MRWA Melbourne Retail Water Agencies

City West Water

Yarra Valley Water

South East Water

Sewer Acceptance Testing Specification

MRWA Specification 13-01.1

Document Details

Document History

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Please note that this Specification may be periodically updated.

Contents

Abbreviations

ABS	acrylonitrile butadiene styrene
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
ASTM	American Society for Testing Materials
AVI	audio video interleave
CCTV	closed-circuit colour television
CWW	City West Water
DN	Nominal size
DVD	digital versatile disc
GRP	glass reinforced polyester
ID	internal diameter; or identification
IO	inspection opening
IS	inspection shaft
JPEG	joint photographic experts group
kPa	kilopascal
m	metre
MC	maintenance chamber
MH	maintenance hole
mm	millimetre
MPEG	motion picture experts group
MRWA	Melbourne Retail Water Agencies
MS	maintenance shaft
N	newton
NATA	National Association of Testing Authorities
OD	outside diameter
PAL	phase alternate line
PDF	portable document format
PE	polyethylene
PP	polypropylene
PVC	polyvinylchloride
SEW	South East Water
SN	stiffness class
TMS	terminal maintenance shaft
VC	vitrified clay
WSAA	Water Services Association of Australia Inc.
YVW	Yarra Valley Water

1 INTRODUCTION

1.1 Purpose

This document has been prepared to provide instruction to consultants, contractors and Water Agency staff involved in the acceptance testing of newly constructed sewers in Melbourne Retail Water Agencies (MRWA) areas. It has been based upon City West Water's Sewer Acceptance Testing Specification (now superseded) and is intended to be a single source of reference for sewer acceptance testing requirements, summarising MRWA requirements and those of related publications, including:

- MRWA edition of the Sewerage Code of Australia (WSA 02-2002-2.3), Section 22, Acceptance Testing
- Conduit Inspection Reporting Code of Australia (WSA 05-2013-3.1)

This specification takes precedence over any other requirements with regards to acceptance testing of sewers.

The Melbourne Retail Water Agencies are committed to introducing new acceptance testing methods as technology advances to ensure that sewer installation quality represents best practice.

1.2 Mandatory and informative

This specification provides a mixture of mandatory and informative statements.

Informative text has been *italicised* to enable differentiation from mandatory statements. The information and guidance of informative text has been deliberately interspersed throughout the mandatory requirements to provide some context and enable better understanding of the mandatory requirements.

However, it is emphasised that the exact approach taken to all aspects of acceptance testing for a particular sewerage project is the decision of the Water Agency, and Designers and Constructors involved in each project. This specification provides technical information to aid in that process.

2 GENERAL

Acceptance testing is required to test the capability of the sewer assembly to satisfy design requirements as specified. It is not intended to test the material capability. Testing is intended to:

a) Reveal the existence of any assembly and structural faults.
b) Ensure the sewer is laid on grade and can operate without blockage, infiltration and exfiltration.
c) For open trench construction, confirm the success of placement and compaction of pipe embedment and trench fill, design and installation of maintenance structures.
d) Ensure that the sewer and structures are free of construction debris.

Undertake acceptance testing of all sewers and structures in accordance with the Specification and Table 2-1, and in the following order:

1. Visual inspection—above-ground
2. Compaction testing
3. Pressure testing (low pressure air or vacuum)
4. Infiltration check
5. Deflection (ovality) testing of flexible sewers using a proving tool, if not to be completed electronically
6. CCTV inspection, which may include:
    a) Internal inspection;
    b) Measurement of sewer grade; and
    c) Electronic deflection (ovality) testing of flexible sewers.

Table 2-1

SEWER TESTING REQUIREMENTS

Test	Section of Sewer System			Notify Water Agency
	Sewers* < DN300	Sewers* ≥ DN300	Maintenance Holes (MH)	
Visual Inspection	✓			Not required
Compaction Testing	✓ (refer Note 1)			✓
Pressure Testing (refer Note 2)	✓ Vacuum or low pressure		✓ Vacuum only	✓
Infiltration Check	✓			✓
Deflection (ovality) Testing	✓ Proving tool or electronic (refer Note 3)	✓ Electronic only	N/A	✓
CCTV Inspection (including measurement of sewer grade)	If depth is ≥5m (refer Note 3)	✓	N/A	✓

*'Sewers' includes all components of the sewer system except Maintenance Holes.

NOTES:

1 Refer to the MRWA Backfill Specification 04-03 for backfill testing requirements. Refer to Section 4.2 of this specification for embedment testing requirements (when testing is requested by the Consultant/Superintendent or Water Agency).

2 *Either low pressure air testing or vacuum testing may be used for sewers, whereas only vacuum testing shall be used for maintenance holes. Combined vacuum testing of sewers and maintenance holes may be used, subject to the requirements set out in section 5.*

3 CCTV Inspection will be required for the entire sewer line (i.e. pipe between consecutive maintenance holes) where the depth to invert is ≥ 5m. If CCTV is required, deflection (ovality) testing must be electronic.

For all Land Development sewerage projects, a minimum of two clear working days notification is required for the tests indicated in Table 2-1 by lodging a Testing Notification Form with the relevant Water Agency.

For Capital Works projects, a minimum of two clear working days notification is to be applied if not specified in the contract documentation.

The lodgement, acceptance and completion of all work on live sewers must be facilitated via the relevant Water Agency's procedure for live sewer notifications. Compliance to the Water Agency's work on live sewer policy shall be adhered to at all times for both Land Development and Capital works projects.

The reporting of results shall be carried out in accordance with the requirements set out in this specification. All test results, including unsatisfactory results, shall be documented and reported to the accredited Consultant/Superintendent.

Compaction test results shall be submitted along with summary reports of pressure testing, infiltration check, deflection testing and CCTV inspections. Summary reports shall provide a clear summary of sections tested, whether they were acceptable or not acceptable and any rectification works undertaken, in accordance with this specification.

Compaction testing shall be carried out by a NATA accredited organisation that holds current listing for the relevant acceptance test.

Clean sewers and structures before any test is performed, such that the test can be completed with clear and accurate results.

If any of the tests prove to be unsatisfactory, detect and rectify the fault. Continue to rectify and retest the sewer until a satisfactory test result is obtained. Even if testing produces satisfactory results, rectify any sewer, structure or appurtenance that has a visible or detectable leak, blockage, malfunction or other defect.

3 VISUAL INSPECTION – ABOVE GROUND

Visually inspect all sewers, maintenance structures, access covers and vents to ensure they are as specified on the design drawings.

Verify by inspection of purchase records and/or visual examination and/or other appropriate means that all products and materials used are approved by the Water Agency.

Rectify any faults identified.

4 COMPACTION TESTING

4.1 General

Undertake field density testing of engineered or controlled fill, pipe embedment, trench fill and embankments in accordance with the following sections.

Alternative test methods and more stringent values specified in the Project Specification or Design Drawings shall take precedence.

Test locations shall be representative of the filled area, trench or embankment.

Drives and tunnel fill do not require compaction testing.

4.2 Embedment compaction testing

4.2.1 Applicability

Undertake compaction testing of pipeline embedment for sewers when requested by the Consultant/Superintendent or Water Agency.

Embedment compaction testing is typically unnecessary for mains ≤DN 300 where:

a) *the allowable bearing pressure of the native ground is ≥50 kPa when assessed in accordance with WSAA Standard Drawing SEW-1200;*
b) *pipe laying and embedment compaction was carried in accordance with this specification; and*
c) *a pre-qualified compaction method was used in accordance with MRWA edition of WSA 02-2002 Clause 20.3.2.*

4.2.2 Frequency and location of embedment tests

Except where the provisions of MRWA edition of WSA 02-2002 Clause 20.3.2 apply, test sewers ≤DN 300 at the spring line (±50 mm) for each 100 lineal metres of pipeline or part thereof.

