as per MRWA-S-208.
D. Sleeves shall be approved GRP, steel, RC concrete or butt fused PE.
E. Concrete encasement shall extend to the end of pipe sockets at both ends as per MRWA-S-202.
F. Melbourne water often allows this clearance to be reduced by 50% if there is a compelling reason.
G. Vicroads do not typically require sleeves for gravity flows.

NOTES Regarding Syphons:

1. Syphons require water agency approval.
2. Syphon sewer crossings of existing obstructions shall consist of horizontal directional drilled (HDD) PE or fusible PVC pipe if possible.
   2.1. Pipe shall be butt welded and de-beaded internally.
   2.2. No concrete encasement or sleeving is required in this case.
3. Any alignment between upstream and downstream maintenance holes is acceptable provided:
   3.1. PE or PVC pipe is bent within the constraints of PIPA guideline POP202.
   3.2. The pipe always maintains minimum clearance below the obstruction and minimum cover.
   3.3. The pipe is constantly falling to midway of obstruction and constantly rising to the discharge point.
4. Syphons are typically twin pipes.
   Smaller pipe to contain all PDWF. Larger pipe to contain remaining flow.
   Water agency planning will designate the sizes and number of mains in the syphon.
5. Maintenance Structures at both ends of syphons shall be MHs unless the syphon is a single pipe ≤DN150, in which case MCs may be used.
6. At upstream and downstream maintenance structures:
   6.1. Match invert of smaller syphon sewer with invert of incoming / outgoing sewer (allowing for drop across the MHs).
   6.2. Match invert of larger syphon sewer with the obvert of the smaller syphon sewer.
7. Vertical drop across syphon to equal 600 + calculated head loss of syphon.
8. Syphons must achieve a minimum velocity of 1.5 m/s at PDWF.
9. All syphon pipework shall be acceptance tested as per >DN300 gravity pipe.
10. Design & construct maintenance structures as per MRWA-S-300 series drawings.

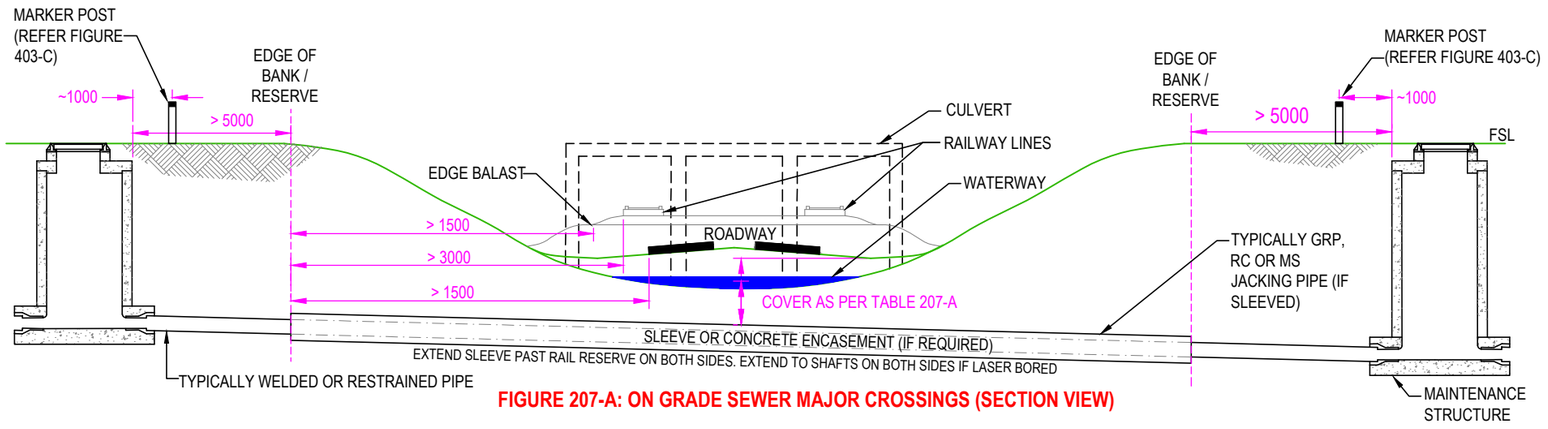
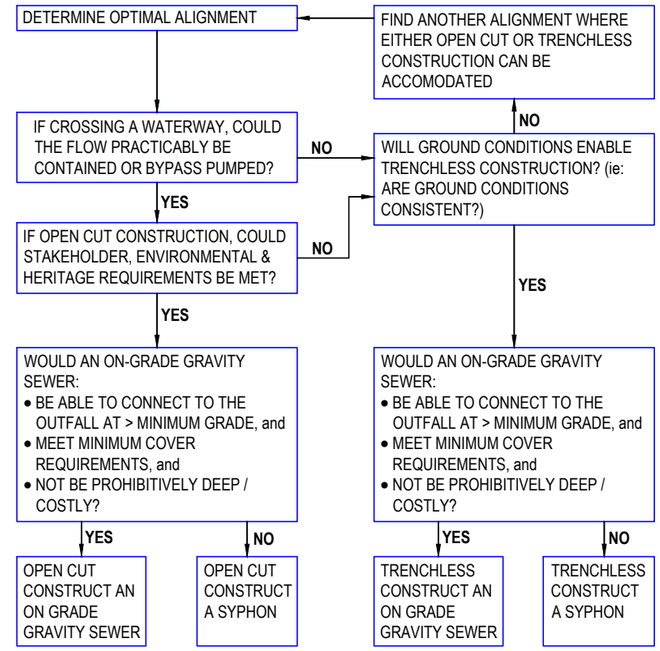