For sewers >DN 375, test at the spring line (±100 mm) for each 50 lineal metres of pipeline or part thereof.

4.2.3 Acceptance criteria

Ensure embedment compaction test results are not less than the values given in Table 4-1 and Table 4-2 as appropriate. These tables specify the default methods of compaction testing and required results that demonstrate adequate pipe support.

Test methods for determining the degree of compaction shall comply with the appropriate part of AS 1289.

Conduct testing of embedment compaction before trench filling.

Table 4-1

FLEXIBLE PIPES – MINIMUM EMBEDMENT COMPACTION

Material type	Test method	Minimum value (%)	
		Trafficable areas	Non-trafficable areas
Cohesionless	Density index (Note)	70	60
Cohesive	Dry Density Ratio or Hilf density	95	90

NOTE: Graded gravels and sands having fines (silts and clays) greater than 5% shall have their compaction determined by the dry density ratio test method.

Table 4-2

RIGID PIPES – MINIMUM EMBEDMENT COMPACTION

Material type	Test method	Minimum value (%)	
		Trafficable areas	Non-trafficable areas
Cohesionless	Density index (Note)	60	60
Cohesive	Dry Density Ratio or Hilf density	90	90

NOTE: Graded gravels and sands having fines (silts and clays) greater than 5% shall have their compaction determined by the dry density ratio test method.

4.2.4 Retesting

If one or more of the initial test results do not comply with Table 4-1 or Table 4-2, conduct two additional tests in the zone represented by the initial test. If one or more of the repeat tests does not comply, re-compact the full zone and continue repeat testing. Continue this cycle until the embedment compaction test results comply with Table 4-1 or Table 4-2.

4.3 Trench fill compaction testing

Compaction testing of trench fill / backfill shall be undertaken in accordance with the MRWA Backfill Specification 04-03, available from www.mrwa.com.au

4.4 Other fill compaction testing

Compaction testing of other fill shall be undertaken in accordance with the MRWA Backfill Specification 04-03, available from www.mrwa.com.au

5 AIR PRESSURE AND VACUUM TESTING OF SEWERS

5.1 General

Pressure (leakage) testing, either low pressure air testing or vacuum testing, is only qualitative as pressure losses do not directly reflect water leakage rates. It is used to identify points of leakage and potential pipeline infiltration and exfiltration due to damaged pipe seals and joints.

The sewer system may be tested by either of these methods:

1. ***Sewers and MHs tested separately***. Vacuum or air pressure test all sewers ≤DN 1500 in accordance with sections 5.2.1 or 5.2.2. Include external MH drops, property connection sewers, vertical risers, MCs, MSs and inspection shafts and fittings. **Do not include MHs** which shall be vacuum tested separately in accordance with section 5.4.
2. ***Sewers and MHs tested together***. Vacuum test all sewers ≤DN 600 in accordance with section 5.5. **Include MHs**, external MH drops, property connection sewers, vertical risers, MCs, MSs and ISs and fittings. A maximum of 300 lineal metres of the sewer system at a time may be tested by this method.

Test sewers >DN 1500 in accordance with section 5.3.

The following Table 5-1 summarises the test pressures used in each test method.

Table 5-1

PRESSURE TESTING – SUMMARY OF TEST PRESSURES

Location	Initial pressure	Starting pressure	Allowable pressure loss	
			Rubber ring jointed (VC, PVC, PP, GRP etc.)	Solvent cement jointed PVC or fusion jointed PE
Sewers *Low pressure*	28 kPa	28 kPa	7 kPa	2 kPa
Sewers *Vacuum*	-28 kPa	-28 kPa		
Maintenance Holes *Vacuum only*	-35 kPa	-28 kPa	5 kPa	
Complete sewer system (sewers & MHs together) *Vacuum only* *Sewers ≤DN600 only*	-35 kPa	-28 kPa	5 kPa	2 kPa

Where a combination of rubber ring and solvent cement or fusion jointed pipe materials have been installed, adopt the test durations for solvent cement and fusion jointed pipes.

Undertake vacuum tests in preference to air pressure tests where the Specification does not specify the test method.

Do not conduct pressure or vacuum testing of flexible pipes until at least 14 days after completion of placement and compaction of trench and embankment fill material.

Safely store and present test pressure gauges for use in a satisfactory condition. Gauges shall have a range of 0 to 60 kPa for low pressure and 0 to -60 kPa for vacuum, with figure intervals of 5 or 10 kPa and minor graduations of 1 kPa. The minimum diameter of the gauge face shall be 100 mm.

Calibrate gauges no less than 12 monthly by a NATA laboratory certified to undertake such activity. Gauge calibration certificates or date stamped calibration labels shall be held with the gauges. Do not use gauges with no current and valid proof of calibration.

For sewers of size >DN 750, the Water Agency shall advise testing requirements and/or enhanced inspection and control requirements. These shall be agreed prior to the beginning of construction so that it is clear what is required. The Constructor shall take particular care in respect of additional safety precautions required for testing large diameter sewers.

Sewers ≥DN 750 should be inspected and tested during construction and before the construction of MHs. The test may be conducted after trench filling but repair / rectification costs would almost certainly be greater.

Where infiltration is evident, all points of infiltration must be identified and repaired in accordance with Section 6, regardless of whether the pressure or vacuum test passes.

5.2 Testing methods for sewer mains ≤DN 1500

5.2.1 Vacuum testing

Plug all sewer inlets and outlets and cap and seal all MS/MC/IS or IO risers in the test length of sewer.

Apply an initial test vacuum pressure (negative pressure) of approximately 28 kPa. Close the valve on the vacuum line and shut off the vacuum pump. Allow the air pressure to stabilise for at least 3 minutes to identify any initial leakage.

When the pressure has stabilised and is at or above the starting test vacuum of 28 kPa, commence the test by initiating time recording. Record the drop in vacuum over the test period specified in Table 5-2.

Accept the length of sewer under test if the test vacuum loss is ≤7 kPa (rubber ring jointed pipes) or ≤2 kPa (solvent cement jointed PVC or fusion jointed PE) over the test period.

If the sewer fails the test, re-apply the vacuum to identify any leaks.

Rectify all defects prior to conducting any further testing. Rectify any visible or audible faults even if the vacuum testing is satisfactory. Retest each repaired section in accordance with this Specification.

This test method is based on ASTM test method C1214M, available from www.astm.org/cgi-bin.

Table 5-2

VACUUM TESTING ACCEPTANCE TIMES

Pipe size DN	Test length (m)					
	50	100	150	200	250	300
	Minimum test duration (minutes)					
100	2	2	2	2	3	3
150	3	3	3	5	6	6
225	4	5	8	10	13	15
300	6	9	14	18	23	29
375	7	14	22	29	36	43
450	10	21	31	41	52	66
525	14	28	42	56	70	86
600	18	37	55	73	92	106
675	23	46	70	93	116	144
750	29	57	86	115	143	168
900	41	83	124	165	207	243
1000	51	102	153	204	255	300
1050	56	112	169	225	281	319
1200	73	147	220	294	367	460
1500	115	230	344	459	574	700

NOTES:

1 Timing of the test duration shall commence after the 3 minutes initial pressurisation and only after pressure has stabilised.

2 Test duration times for other combinations of pipe size and test length shall be interpolated.

3 These times also apply to low pressure air testing for pipes ≥DN 675.

5.2.2 Low pressure air testing

Limit testing to sewers ≤DN 1500 and to runs between maintenance structures of ≤300 m.

Low pressure air testing shall be completed after trench backfilling and compaction, and where maintenance holes/shafts/inspection shafts and property connections have been completed.

Plug all sewer inlets and outlets and cap and seal all MS risers in the test length of sewer.

All test plugs shall be appropriately secured in accordance with the manufacturer's specifications.

Slowly apply an initial test pressure of approximately 28 kPa, since rapid pressurisation can cause significant air temperature changes that may affect testing accuracy. Where the sewer is below the water table, increase the stated pressure to the level directed by the accredited consultant/Superintendent to achieve a differential pressure of 28 kPa, **but do not exceed 50 kPa actual test pressure**.

Close the valve on the air pressure line and shut off the pump. Allow the air pressure to stabilise for at least 3 minutes to identify any initial leakage.

When the pressure has stabilised, reduce the pressure to 28 kPa (the test pressure) and initiate the time recording. Record the drop in pressure over the test period.

For pipelines ≤DN 600, the test durations specified in Table 5-3 shall apply.

Accept the length of sewer under test if the test pressure loss is ≤7 kPa (rubber ring jointed pipes) or ≤2 kPa (solvent cement jointed PVC or fusion jointed PE) for the relevant time interval specified in Table 5-3.

Table 5-3

LOW PRESSURE AIR TESTING ACCEPTANCE TIMES

Pipeline nominal size (DN)	Test duration (minutes)	
	Rubber ring jointed pipe	Solvent cement or fusion jointed pipe
100 and 150	3	6
225 and 300	6	9
375	9	9
450	9	N/A
525 and 600	12	N/A

For pipelines ≥DN 675 (irrespective of material or jointing system) and ≤DN 1500, the test durations specified in Table 5-2 shall apply. Accept the length of sewer under test if the test pressure loss is ≤7 kPa for the relevant time interval specified in Table 5-2.

If the sewer fails the test, re-apply the test pressure to identify any leaks.

Rectify all defects prior to conducting any further testing. Rectify any visible or audible faults even if the pressure testing is satisfactory. Retest each repaired section in accordance with this Specification.

A calibrated pressure relief valve, set at a maximum pressure of 50 kPa, shall be installed on all low pressure testing equipment.

5.3 Testing of sewer mains >DN 1500

Design and construct a joint test apparatus to enable air pressure or vacuum testing of each joint from within the sewer.

Every joint of all sewers >DN 1500 including specified maintenance structures and inverted syphons shall be tested.

Test using the relevant test procedure of section 5.2.1 or section 5.2.2.

Make calibration certificates for all pressure and vacuum testing equipment available to the accredited Consultant/Superintendent on request.

5.4 Testing of MHs

5.4.1 General

These sections set out the requirements for testing MHs where they are to be tested individually and separately to sewer pipes.

MHs to be tested shall be selected independently of the Constructor. The accredited Consultant/Superintendent or Water Agency shall nominate the MHs to be tested.

5.4.2 MH testing frequency

Vacuum test 20% of all cast in-situ concrete MHs, but not fewer than 1 (one) MH, for the initial test.

Vacuum test 100% of all pre-cast/pre-fabricated MHs for the initial test.

Where projects contain both pre-cast/pre-fabricated and cast in-situ MHs, view each type as a separate population and the above testing frequency criteria shall apply to each population separately within the project.

If any of the sample MHs fail the initial test, test all remaining MHs in that population.

5.4.3 Test method

Apply an initial test vacuum pressure (negative pressure) of approximately 35 kPa to the top of the MH. Close the valve on the vacuum line and shut off the vacuum pump. Allow the air pressure to stabilise for at least 3 minutes to identify any initial leakage.

When the pressure has stabilised and is at or above the starting test vacuum of 28 kPa, commence the test and initiate the time recording.

Accept the MH under test if the vacuum pressure loss is ≤5 kPa after a minimum test period of 3 minutes.

If the test failed, re-apply the vacuum to identify any leaks.

Rectify all defects prior to conducting any further testing. Rectify any visible or audible faults even if the vacuum testing is satisfactory. Retest each repaired section in accordance with this Specification.

5.5 Vacuum testing of complete sewer system

5.5.1 Applicability

This test method may be used for pipelines ≤DN 600 to test the complete sewer system, including MHs, for lengths of pipeline ≤ 300 lineal metres.

For pipelines ≥DN 675, test MHs separately in accordance with section 5.4, and sewers in accordance with sections 5.2.1, 5.2.2, or 5.3 as appropriate.

5.5.2 Method of test

Plug all sewer inlets and outlets and cap and seal all MS/MC/IS or IO risers in the test length of the sewer system. Apply an initial test vacuum pressure (negative pressure) of approximately 35 kPa. Close the valve on the vacuum line and shut off the vacuum pump. Allow the air pressure to stabilise for at least 3 minutes to identify any initial leakage.

When the pressure has stabilised and is at or above the starting test vacuum of 28 kPa, commence the test by allowing the gauge pressure to drop to 28 kPa, at which point initiate time recording. Record the drop in vacuum over the test period.

Accept the length of sewer under test if the test vacuum loss is ≤5 kPa (rubber ring jointed pipes) or ≤2 kPa (solvent cement jointed PVC or fusion jointed PE) for the relevant time interval specified in Table 5-4.

If the length of sewer system fails the test, retest separately all sewers and MHs within the original combined test length in accordance with sections 5.2.1, 5.2.2, or 5.4 as appropriate.

Table 5-4

VACUUM TESTING OF COMPLETE SEWER SYSTEM

ACCEPTANCE TIMES

Pipe size DN	Test length (m)					
	50	100	150	200	250	300
	Minimum test duration (minutes)					
100	3	3	3	3	3	3
150	3	3	3	5	6	6
225	4	5	8	10	13	15
300	6	9	14	18	23	29
375	7	14	22	29	36	43
450	10	21	31	41	52	66
525	14	28	42	56	70	86
600	18	37	55	73	92	106

NOTES:

1 Timing of the test duration shall commence after the 3 minutes initial pressurisation and only after pressure has stabilised.

2 Test duration times for other combinations of pipe size and test length shall be interpolated.

6 INFILTRATION CHECK

Infiltration is groundwater or stormwater that has entered or leaked into the sewer system. Condensation can occur in newly constructed sewers but is not considered to be infiltration, and is unlikely to contribute significantly to visible flows. Similarly, any other temporary sources of water that are not due to poor workmanship or defective materials might also not be considered to be infiltration. Through an examination of the available evidence, the Water Agency will determine if water present is a result of infiltration. Any continuously flowing water will likely be deemed to be infiltration. Still pools of water which are not growing in size will not be deemed to be infiltration.

Check for infiltration by visual inspection of sewer access points or internal (CCTV) inspection of sewers and provide a report recording the location and volumes of any infiltration.

No infiltration will be accepted on newly constructed sewer systems.

Rectify points of infiltration prior to conducting any further testing.

Rectify any visible or audible faults even if no infiltration is observed.

7 DEFLECTION (OVALITY) TESTING OF FLEXIBLE SEWERS

7.1 General

Deflection testing is a valuable method of confirming the success of embedment placement and compaction for non-pressure flexible pipelines.