FIGURE 207-A: ON GRADE SEWER MAJOR CROSSINGS (SECTION VIEW)

FIGURE 207-D: CROSSING DECISION MAKING PROCESS



Melboure Water waterway crossing requirements:

1. A Melbourne Water (MWC) permit to work is required prior to commencement of any works.
2. Prior to commencement of construction, a site environmental management plan (SEMP) is to be submitted to Melbourne Water.
3. Prior to commencement of construction, a work method statement and risk task assessment must be submitted outlining the general construction technique to be adopted.
4. If the crossing is to be open cut constructed, the pipe is to be protected via concrete encasement or a concrete slab place above the pipe.
5. Open cut crossings require a rock chute along the bed and banks at the crossing location in accordance with Melbourne Water standard 'Rockwork and Rip Rap Detail: Service Crossing Open Trenching'.

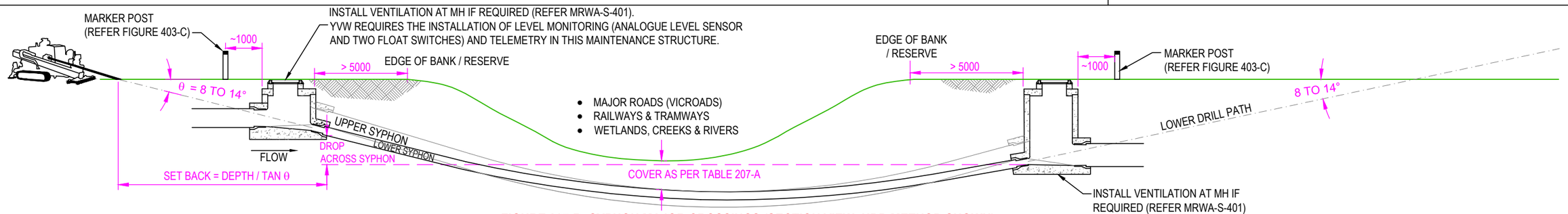


FIGURE 207-B: SYPHON MAJOR CROSSINGS (SECTION VIEW- HDD METHOD SHOWN)
OTHER CONSTRUCTION METHODS (ie: OPEN CUT) MAY BE MORE APPROPRIATE

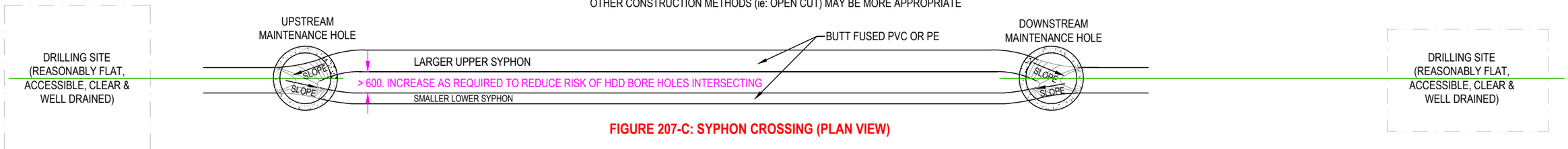


FIGURE 207-C: SYPHON CROSSING (PLAN VIEW)

REV	DESCRIPTION	DATE	APPROVED
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ

ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE

	NAME	DATE
DESIGNED:	R. JAGGER	1 JULY 2015
DRAWN:	R. JAGGER	1 JULY 2015

CHECKED:	NAME	DATE	APPROVED:	NAME	DATE
☒ CWW	D. MOORE	01/09/15	☒ CWW	R. CARRUTHERS	01/09/15
☒ SEW	C. PAXMAN	01/09/15	☒ SEW	D. O'DONOVAN	01/09/15
☒ YVW	K. DAWSON	01/09/15	☒ YVW	J. TOMASI	01/09/15

ISSUED 2015 | VERSION 1

MELBOURNE RETAIL WATER AGENCIES
City West Water
South East Water
Yarra Valley Water