Deflection testing can be undertaken using:

a) *Physical measurement in large diameter sewers.*
b) *Electronic testing - CCTV light ring and measurement software (refer also to Section 8).*
c) *An ovality proving tool calibrated to NATA's requirements.*

Proving tools may damage the sewer if not correctly sized.

For sewers <DN 300 where CCTV internal inspection is not required, a proving tool may be used. However, electronic testing is encouraged.

Where CCTV internal inspection is to be undertaken, ovality shall be tested electronically. For sewers <DN 300 a proving tool may only be used as an alternative if Water Agency approval is obtained.

Do not conduct deflection testing until at least 14 days after completion of placement and compaction of trench and embankment fill material.

Test sewers in sections from maintenance structure (MH, MS/MC or TMS) to maintenance structure.

Where the inside diameter of fittings (e.g. junctions, bends) is less than the pipe internal diameter, the pull-through prover method of testing may not be valid/possible. In this situation electronic testing shall be used.

7.2 Ovality proving tools

7.2.1 Size and material

Ovality proving tools (also known as “provers”) shall be made from a “soft” material, e.g. plastic or wood, to minimise damage to the pipeline and shall have pulling rings at each end and be marked to indicate the nominal pipe size and outside diameter.

The diameter and shape of the proving tool shall be calibrated to NATA requirements for each combination of pipe material, class (stiffness), type (plain wall, sandwich construction, ribbed and profile wall) and manufacturer. This information shall also be stamped on the proving tool for reference. The cross-section of the tools shall be fully circular and vaned proving tools will not be accepted.

Table 7-1 provides a list of default prover diameters for common sewer pipe materials and sizes.

Table 7-1

PROVER OUTSIDE DIAMETER FOR PVC AND PP PIPES

Pipe Size DN	Minimum Outside Diameter of Prover[1,2,3,4] mm		
	PVC – SN8, min		PP – SN10, min
	Solid Wall	Sandwich Wall	Profiled Wall
150	140	139	137
225	220	219	212

NOTES:

1 The tolerance on outside diameter of provers is ±0.5mm.

2 Prover ID = [(1-(%Allowable Deflection/100) x Mean Pipe ID – 2.5 – 0.15 x Out of round tolerance per AS 1260].
Australian Standards for PVC (AS/NZS 1260—plain wall and structured wall) and PP (AS/NZS 5065) sewer pipes do not specify internal diameters of pipes. Australian manufacturers of PVC and PP sewer pipe provided dimensions. The AS/NZS 1260 out of round allowance was applied to PP since AS 5065 does not cover out of roundness.

3 % Allowable Deflection is as shown in Table 7-2.

4 Applies only to pipes conforming to AS/NZS 1260 and AS 5065.

Where Table 7-1 cannot be applied, the internal pipe diameter may be measured before construction, and the external diameter of the proving tool shall be determined from:

$$OD = D_i (1 - n/100) - 2.5 \quad \pm 0.5 \text{ mm}$$

where:

OD = prover outside diameter, mm
n = allowable percentage short-term deflection, % (refer Table 7-2)
D_i = internal pipe diameter, mm.

This equation is adapted from Appendix O of AS/NZS 2566.2:2002.

Table 7-2

MAXIMUM ALLOWABLE SHORT-TERM PIPE DEFLECTIONS

Pipe material	Maximum allowable short term vertical pipe deflection, n %			
	14 days	30 days	3 months	1 year
Plastics				
ABS, PE, PP, PVC	4.8	5.0	5.5	6
GRP	3.8	4.0	4.4	4.8
Metallic				
Ductile iron	1.0	1.0	1.1	1.2
Steel				
Welded joint with:				
—No cement mortar lining	2.9	3.0	3.3	3.6
—Cement mortar lining	1.9	2.0	2.2	2.4
Elastomeric joint	1.0	1.0	1.1	1.2

NOTE: Deflection testing should not be conducted until at least 14 days after completion of placement and compaction of trench and embankment fill material.

7.2.2 Ovality proving tool gauges

Ovality proving tools suffer from wear and tear, losing their correct size through constant use. Consequently, the tools need to be dimensionally checked using an ovality proving tool gauge.

The gauge is used to determine whether or not the proving tool has retained its correct size after some period of use. It is designed so that correctly sized proving tools are unable to pass through the gauge. Only when the proving tool is undersized through wear will it pass through the gauge, and at this point the tool must be replaced.

Ovality proving tools shall be dimensionally checked using an approved ovality proving tool gauge on each project prior to use. Any tools that pass through the gauge will not be accepted for use in ovality testing.

Ovality proving tool gauges shall be approved for use by the Water Agency for each combination of pipe material, class, type and manufacturer. This information shall also be stamped on the gauge for reference. Gauges shall be made from toughened tool steel or case hardened mild or stainless steel, and shall be sized to be 0.2 mm smaller than the correct size of the relevant ovality proving tool.

7.3 Flexible sewers <DN 300

Test all flexible gravity sewers <DN 300, either electronically or by proving tool.

Conduct the test not less than 14 days after placement and compaction of trench fill.

Test either by pulling an appropriate proving tool through each section of pipe by hand winching to demonstrate that the maximum allowable deflection is not exceeded, or by using another authorised instrumental method capable of measuring and recording actual pipe deflections to an accuracy of ±0.50 % actual pipe internal diameter.

Failure to pull the proving tool through the sewer with a maximum pulling force of 400 N shall be deemed an unsatisfactory test result. Record locations where the proving tool is unable to pass.

Repair all sections of pipe that exhibit excessive deflection. Retest each repaired section electronically in accordance with Section 8 of this Specification.

7.4 Flexible sewers ≥DN 300

All flexible gravity sewers ≥DN 300 shall be tested electronically, i.e. by CCTV light ring and measurement software, in accordance with Section 8 of this specification.

For larger sewers where it is demonstrated that electronic ovality testing equipment is unavailable and personnel entry is not possible, the ovality testing method shall be agreed with the Water Agency.

7.5 Physical measurement in large diameter sewers

For large sewers where personnel entry is possible, the following method for physical measurement of the sewer ovality may be used subject to agreement with the Water Agency.

Use an infrared distance meter or equivalent method to take measurements from the centre of every second pipe. Record measurements at 3, 4, 5, 6, 7, and 8 o'clock, directing the beam through the centre of the sewer in each case.

At least one photo of a measurement in progress shall be taken at each location, and photos shall be submitted to the Water Agency with the Construction Verification form.

For the purposes of determining the deflection of a pipe, assume that a pipe has been deformed from a circle of internal diameter "D", to an ellipse with a minor diameter "D_{min}", which is equal to the shortest internal measurement. Produce a table with the 6 values at each chainage that is tested and nominate "Dmin" for each chainage.

% Ovality (deflection) shall be calculated as: $(D - D_{min}) / D \times 100$

This equation is adapted from Appendix O of AS/NZS 2566.2:2002.

Accept sewers with % Ovality values less than those given in Table 7-2.

Repair all sections of pipe that exhibit unacceptable deflection. Retest each repaired section in accordance with this Specification.

8 CCTV INSPECTION

8.1 General

CCTV inspection is a valuable method of confirming the acceptable installation of sewers, confirming as-constructed information and providing the Water Agency with a good record of its sewer assets.

Electronic deflection testing (using laser profiling) and measurement of sewer grade (slope) should be performed concurrently with the CCTV internal inspection. Typically CCTV footage is taken in one direction, and laser profiling is carried out on the return journey. If Water Agency approval has been obtained for CCTV to be undertaken without laser profiling, ovality ball tests are required to be completed prior to engaging the CCTV contractor.