MRWA SEWERAGE STANDARDS

MAJOR CROSSINGS

NOT TO SCALE

MRWA-S-207

Planning	Design	Construction
✓	✓ ✓	✓ ✓

TABLE 208-A: TRENCHLESS RISK DEFINITIONS AND REQUIREMENTS

	LOW RISK	MEDIUM RISK	HIGH RISK
DEFINITION	LENGTH < 25m	LENGTH > 25m, or CROSSING A LESS SIGNIFICANT WATERWAY, VICROADS RD, TRAMWAY, or WATER MAIN, SEWER OR DRAIN > DN2000	LENGTH > 100m, or SIGNIFICANT WATERWAY, RAIL or FREEWAY CROSSING
DESIGN	N/A	REF REQ.1	REF REQ.1
GEOTECHNICAL	N/A	N/A	REF REQ.2
CONSTRUCTION	REQ.3 and 4 or 5	REQ.3 and 4 or 5	REQ.3 and 4 or 5

NOTES Regarding Table 208-A:

- Significant waterways can be defined as > 10m wide (if wetlands or lakes) or > 2m (average width of river or creek).
- All other waterways (marked as a water body in the melways) can be considered to be less significant.
- Risk assessment of bored alignments also needs to consider the following risk factors:
  1. Impact on existing structures & services, ie: loading from existing structures and risk of not meeting minimum clearances.
  2. Presence of high water table & the impact on drilling techniques.
  3. Native soil physical properties and consistency.
  4. Ability of the technique to meet the grade and positional tolerances.

TABLE 208-B: ACCEPTABLE TRENCHLESS JOINT TYPES

SITUATION	MIN ACCEPTABLE JOINT STRENGTH
>100m	HIGH
50m TO 100m	MEDIUM
<50m WITH BORE HOLE WHICH MAY COLLAPSE	MEDIUM
<50m WITH STABLE AND OPEN BORE HOLE	MED-LOW
<25m WITH STABLE AND OPEN BORE HOLE	LOW

TABLE 208-C: PIPELINE JOINT TYPES AND LIMITATIONS

JOINT STRENGTH	JOINT / PIPE TYPE	LIMITATIONS
HIGH	JACKING PIPE. WELDED STEEL. BUTT WELDED PE or PVC. RESTRAINED JOINT DI	JACKING / WINCHING FORCES CANNOT EXCEED LIMIT OF PIPELINE.
MEDIUM	THREADED RRJ PIPE. BUTT JOINT REBATED PVC	WHERE SIGNIFICANT RISK OF BORE HOLE COLLAPSE, PUSH / PULL PIPE IN BEHIND BORE HEAD.
MED-LOW	PP	REQUIRES STABLE OPEN BORE HOLE.
LOW	PVC DWV (RRJ or SCJ)	MAY ONLY BE INSTALLED BY HAND. PIPE SPACERS / LOCATORS SHALL ALWAYS BE USED.

REQ.1- Design Requirements for High and Medium Risk Trenchless Construction :

1. Nominate the risk level, sleeve and joint / pipe requirements.
2. Provide geotechnical information to the contractor (refer adjacent section) in high risk situations.
3. Obtain approval from the Water Agency for the HDD construction of any gravity sewers.
4. Obstructions.
   - 4.1. The risks of underground obstructions (poor ground, underground assets) shall be determined and mitigated through the obtainment of geotechnical and asset information.
   - 4.2. Consult with HDD / micro-tunneling practitioners where poor ground (eg: rocks in clay / sand / gravel or unweathered rock) conditions are present to determine whether the proposed technology is practical.
   - 4.3. Above ground items requiring protection (fauna, flora, heritage, other authority assets) shall be determined through a feature survey and investigation based on regulatory requirements.
   - 4.4. Specify a suitable alignment and installation method for the new pipeline accordingly.
5. Plan and long section design drawings require:
   - 5.1. Indication of where obstructions and protected items are located.
   - 5.2. Method of construction (open cut / laser bore / HDD) shall be nominated for each pipe length.
   - 5.3. For micro-tunneled pipelines, indicate:
     - 5.3.1. The SN rating of jacking pipe (refer adjacent section).
     - 5.3.2. Expected size and locations of boring shafts.
       Approximate shaft sizes of 2m x 4m (DN150 to DN375), 2m x 6m (DN450 - DN900) and 4m x 8m (>DN900) may be used.
       Long dimension of shaft shall be in line with the pipe.
       Access for equipment (eg: truck access) to shaft shall be acceptable.
     - 5.3.3. Suggested method of shaft construction:
       Caisson or sheet pile perimeter (where ground conditions are weak or unstable & / or where high ground water is expected).
       Shields or soldier pile (where solid & dry ground).
     - 5.3.4. Expected location of staging area around the boring shafts.
       Sufficient space around bore shafts shall be provided for location of plant, equipment and materials.
   - 5.4. For HDD installed pipelines:
     - 5.4.1. Pipe type and SDR.
       The drilling limits of PE100 pipe is as follows:
       SDR17 -230m limit
       SDR13.6 -280m limit
       SDR11 -350m limit
       SDR9 -420m limit
       (these are linear pipe metres, not "as the crow flies" distances).
       Check that the selected SDR is able to withstand vertical loads.
     - 5.4.2. Expected size and location(s) of drilling site(s) and pipe jointing site(s).
       Typically, entry requires ~50m² and exit sites require 25m².
       Access for equipment (eg: truck access) to shaft shall be acceptable.
       Sites need to be reasonably flat, clear and well drained.
     - 5.4.3. Drill insertion point(s), angle(s) and set back(s) from maintenance shafts.
6. Groundwater management.
   The designer shall nominate the limits of discharge quality, quantity and available discharge points.
7. All necessary third party approvals and conditions shall be obtained and their conditions included in the design drawings or specifications.
   Settlement monitoring requirements and limits (if any) shall be included.

REQ.2- Geotechnical Information Required for High Risk Trenchless Construction:

The designer shall engage a geotechnical consultant to undertake bore hole analysis and report on ground conditions as follows:

1. Bore holes required as follows:
   - 1.1. Bore hole locations shall co-incide with maintenance shaft locations, with intermediate bore holes required where maintenance structure spacing exceeds 150m.
     The sewer shall not be located over bore hole locations.
   - 1.2. Bore holes shall be undertaken on both sides of a waterway crossing, within a few metres of the waters edge.
   - 1.3. This testing shall be undertaken even in difficult to access locations.
     Dispensation is required where required bore holes cannot be completed.
   - 1.4. Bore holes shall be to a depth at least 5m below the expected sewer level.
   - 1.5. Existing bore hole data in close proximity to required bore holes may be acceptable in lieu of new bore hole excavation(s).
   - 1.6. Where cobbles or boulders are present, large diameter bore holes (>300) or test pits shall be excavated to determine the size and spacing of these larger items.
2. Bore hole information (vs depth / elevation) shall include:
   - 2.1. X, Y co-ordinates and surface elevation.
   - 2.2. Blow count.
   - 2.3. Grain size distribution.
   - 2.4. Plasticity of cohesive soils.
   - 2.5. Stabilized (24 hour) groundwater level.
   - 2.6. In rock:
     - 2.6.1. Compressive strength of rock.
     - 2.6.2. Jointing and fracturing (RQD).
     - 2.6.3. Structural complexity (folding & faults)
     - 2.6.4. Degree of weathering.
     - 2.6.5. Mineralogy.
3. Boring risks shall be assessed and reported, focusing on:
   - 3.1. The stability of any open bore hole.
     - 3.1.1. Unstable formations which may collapse into the bore hole.
     - 3.1.2. Risk of high plasticity clays swelling to partially or completely block the bore hole.

     Where the risk to bore hole stability is moderate to high, HDD should not be selected as the construction method unless this risk can be controlled.
   - 3.2. Loss of drilling fluid or lubricant to surface (eg: frac out).
   - 3.3. Formations which may stop or deflect the boring head.
   - 3.4. Location of aquifers and the implications for boring.
   - 3.5. Optimum depth and alignment for trenchless construction which minimizes the above risks.

Jacking Force Calculation:

1. Jacking force (F) = Fp + Ff
   - 1.1. Fp= penetration resistance. This is the "back force" of the boring head against the earth during boring.
   - 1.2. Ff = frictional resistance. This is the force required to overcome the friction of the jacking pipe in the bore hole.
2. $Fp = 8 \times D^3 P$ (kN)
   - 2.1. D = pipe external diameter (m).
   - 2.2. P = face resistance:
     - 2.0.1. P = 50 for soft materials (soft clay and sand)
     - 2.0.2. P = 60 for mid stiffness materials (stiff clay and mixed gravel & sand)
     - 2.0.3. P = 70 for hard materials (rock)
3. $Ff = 10 \times \pi \times D \times L \times Q$ (kn)
   - 3.1. L = jacking distance (pipe length in m)
   - 3.2. Q = a + 0.4D
     a = 0.15 for stiff clays and rock
     a = 0.24 for sands
     a = 0.34 for soft clay and mixed gravel & sand
4. In summary: $F = 8 D^3 P + 30 D L (a + 0.4D)$

SN Rating of Jacking Pipe:

1. Size the ID of the sewer pipe or sleeve.
2. Estimate jacking force required to install this pipe (using the left method).
3. Select preliminary SN rating of jacking pipe.
   - 3.1. Look up supplier catalogue.
   - 3.2. Select the minimum SN rating which can withstand the estimated jacking force.
4. Review need for intermediate jacking stations (which would reduce jacking force).
   - 4.A. Review required when the jacking length is > 150m or the required SN is > 100,000.
   - 4.B. Assess the jacking forces required if intermediate jacking station(s) were to be used.
   - 4.C. Assess the additional cost of the intermediate jacking stations (consult with laser boring contractor) vs the savings in pipe (due to lower SN rating).
5. Finalise SN rating of jacking pipe.
   Select the lowest cost jacking and pipe system.
6. Check that the SN rating of the pipe will also meet vertical loadings.