CCTV Inspection is required for all sewers DN300 or greater, but also for all sewers with depth to invert ≥ 5m. Where only part of the sewer line (i.e. pipe between consecutive maintenance holes) is ≥ 5m deep, CCTV Inspection will be required for the entire sewer line.

The Consultant/Project Manager is responsible for verifying that all sewer construction works have been completed prior to CCTV of sewers commencing, including any services crossing the sewer and trench fill to finished surface level. CCTV may be conducted prior to road surface and other surface reinstatement works.

CCTV inspections are to be undertaken in accordance with this specification and the Conduit Inspection Reporting Code of Australia WSA 05-2013. Where there are any discrepancies, this specification shall take precedence.

Where required, specialised instruments, apparatus and/or software shall be used to facilitate measurement of parameters. Camera equipment, hardware and software used in measuring the parameters shall be correctly calibrated for each application using the manufacturer's recommended methods. If inspection equipment used to conduct the inspection is not calibrated to NATA's requirements for quantifying observations, record the estimated value as an addendum to the test report.

8.2 Requirements for CCTV Contractors

Minimum competency requirements for CCTV contractors are as follows.

For the company:

a) Public liability insurance, minimum $10m.
b) Evidence of
    - Procedures/SWMS in accordance with legislation;
    - Inspection & test plan (ITP);
    - Access & compliance to MRWA edition of the Sewerage Code;
    - Access & compliance to WSAA Conduit Inspection Reporting Code.
c) Approved by the Water Agency for work on live sewer assets, where required. Refer to the relevant Water Agency for its live sewer access requirements.
d) A certified quality management system is encouraged, but not required.

For key personnel:

a) A Statement of Attainment in Unit NWP331B – *Inspect conduit and report on condition and features*, awarded by a Registered Training Organisation. Required for all CCTV operators.
b) A Statement of Attainment in Unit NWP440A – *Supervise conduit inspection and reporting*, awarded by a Registered Training Organisation. Required for all supervisors, reviewers or managers of the CCTV work, including those who prepare inspection reports from data supplied by qualified CCTV operators.
c) OHS industry induction (White Card).
d) Traffic control training.
e) Confined space entry qualifications.

As deflection testing by laser profile is a relatively recent technology there is no recognised training for operators. Those contractors seeking to provide services as CCTV operators must demonstrate to the Water Agency's satisfaction that they have undergone training in the use of the laser profiler and are competent in its use.

A list of requirements for service providers are currently under review by the MRWA. These requirements will be published in due course on the MRWA website.

8.3 Reporting

All results and reports from the CCTV inspection are to be submitted to the Water Agency in digital form on single or multiple DVDs (as necessary), or a portable hard drive. The DVD(s)/hard drive shall be accompanied with a transmittal form outlining their contents.

Some reports are also required to be submitted to the Water Agency with the Construction Verification form.

Number DVDs and label them with the following general project information:

- Water Agency File Number
- Project Name
- Consultant name (for Land Development projects)
- Contractor name
- Date or period of CCTV inspection(s)

Assign a Section Number (Section 1, 2, 3 etc.) to each sewer line that is being inspected, i.e. to each section of sewer between maintenance structures. In reports, the Section Number should always be related to the upstream and downstream maintenance structures for ease of reference.

The results and reports to be submitted are summarised in Table 8-1. The contents and format of these results and reports are detailed in the following sections.

Table 8-1

SUMMARY OF RESULTS AND REPORTS TO BE SUBMITTED

Test	Submission	Number to be submitted	Submit with Construction Verification?
Internal inspection (CCTV)	Summary Report	One per project	✓
	Assessment Reports	For each sewer line inspected	-
	Video Files	For each sewer line inspected	-
	Database Files	For each sewer line inspected	-
	Defect Photos	For each defect or possible defect	-
Deflection testing	Report	One per project, with a graph for each sewer line inspected	✓
	Video Files	For each sewer line inspected. Usually included with the internal inspection video files.	-
Measurement of sewer grade	Report	One per project, with a graph for each sewer line inspected	✓

8.4 Internal inspection

8.4.1 General

The purpose of internal inspection is to identify any defects and features in newly constructed sewers that may shorten the life of the asset or lead to operational problems and high on-going maintenance cost, so that these defects may be rectified prior to acceptance by the Water Agency.

In general, the defects or unacceptable features observed during an inspection relate to:

a) the configuration of pipes, fittings, maintenance structures and connections;
b) the manufacture of the pipes, fittings and maintenance structures; and
c) storage, handling and installation of the pipes, fittings and maintenance structures.

Inspections may be undertaken by CCTV camera or 3D optical pipeline scanner.

Carry out the internal inspections in accordance with Section 2 of WSA 05-2013, and classify defects in accordance with Appendix A of this specification.

Five minutes prior to commencing the CCTV inspection of each individual pipe section, stained water shall be poured into nearest upstream maintenance structure of the pipe section to be inspected. The volume of stained water required is to be twenty litres per 100m run of pipe. In pipes where there are significant gradient problems a greater volume of stained water may be required; in this instance the CCTV operators shall use their judgement accordingly. The water shall be stained with food grade green vegetable dye sufficient to give strong colour. Any ponding deeper than 15mm or 5% of the pipe diameter (whichever is greater) shall be reported to the Water Agency with the estimated depth and length of the water pool.

Inspection of sewers provides supplementary information to confirm the work as constructed records. In particular, the distance to junctions, connections, bends and other features measured during inspection may be used to verify their correct location. The distance measurements recorded for these features must follow consistent protocols so that they can be replicated on work as constructed plans with the accuracy specified by WSA 05-2013.

The zero or reference position of the camera shall be the centre of the starting maintenance structure, generally a MH or MS, and connections to the maintenance structure shall be recorded.

Where an inspection ends at a drop within a MH, the end position of the camera shall be within the drop bend, such that the connections to the MH wall and the drop bend can be inspected.

The use of CCTV cameras may be limited by the internal characteristics of some materials. For example, black PE pipes or maintenance structures may be very difficult to inspect and identify defects. Similarly, this limitation may apply to steel or ductile iron pipes that are lined or coated with black or dark coloured PE or other black or dark coloured plastics material. In such installations it is recommended that a trial inspection be undertaken to determine if the inspection technique can reliably identify defects and features.

The CCTV operator is also dependent on materials being correctly nominated since some materials may be very difficult to identify from internal inspection.

8.4.2 Acceptable results

The acceptance criteria for CCTV inspection of sewers shall be in accordance with Appendix A of this specification. The CCTV contractor shall use Appendix A for acceptance determination of each defect or feature encountered, and shall record the determination in the inspection report, which will be provided to the Consultant/Project Manager.

Repair all sections of pipe with unacceptable defects. Following repairs, conduct another CCTV inspection for each line in which an unacceptable defect was recorded. The inspection shall be undertaken as per this specification and such that it can be confirmed or otherwise that the defect(s) have been rectified. Undertake additional repairs and CCTV as necessary until confirmation is obtained.

8.4.3 Reporting of results

8.4.3.1 Summary report

The summary report shall be prepared by the Consultant/Project Manager, with the purpose of providing an overview of all defects that were identified in the internal inspection.

The summary report shall be provided in PDF format with a filename of the following convention:

*Water Agency File Number*_Internal_Inspection_Summary_Report.pdf

e.g. 13PD1234_Internal_Inspection_Summary_Report.pdf

The summary report shall be included on the submitted DVD/hard drive but shall also be submitted with the Construction Verification Form.

Information to be included in the summary report shall be as shown in Figure 1, best presented in landscape format.