REQ.3-General Construction Requirements:

- Comply with the pipe manufacturers instructions with respect to the suitability and conditions of use of the pipe for the selected construction method.
- Comply with requirements of Table 208-C.
- Annular Space (space between bore hole and sleeve (if sleeved) or between bore hole and carrier pipe (if not sleeved)) and Grouting:
  - 1.1. Grouting between sleeve and carrier pipe is not required.
  - 1.2. It is preferred that the overcut diameter not exceed 30mm.
  - 1.3. When annulus > this limit, grout the annulus as per WSA03 MRWA edition (ie: use a flowable grout, eg: liquafill or bentonite).
  - 1.4. Grouting should commence as soon as possible after pipe installation (to prevent material falling into the annulus).
    It should occur within 4 hours of completion in weak ground and within 24 hours when the bore hole is stable.
  - 1.5. Ensure grouting pressures do not exceed the buckling capability of the sleeve / pipe when empty.

REQ.4- Construction Requirements for Laser Boring / Microtunneling:

1. Shafts.
   Shafts are to be prepared in close consultation with the boring contractor. Issues to address include:
   - 1.1. Preparation of the thrust area.
     How is the strength of the native ground behind the thrust block to be maintained.
   - 1.2. Depth of shaft.
     Sufficient clearance below the invert of the sewer is required to enable the jacking frame to be correctly set (0.5m to 1.2m extra depth typically required).
   - 1.3. Preparation of shaft base (type & size of concrete pad).
   - 1.4. Location of props and bracing which may impede access of materials and equipment into the shaft.
   - 1.5. Type of shaft support (sheet pile, shield, solder set, caisson).
   - 1.6. Method of managing any weak ground.
   - 1.7. Method of groundwater management.
   - 1.8. Stabilisation / sealing of the bore entry point to prevent slurry or lubricant from coming back into the shaft.
2. Settlement / subsidence.
   The contractor shall monitor and control the settlement of road and railway crossings to the satisfaction of the controlling agency.
3. Requirements for intermediate jacking stations (IJSs).
   - 3.1. At least one IJS for drives exceeding 150m.
   - 3.2. At least two IJSs for drives exceeding 250m.
   - 3.3. As required to keep jacking forces within 70% capacity of the:
     - 3.3.1. Jacking pipe, and
     - 3.3.2. Jacking frame, and
     - 3.3.3. Thrust block.

REQ.5- Construction Requirements for Horizontal Directional Drilling (HDD):

1. Construction risks shall be adequately identified and controlled by the contractor. This assessment and control plan shall at least indicate the preventative and remedial actions for:
   - 1.1. Loss of drilling fluid (frac out).
   - 1.2. Loss of circulation of drilling fluid (indicating frac out).
   - 1.3. Drilling mud seepage (spillage) onto land or into a waterway.
   - 1.4. Collapsed hole.
   - 1.5. Washout of cavity and collapse of the surface.
   - 1.6. Stuck or deflected drill stem.
   - 1.7. Swelling of high plasticity clays which may partially or completely block the bore hole.
   - 1.8. Lost tools.
   - 1.9. Pedestrian safety.
   - 1.10. Traffic hazards.
   - 1.11. Damage to flora, fauna and assets.
   - 1.12. Site security.
   - 1.13. Pull back force exceeding the tensile limit of pipe.
   - 1.14. Unsatisfactory pipe jointing.
   - 1.15. Damage to pipe (during pull back).
2. To ensure bore hole blockage and fluid losses are detected and addressed, monitoring and reporting shall be undertaken which at least:
   - 2.1. Strictly monitors drilling fluid volumes,
   - 2.2. Monitors annular pressure.
   - 2.3. Monitors cutting returns.
   - 2.4. Monitors the ground and waterways within 400m of boring.

   Any loss of drilling fluid or drilling mud shall be contained and immediately reported to the water agency.
3. The pipe shall not be bent beyond the minimum radius of the pipe (refer PIPA document POP202).
4. The installed pipe shall be allowed to relax and cool for at least 12 hours before it is restrained at either end.
5. The location of the drill stem (& therefore pipe) shall be monitored and recorded in the as constructed documentation (to ensure pipe can be located in future).
6. Settlement / subsidence.
   The contractor shall monitor and control the settlement of road and railway crossings to the satisfaction of the controlling agency.
7. All HDD constructed sewers shall be acceptance tested as for gravity sewers > DN300.