CCTV Inspection Summary Report

Project: Riverview Estate Stage 4

Water Agency File Number: 13PD1234

Consultant: Smith Group

Contractor: John Constructions

Date of inspections: 26-27 August 2013

Defect ID	Section	Start MH	End MH	Chain-age	Defect Code	Description	Classification	Comments
1	2	CMP1-2	CMP1-3	3.86	JDR	Joint displaced radially, 15-20mm	Not acceptable	-
2	2	CMP1-2	CMP1-3	42.55	D	Deformation	Not acceptable	Confirmed by laser profile
3	3	CMP1-3	CMP1-4	9.19	JDR	Joint displaced radially, <5mm	Acceptable	-

Figure 1: Summary Report Template (blue text is example text only)

8.4.3.2 Assessment reports

The CCTV contractor shall produce assessment reports for each sewer line in accordance with WSA 05-2013 and Appendix A of this specification. The minimum requirement is for the reports to be in WinCan 8 format; however the MRWA are open to the use of alternative and improved formats provided they include the following as a minimum:

- Water Agency File Number
- Project name
- CCTV contractor's name and operator's name
- Date and time of inspection
- Suburb and closest street
- Section number
- Names of upstream and downstream maintenance structures
- Depth to inverts of maintenance structures
- Direction of inspection (*upstream* or *downstream*)
- Purpose of inspection (*new construction*)

- Use of conduit (*sewage*)
- Type of conduit (*gravity sewer*)
- Conduit shape, diameter and material
- Each observation, with its code and position set out in sequential order in the direction of the CCTV inspection
- Photos of each defect or possible defect

Note that preliminary grading of the structural and service condition of the sewer is not required to be included in the assessment reports, as set out in WSA 05-2013 section 2.13.

A separate file shall be provided for each sewer line inspected, in PDF format, with a filename of the following convention:

*Water Agency File Number_YYYYMMDD_HHMM_*Section *number_Start MH_End MH*.pdf

e.g. 13PD1234_20130228_1430_Section02_CMP1-2_CMP1-3.pdf

8.4.3.3 Video and database files

CCTV video files shall be provided for each sewer line, showing a record of the entire inspection to its conclusion. The footage must be without breaks or jumps in the picture.

Electronic deflection testing footage should be included as this is undertaken on the return journey.

Header information shall be displayed for a minimum of 30 seconds at the start of each inspection length, including the following information as a minimum:

- Section number
- Water Agency File Number
- Consultant name
- Construction contractor name
- Operator and CCTV contractor name, e.g. John Smith, PipeCam
- Textual description of location, such as the street address
- Purpose of inspection (usually *new construction* or *confirming rectification works*)
- Pipe material
- Pipe diameter

The following information (as a minimum) shall be superimposed on the video at all times:

- The time
- The date
- Chainage
- Downstream maintenance structure name
- Upstream maintenance structure name
- Direction of inspection (*upstream* or *downstream*)

If the inspection is abandoned, the closing screen of the video shall display a reason for the abandonment.

A separate video file shall be provided for each sewer line inspected, in MPEG-1, MPEG-2, MPEG-4 or AVI format, with a filename of the following convention:

*Water Agency File Number_YYYYMMDD_HHMM_*Section *number_Start MH_End MH*.mpg

e.g. 13PD1234_20130228_1430_Section02_CMP1-2_CMP1-3.mpg

All associated database files shall be submitted along with the video files.

8.4.3.4 Photographs

Digital photographs shall be provided in accordance with WSA 05-2013, in particular section 2.12.4. Photographs shall be taken of all defects encountered during the CCTV inspection, as well as any possible defects, i.e. where the operator is unsure whether a feature should be classified as a defect.

Photographs shall be included within the assessment reports and also as separate files.

The resolution of photographs shall be sufficient to allow clear identification of the feature, but shall be PAL resolution (720 x 576 pixels) as a minimum. Photographs shall be submitted in JPEG format.

8.5 Electronic deflection testing

8.5.1 General

Deflection testing should be undertaken along with the CCTV internal inspection, typically on the return journey of the CCTV camera.

The laser profiler, when mounted on the CCTV tractor, should be capable of being inserted into sewers via access points from the surface i.e. personnel should not need to access the sewer. Some access point chases, however, are curved making placing of the tractor from above difficult, in which case Confined Space person entry may be required.

Electronic ovality testing equipment can generally only be inserted at maintenance holes. Depending on the Electronic Ovality Testing equipment used, a tractor and wand also may not be able to negotiate abrupt changes in directions or waterseals, especially on smaller pipelines. Where such problems are encountered, inspect the sewer line from the other direction. Where these restrictions prevent certain sections of sewers from being electronic ovality profiled, consult the Water Agency for direction on acceptable alternative arrangements.

The laser profiling equipment shall be regularly serviced and calibrated.

8.5.2 Acceptable results

The acceptance of laser profile deflection tests will occur when a suitably qualified person has viewed the outputs and signs off that the deflections are within permitted limits. The viewing and analysis of outputs shall be completed in the field or office by the Consultant's representative.

For the purposes of determining the deflection of a pipe, assume that a pipe has been deformed from a circle of internal diameter "D", to an ellipse with a minor diameter "D_{min}", which is equal to the shortest internal measurement.

% Ovality (deflection) shall be calculated as: $(D - D_{min}) / D \times 100$

This equation is adapted from Appendix O of AS/NZS 2566.2:2002.

Accept sewers with % Ovality values less than those given in Table 7-2.

Repair all sections of pipe that exhibit unacceptable deflection. Retest each repaired section in accordance with this Specification.

8.5.3 Reporting of results

8.5.3.1 Report

Provide a report showing continuous graph of chainage plotted against % ovality. The graph shall include access point numbers and be generated automatically by the laser profiler. It should not require input from the operator.

Include in the report a photograph of the light ring for each location where ovality limits are exceeded.

The first page(s) of the report shall include project information and an interpretation of the results stating whether any parts of the sewer are outside the permitted limits. Figure 2 shows a template for this, best presented in landscape format.

Electronic Deflection Testing Report

Project: Riverview Estate Stage 4

Water Agency File Number: 13PD1234

Consultant: Smith Group

Contractor: John Constructions

Date of inspections: 26-27 August 2013

Section	Start MH	End MH	Chainage	Pipe type	Allowable Deflection*	Measured Ovality	Comments
2	CMP1-2	CMP1-3	42.55	DN225 PVC	4.8%	6.7%	-
4	CMP1-4	CMP1-5	12.24	DN300 PVC	4.8%	9.2%	-

* From Table 7-2

Figure 2: Electronic Deflection Testing Report Template

(blue text is example text only)

The report should be provided in PDF format with a filename of the following convention:

*Water Agency File Number*_Electronic_Ovality_Report.pdf

e.g. 13PD1234_Electronic_Ovality_Report.pdf

The ovality plot and associated data may also be provided in a Microsoft Excel format (XLS or XLSX).

The report shall be included on the submitted DVD/hard drive but shall also be submitted with the Construction Verification Form.

8.5.3.2 Video files

Typically, laser profiling is carried out on the return journey of the CCTV camera after an internal inspection, and as such the laser profile footage should be included in the video files for internal inspection.

Should a deflection test by laser profile be undertaken independently of an internal inspection, the video footage header information, file type and name shall comply with the same requirements as for internal inspection (refer section 8.4.3.3).

8.6 Measurement of sewer grade

8.6.1 General

The recording of sewer grade against chainage is used to provide confirmation that the sewer has been graded as per the design. It is accepted that CCTV tractors have some margin of error in measuring grade and this should be taken into account when assessing results.

Where there is evidence from internal inspection or other acceptance tests that the sewer grade may be outside of construction tolerances, the results of the CCTV tractor grade measurements may be informative in determining if the constructed grade is acceptable.

Measure the grade of sewers using an inclinometer fitted to the tractor of the CCTV scanner or optical 3D pipeline scanner. Prior to measurement, determine and record the % grade error margin through trials of the tractor on rough surfaces of known grade to calibrate the inclinometer. Calibration and measurement of the grade shall be in accordance with the manufacturer's specifications.

8.6.2 Reporting of results

Record measurements of sewer grade on an inclination graph, usually automatically produced by the software being used.

As a guide, the following features should typically be included on each graph:

- *x-axis: the chainage or position along the sewer (m), corresponding to the CCTV results.*
- *y-axis: on the left, the altitude (m); and on the right, the inclination or grade (%).*
- *Plotted on the graph:*
    a. *The invert and obvert as straight lines between the measured start and end levels (chainage vs. altitude)*
    b. *The measured invert along the sewer (chainage vs. altitude)*
    c. *The measured grade (chainage vs. inclination)*

Provide the inclination graphs in PDF or Microsoft Excel format for each section of sewer inspected by CCTV, with a filename of the following convention:

*Water Agency File Number*_Sewer_Grade_Results.pdf

e.g. 13PD1234_Sewer_Grade_Results.pdf

The results shall be included on the submitted DVD/hard drive but shall also be submitted with the Construction Verification Form.

Make calibration records for the inclinometer available to the Water Agency on request.

APPENDIX A ACCEPTANCE CRITERIA FOR INTERNAL INSPECTION OF NEWLY CONSTRUCTED SEWERS

A1 INTRODUCTION

Tables A1 to A3 inclusive have been developed to assist CCTV operators report and determine the acceptability of defects and/or features in newly constructed sewers that can:

a) *reduce asset life;*
b) *impair operational performance; or*
c) *increase maintenance costs.*

Separate tables are provided for rigid and flexible sewer pipes. It is important to use the correct table for the type of sewer being inspected.

The criteria have been developed from a variety of sources including direct consultation with pipe manufacturers.

Refer to the Conduit Inspection Reporting Code of Australia WSA 05-2013 for an explanation of defect/feature codes referenced in the following tables.

Table A1

DEFECT AND FEATURE REPORTING SUMMARY FOR FLEXIBLE SEWER PIPES – PLASTICS (PVC, PE, PP, GRP), DUCTILE IRON AND STEEL

Defect/Feature	Characterisation 1	Characterisation 2	Quantification 1	Acceptance Determination Remarks
Cracking C	L, C, S, or M	S		Not acceptable. Not usually a feature of these pipe materials but may be apparent in cement mortar linings and internal corrosion barrier ("gel-coat") of GRP. Report as Lining defective 'PL'.
	L, C, S, or M	W		Not acceptable. Not usually a feature of these pipe materials but where it does occur it would generally indicate excessive external loads from construction equipment.
Fracturing F	L, C, S, or M			Not acceptable
Breaking B	D, M, or E			Not acceptable
Deformation D				Report in remarks. Acceptance to be determined by laser profile deflection test.
Local or point deformation – no code	No code Record General Comment GC			Report and refer to the Water Agency for acceptance determination. An unusual feature with many possible causes.
Collapsed X				Not acceptable
Porous sewers (pipes) PP				Not acceptable. Not likely to be a feature of these pipes.
Surface damage S	W			Report and refer to the Water Agency for acceptance determination
	Z			Identify where possible, report and refer to the Water Agency for acceptance determination
	CP or H			Not acceptable. Not likely to be observed in new sewers.
Lining defective PL	D•, E•* or B•*			Not acceptable * Applicable to internal corrosion barrier in GRP pipes • Applicable to PE internal lining of ductile iron and steel pipes
	Z			Identify other defects where possible, report and refer to the Water Agency for acceptance determination

Refer to WSA 05-2013 Section 3.7 for code definitions

continued

Defect/Feature	Characterisation 1	Characterisation 2	Quantification 1	Acceptance Determination Remarks
Deposits on wall or in invert DE	E			Not acceptable - should not occur in new sewer
	S or R			Not acceptable
	C			Not acceptable
	W or Z			Identify where possible, report and refer to the Water Agency for acceptance determination. Excessive solvent cement from PVC pipe joints is not usually an issue for non-pressure PVC pipes, but should be reported and referred to the Water Agency for acceptance determination.
Exfiltration EX				Not acceptable - exfiltration is most likely associated with a joint defect or broken pipe
Infiltration S	S, D, R or G			Not acceptable
Ingress of soil ING				Not acceptable
Roots R	T, F, or M			Not acceptable – should not occur in new sewer
Joint displacement JD	L			Not acceptable – if joint displacement exceeds maximum for the joint specified by manufacturer
	R		>5 mm for pipe sizes up to DN 250 >10 mm for pipe sizes from above DN 250 to DN 500 >20 mm for pipe sizes above DN 500	Not acceptable above limits indicated. Record any leaks under Infiltration S.
	A			Should not occur in new ‘straight’ sewers (see maximum limits for ‘curved’ sewers below). Report deflection. For ‘curved’ sewers using ‘pulled’ pipes report the distance between the end of spigot and end of socket (adjoining pipe) at worst point and the angular deflection at the joint. Refer to Water Agency for acceptance determination.
Jointing material (seal) intrusion) JI	R	N, HH, HL or B		Not acceptable
	Z			Report and refer to the Water Agency for acceptance determination

Refer to WSA 05-2013 Section 3.7 for code definitions

continued

Defect/Feature	Characterisation 1	Characterisation 2	Quantification 1	Acceptance Determination Remarks
Point repair RP	L, I, S, H or IC			Some techniques may not be acceptable in new sewers. Report in remarks and refer to the Water Agency for acceptance determination.
	Z			Identify repair technique, report in remarks and refer to the Water Agency for acceptance determination
Defective repair RX	M or P			Not acceptable
	B or Z			Determine extent of 'bellies' or other defects, report in remarks and refer to the Water Agency for acceptance determination
Obstruction OB	B, M, I, J or C			Not acceptable
	Z			Report in remarks and refer to the Water Agency for acceptance determination
	P or S			Report in remarks and refer to the Water Agency for acceptance determination
Flow (water) level WL			>15 mm or 5% of pipe diameter (whichever is greater) where there is no upstream flow or blockages downstream, i.e. evidence of ponding / reverse grades.	Not acceptable above limit indicated. Report depth and length of pool.
Defective junction JX	P, D, B, BC, SR, SE or Z			Not acceptable
Connection CN	G or P			Should not occur in new sewer. Report unexpected or poorly constructed connections in remarks and refer to the Water Agency for acceptance determination.