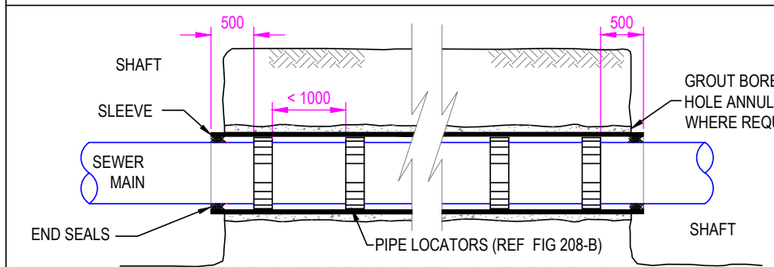


FIGURE 208-A: TYPICAL SLEEVE INSTALLATION

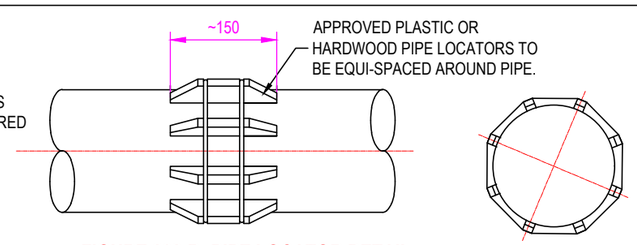


FIGURE 208-B: PIPE LOCATOR DETAIL

NOTES Regarding Sleeves:

- Pipes only to be sleeved only when mandated by the controlling authority.
- Sleeves to consist of a high joint strength pipe (refer Table 209-C).
- Sewer mains to be supported using pipe locators within sleeve. Pipe locators maybe omitted in the case of welded PE mains with approval of the Water Agency.
- Sewer main supports (as shown in Figure 208-B) must be firmly fastened and not move once attached.

REV	DESCRIPTION	DATE	APPROVED
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ

ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE

DESIGNED: R. JAGGER DATE: 1 JULY 2015
DRAWN: R. JAGGER DATE: 1 JULY 2015

CHECKED:	NAME	DATE	APPROVED:	NAME	DATE
☒ CWW	D. MOORE	01/09/15	☒ CWW	R. CARRUTHERS	01/09/15
☒ SEW	C. PAXMAN	01/09/15	☒ SEW	D. O'DONOVAN	01/09/15
☒ YVW	K. DAWSON	01/09/15	☒ YVW	J. TOMASI	01/09/15

ISSUED 2015 VERSION 1

MELBOURNE RETAIL WATER AGENCIES

City West Water™ South East Water Yarra Valley Water

MRWA SEWERAGE STANDARDS

TRENCHLESS CONSTRUCTION

NOT TO SCALE

MRWA-S-208

Planning	Design	Construction
	✓ ✓	✓ ✓

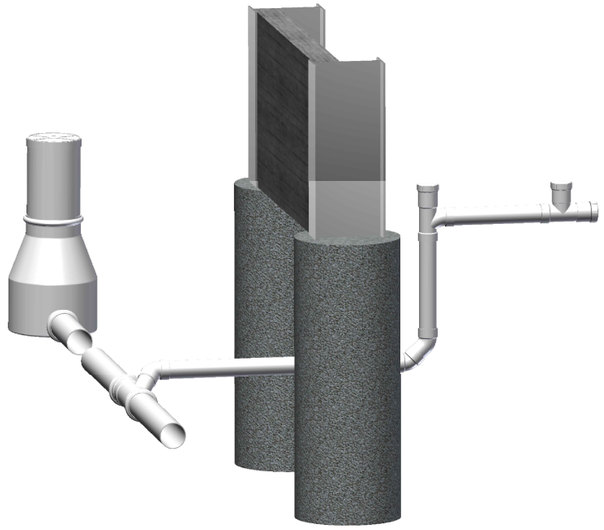


FIGURE 209-A: SEWERAGE ASSETS AROUND RETAINING WALLS (ISOMETRIC)

NOTES Regarding Sewerage Assets around Retaining Walls:

1. The offsets and conditions stipulated in MRWA-S-111 shall take precedence over these requirements.
2. Refer to MRWA document "Guidelines for Proposed Works Over / Adjacent to Water Authority Assets up to and including 225mm diameter" for further details and the principals of protection of sewers from loads of structures.
3. Build over approval for construction above existing sewers is required.
4. Build over approval is not required for retaining walls over new sewers where the conditions of this drawings are met.
5. The requirements of this document relate to retaining walls in all locations, whether they be in private or public land.
6. Key objectives of retaining wall and sewerage designs shall be;
   - 6.1. Ensure structural integrity of the sewerage system throughout the life of the asset (ie: manage risk of sewerage main deflection and backfill subsidence).
   - 6.2. Ensure structural integrity of the retaining wall (ie: manage the risk of deflection, collapse or subsidence of the retaining wall).
   - 6.3. Ensure adequate access to sewerage mains for operations maintenance and plumbing activity.
7. Where there are retaining walls, sewerage system designs shall indicate/ include:
   - 7.1. The location of all retaining walls.
   - 7.2. The offset of all maintenance structures within 2m of retaining walls.
   - 7.3. Foundation and retaining wall structural details.
   - 7.4. Schedule of retaining wall details including wall height, footing depth and retaining wall type.
   - 7.5. Where pier and beam foundations to a level below the sewer invert level are **not** used:
     - 7.5.1. Provide details which demonstrate that the retaining wall will tolerate a 1m wide trench being excavated adjacent to or underneath the retaining wall without negative affect. Signoff from a suitably qualified and experienced engineer shall be provided with these details.
     - 7.5.2. Provide structural calculations for walls > 600 high which shall include live construction and static loads from the retaining wall.
8. Requirements of the retaining wall:
   - 8.1. Height shall be < 2m tall.
   - 8.2. Where practicable, sewerage pipelines shall be constructed before retaining walls.
   - 8.3. When piles are constructed after sewers, retaining wall foundations shall be bored and not driven.
   - 8.4. Retaining walls > 800 high shall be designed in accordance with AS4678 earth retaining structures.
9. Requirements of sewers crossing under retaining walls:
   - 9.2. Diameter ≤DN225.
   - 9.3. Depth of sewer main shall be < 3.5m.
   - 9.4. Pipe shall cross retaining wall at a 90° angle +/- 10°, within 600 to 1000 of retaining wall footings if possible.
10. Clearances and minimum offsets:
    - 10.1. Minimum vertical clearance between pipe and retaining wall of 600.
    - 10.6. Property connections end fittings (IO) shall be kept at least 1m clear of retaining walls.
    - 10.2. All pipe and fittings shall be located above the angle of repose from the bottom of retaining wall footings where possible.
    - 10.3. Sewers adjacent to but not crossing a retaining wall shall have a minimum offset from the wall of 1.0m (for sewers ≤DN225) or 1.5m (for sewers >DN225).
    - 10.4. Maintenance structures and their covers shall have a >1m horizontal offset from retaining walls. Maintenance structures shall be located to maximise ease of access.
    - 10.5. Where MHs are located within 2m of a retaining wall, the design shall specify the location of covers so that the closest edge of the cover is >1m from the retaining wall.

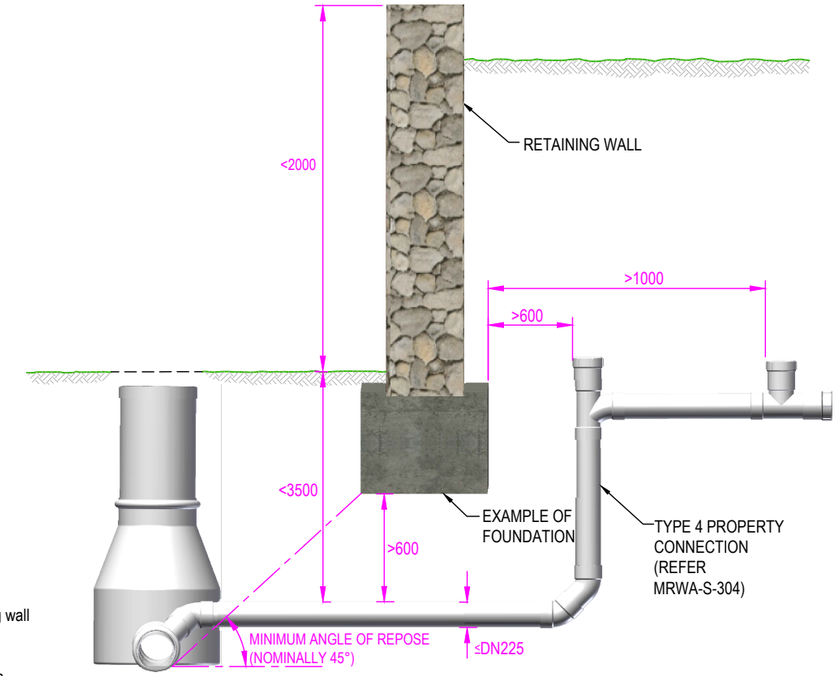


FIGURE 209-B: SEWERAGE ASSETS AROUND RETAINING WALLS WITH FOOTINGS (ELEVATION)