Refer to WSA 05-2013 Section 3.7 for code definitions

Table A2

DEFECT AND FEATURE REPORTING SUMMARY FOR RIGID SEWERS – VITRIFIED CLAY, STEEL REINFORCED CONCRETE

Defect/Feature	Characterisation 1	Characterisation 2	Quantification 1	Acceptance Determination Remarks
Cracking C	L, C, S, or M	S		Surface cracking is common in concrete and is usually not of concern. Such cracking is usually of limited extent and does not indicate structural failure. However, surface cracking that is extensive may indicate a problem with concrete quality. Report in remarks for the Water Agency to review. Surface cracking is unlikely in VC products currently on the market although it should be noted that internally glazed VC pipes are now again available. If surface cracking is observed report in remarks for the Water Agency to review.
	L, C, S, or M	W		Not acceptable - all of these types of cracking are indicative of poor handling, unsatisfactory installation and or overloading.
Fracturing F	L, C, S, or M			Not acceptable
Breaking B	D, M, or E			Not acceptable
Deformation D				Not acceptable
Collapsed X				Not acceptable
Porous sewers (pipes) PP				Not acceptable
Surface damage S	S, AV*, or W			Report and refer to the Water Agency for acceptance determination
	Z			Identify, report and refer to the Water Agency for acceptance determination
* Not applicable to VC	AP*, AM*, RC*, CP*, H* or WS*			Unlikely to be observed in new construction
	RV* or RVP*			Not acceptable - cover to reinforcement is clearly less than specified in relevant pipe standard

Refer to WSA 05-2013 Section 3.7 for code definitions

continued

Defect/Feature	Characterisation 1	Characterisation 2	Quantification 1	Acceptance Determination Remarks
Lining defective PL** ** Applicable to plastics lined concrete pipes only	D, E, WD or L			These defects not acceptable. The lining is placed during manufacture in the top 330° of the pipe and is required to be joined after installation at each pipe joint.
	Z			Not acceptable - lining on invert of pipe (pipe installed upside down)
	Other			Identify other defects, report in remarks and refer to the Water Agency for acceptance determination
Deposits on wall or invert DE	E			Should not occur in new sewer
	S or R			Not acceptable
	C			Not acceptable
	W or Z			Identify material, report in remarks and refer to the Water Agency for acceptance determination
Exfiltration EX				Not acceptable
Infiltration S	S, D, R or G			Not acceptable
Ingress of soil ING				Not acceptable
Roots R	T, F, or M			Should not occur in new sewer
Joint displacement JD	L			Not acceptable – if joint displacement exceeds maximum for the joint specified by manufacturer
	R		>5 mm for pipe sizes up to DN 250 >10 mm for pipe sizes from above DN 250 to DN 500 >20 mm for pipe sizes above DN 500	Not acceptable above limits indicated. Record any leaks under Infiltration S.
	A			Should not occur in new ‘straight’ sewers (see maximum limits for ‘curved’ sewers below). Report deflection. For ‘curved’ sewers using ‘pulled’ pipes report the distance between the end of spigot and end of socket (adjoining pipe) at worst point and the angular deflection at the joint. Refer to the Water Agency for acceptance determination.

Refer to WSA 05-2013 Section 3.7 for code definitions

continued

Defect/Feature	Characterisation 1	Characterisation 2	Quantification 1	Acceptance Determination Remarks
Jointing material (seal) intrusion) JI	R	N, HH, HL or B		Not acceptable
	Z			Report in remarks and refer to the Water Agency for acceptance determination
Point repair RP	L, I, S, H or IC			Some techniques may not be acceptable in new sewers. Report in remarks and refer to the Water Agency for acceptance determination.
	Z			Identify repair technique, report in remarks and refer to the Water Agency for acceptance determination
Defective repair RX	M or P			Not acceptable
	B or Z			Determine extent of 'bellies' or other defects, report in remarks and refer to the Water Agency for acceptance determination
Obstruction OB	B, M, I, J or C			Not acceptable
	Z			Report in remarks and refer to the Water Agency for acceptance determination
	P or S			Report in remarks and refer to the Water Agency for acceptance determination
Flow (water) level WL			>15 mm or 5% of pipe diameter (whichever is greater) where there is no upstream flow or blockages downstream, i.e. evidence of ponding / reverse grades.	Not acceptable above limit indicated. Report depth and length of pool.
Defective junction JX	P, D, B, BC, SR, SE or Z			Not acceptable
Connection CN	G or P			Should not occur in new sewer. Report unexpected or poorly constructed connections in remarks and refer to the Water Agency for acceptance determination.

Refer to WSA 05-2013 Section 3.7 for code definitions

Table A3

REPORTING SUMMARY FOR ITEM CONFIGURATION – ALL SEWERS

The configuration of items in a new sewer is usually defined in design drawings, standard drawings and specifications. Compliance with some of these requirements may be determined by inspection.

The operator shall have a copy of design drawings, standard drawings and specifications applicable to the works being inspected for reference in determining the acceptance of nominated and other features.

The following table describes nominated features that are to be reported.

Feature	Description	Remarks
Rocker pipes	These are shorter pipes than the normal unit pipe length and are required adjacent to structures such as maintenance holes, other structures and concrete encasement. The purpose is to allow for differential settlement between the structure and the pipeline without cracking, fracturing or distortion of the pipe adjacent to the structure.	The required length of rocker pipe and the configuration of pipes at the structure are specified in design drawings, standard drawings and/or specifications for particular pipe materials. The operator should record the distance at each joint adjacent to the structure to determine the length of the rocker pipe and report it in remarks. Not acceptable if length is outside of a tolerance of ± 150 mm of required length – refer to the Water Agency for acceptance determination.
Bends	Bends occur in some sewers at changes of direction and/or grade. In some cases compound bends (vertical and horizontal) may be encountered. In small diameters up to DN 225 bends are likely to be moulded or post-formed long radius. For ≥DN 225 it is likely that bends will be fabricated in a 'lobster back' with a series of mitre cuts and the pipes joined with epoxy, hot air welding or some other technique.	Not acceptable if the camera unit cannot pass through the bend. Not acceptable if jointing materials at mitres intrude more than 10 mm into the pipe. Not acceptable if the bend is not shown on the design drawings. Bends should only occur close-coupled to maintenance structures. Report bends found independent of maintenance structures and refer to the Water Agency for acceptance determination. The transition to bend from straight line should not exceed the angular deflection for the joint system used. Record joint deflection if observable and refer to the Water Agency for acceptance determination. The distance at the start and finish of bends shall be recorded in the inspection report.
Connections	This is where another sewer to provide a service for a customer has been connected to the pipeline being inspected after the pipeline has been installed. The connection is formed by making a hole in the original pipe and setting the connecting pipe in place. This feature is not part of new sewer construction.	Should not occur in newly constructed sewer.

continued

Feature	Description	Remarks
Junction	A junction is a prefabricated fitting installed as part of the original construction or post construction by inserting the junction fitting in the pipeline. Junctions are provided to allow customers to connect house drains directly to the sewer or allow a property connection sewer to be extended to the customer's property.	Not acceptable if configuration differs from the configuration specified on the design plans. Not acceptable if the configuration includes a horizontal bend in the property connection. All junctions for direct customer connection should be provided with a PVC plain wall solvent weld socket with screwed cap or for VC, a plugged VC to PVC plain wall adaptor. Inspect each junction lateral and report compliance.
Maintenance shafts, chambers and inspection shafts	Provide access to the sewer for maintenance equipment but not person entry. May have an integral bend or may have an adjoining (generally upstream) long radius bend. Can have up to two property connection inlets. Reticulation connections are not permitted.	Not acceptable if the inspection equipment and/or transportation unit cannot traverse through the maintenance shaft. Not acceptable if there is a reticulation connection or more than two property connections. The transition to maintenance shaft from bend or straight line must not exceed the angular deflection for the joint system used. Record joint deflection if observable and refer to the Water Agency for acceptance determination.
Pipes	Conduits of varying length, size and material to convey gravity sewage.	Record the typical pipe length that has been used to construct the sewer. Not acceptable if the pipe length, size (diameter) or material differs from what is specified on the design plans.