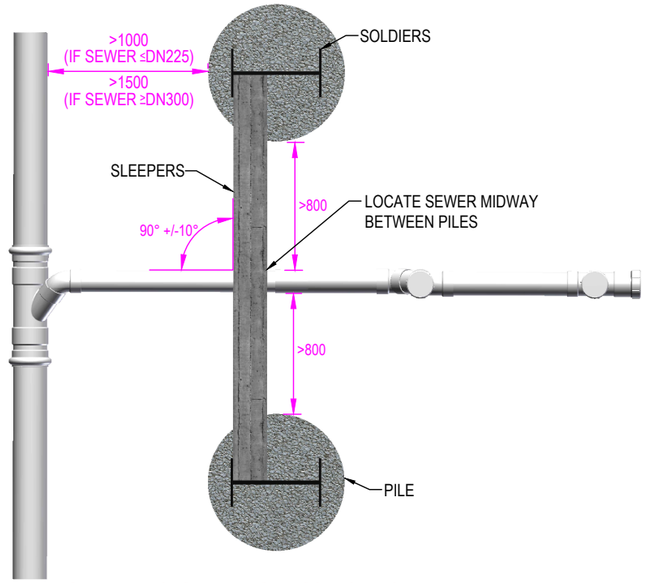


FIGURE 209-C: SEWERAGE ASSETS AROUND RETAINING WALLS WITH PILES (PLAN)

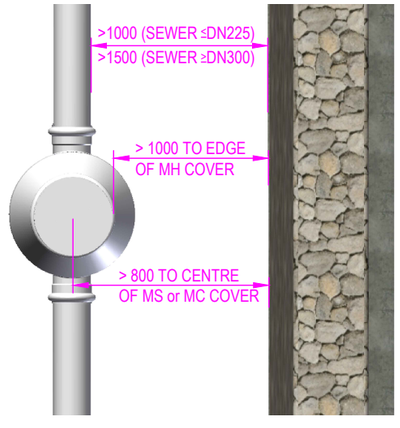


FIGURE 209-D: MAINTENANCE STRUCTURE OFFSET FROM RETAINING WALLS (PLAN VIEW)

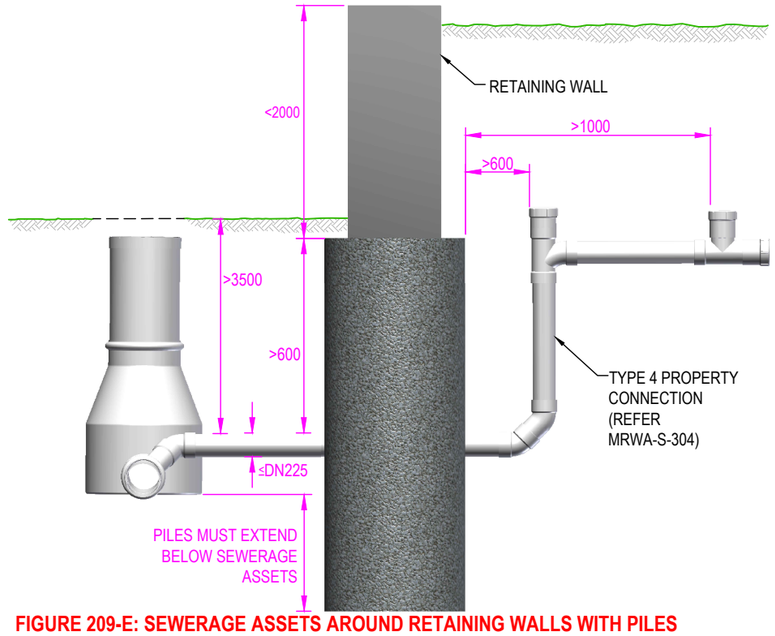


FIGURE 209-E: SEWERAGE ASSETS AROUND RETAINING WALLS WITH PILES (ELEVATION)

ALL DIMENSIONS IN mm UNLESS STATED OTHERWISE			
2	PUBLISHED FIRST ISSUE	01/10/15	CP / JT / KD / RJ
1	PRE-PUBLISHED DRAFT	01/03/15	CP / JT / KD / RJ
REV	DESCRIPTION	DATE	APPROVED

DESIGNED:	R. JAGGER	DATE: 1 JULY 2015			
DRAWN:	R. JAGGER	DATE: 1 JULY 2015			
CHECKED:	NAME	DATE	APPROVED:	NAME	DATE
☒ CWW	D. MOORE	01/09/15	☒ CWW	R. CARRUTHERS	01/09/15
☒ SEW	C. PAXMAN	01/09/15	☒ SEW	D. O'DONOVAN	01/09/15
☒ YVW	K. DAWSON	01/09/15	☒ YVW	J. TOMASI	01/09/15
ISSUED 2015			VERSION 1		

MELBOURNE RETAIL WATER AGENCIES

City West Water™ | South East Water | Yarra Valley Water

MRWA SEWERAGE STANDARDS

SEWERAGE ASSETS AROUND RETAINING WALLS

NOT TO SCALE

MRWA-S-209

Planning	Design	Construction
	✓ ✓ ✓	