CCTV of Stormwater Systems

Cairns Regional Council

Commentary Guidelines

Introduction

Councils inherit assets through the donated asset process. In doing so, Councils immediately receive assets that are *fit for purpose* and consequently assume the long term maintenance responsibilities and any potential liability of future failures or deficiencies that occur during the life of the pipe. The high cost, of retroactive repairs or replacement, creates a need for Councils to check the integrity of the pipe and workmanship of the assets being donated. Council seeks to do this by undertaking CCTV Inspections of underground pipe drainage works received by Council as part of the donated assets process.

The purpose of this commentary is to provide guidance on the interpretation of CCTV footage and on what Council's expectations are with regard to acceptable defects and unacceptable defects. This document is to be read in conjunction with FNQROC Development Manual Specification S4.26 – CCTV Inspection of Stormwater Drainage Systems.

Current FNQROC Submission Requirements

As part of the project documentation to be provided at the early plan sealing (EPS) [1]or works acceptance stage, the CCTV footage and associated certification or CCTV inspection report[2] are to be submitted to Council. The CCTV inspection report must be prepared in accordance with the requirements of section S4.26 of the FNQROC development manual. Council's acceptance of such must be obtained ***prior*** to the issue of acceptance of the Early Plan Seal (EPS) or Works Acceptance (WA) inspections. In order to expedite the acceptance process it is recommended that the Certifying Consultant arrange a joint viewing of the CCTV footage with a Council officer. Both parties can then agree on which items may present issues to be addressed. The Consultant should ensure that their own assessment, including recommendations, has been done prior to any joint viewing with Council.

CCTV Requirements

The Current FNQROC Development Manual Stipulates that all underground stormwater pipe drainage (between 375mm and 2000mm) must be inspected using CCTV camera on completion of all backfilling and compaction operations. This must be undertaken not more than two (2) weeks prior to the EPS or WA inspections – whichever is earlier.)

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[1] If the CCTV inspection is undertaken as part of the EPS process, Council may request that portions of the stormwater network be reinspected as part of the WA inspection. An example of when the re-inspection of stormwater pipes would be required to be re-inspected by CCTV may include:-

- Stormwater pipes which run under trafficable areas (street, access-ways etc.), which may have been exposed to additional compaction works between the EPS inspection and the WA inspection. It is the RPEQ's responsibility to identify any stormwater pipes which may be exposed to further compaction works between EPS/ WA, and Council's responsibility to identify which lengths (if any) need to be re-investigated. A full CCTV re-inspection of the stormwater network is not expected. The cost of re-inspection shall be borne by the applicant.

[2] If no defects are identified in the CCTV footage, then the RPEQ may simply certify the works as being in accordance with the requirements of FNQROC and the relevant Australian Standards. However, if defects are identified, a 'CCTV inspection report' is to be provided in accordance with sections S4.26, "Acceptance Criteria" and "Submissions" in the Council's FNQROC manual. The recommended method and extent of any remediation works required are to be identified in the report.

This inspection is required to ensure that the drainage system is without defects or deficiencies of any kind (construction, structural or serviceability). It is further utilised by Council to verify the information provided by the applicant as part of the 'As Constructed' drawings.

CCTV inspections must be carried out by suitably qualified and experienced CCTV operators, utilizing equipment appropriate to record sufficient information for the assessment of compliance against the relevant Australian Standards and Manufacturer's recommendations. All CCTV work is to be performed under the direction of the Engineer (RPEQ) responsible for the site.

Calibration of Equipment

In order to accurately quantify defects within a nominated section of pipe, the CCTV equipment utilized must be calibrated against a standardised procedure. A simple procedure which provides a reliable reference point can be used. The sample procedure listed below is an acceptable calibration procedure for the CCTV camera. Other methods may be used with justification and validation.

Sample Calibration Procedure

Prior to the commencement of survey for each different pipe diameter, the CCTV camera is to be inserted into a reference pipe (or, alternatively, stock footage may be utilized) of the same diameter, and is then positioned in the invert of the pipe and the camera set to zero zoom. The camera is then to be pointed directly at the invert of the pipe and focused on a graduated 1:1 scale bar (including concentric scale). This initial setup (camera looking at the invert, zero zoom) is to be taken as the 0^{O} reference point (or 'datum'). The camera is to be rotated through 90 , 180 and 270 from the datum, and reference footage taken of the scale bar at each location. All scales are to be clearly legible to the viewer. The camera resolution settings shall be adjusted, where necessary, to achieve this. Calibration of scale of the CCTV footage at a minimum of 3 different levels of zoom for each direction shall also be taken.[3] This calibration of the scaling mechanism will allow the determination of the size and extent of defects, and their assessment against allowable limits.

Alternatively consultation can be made with the CCTV operators to determine if it is possible to attach a ruler or scale to the front of the camera (without obstructing the view) which would give an indication of crack of gap size as it traverse the pipe.

Defect Types and Examples

Reference Documentation

The Water Services Association of Australia, Conduit inspection Reporting Code of Australia (WSA05-2008) is to be used as the basis of the determination and reporting of defect types and classifications.

[3] Nominally zoom settings should include minimum zoom (zero), maximum zoom and one intermediate point.

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1. Cracks and Fractures

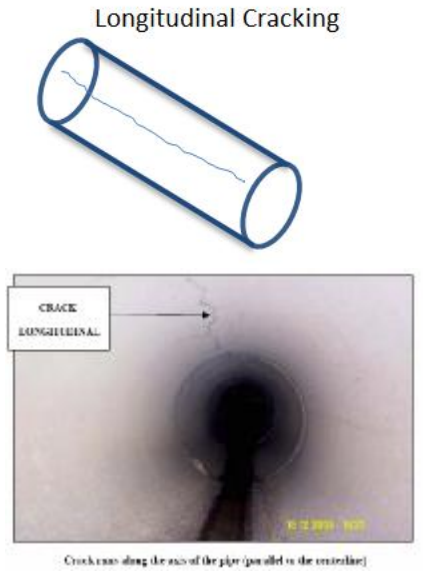
Cracks differ from fractures in that a crack has no discernible separation along the failure surface, whereas a fracture does. Table 1 summarises the major crack/ fracture defect types.

Two major cracking types exist:-

1) *Surface cracking*, which is characterised by short virtually indistinguishable, zero separation type cracks which usually form as part of the casting process (ie. Plastic shrinkage cracking and the like), and

2) Wall cracking, which indicate poor pipe handling and installation techniques[4].

Table 1: Examples of Crack and Fracturing defects

Defect Type	Failure Criteria		Examples
	Minor (Surface Cracking)	Major (Wall Cracking)	
Longitudinal	0-30mm – to be documented and scored as per WSA05 guidelines and submitted to asset owner for review	Not Acceptable	

[4] Reference is made to S4.26 "Pre-Inspection Criteria", points 1 and 2, which state that it is the contractors responsibility to make the assessment that the pipes are 'fit-for-purpose and meet the requirements of AS4058. It is on the basis of the contractors checks being satisfactorily completed, and pipes accepted by the contractor, that if any defects are subsequently identified during the CCTV inspections (e.g. Cracking, fracturing, deflections, chipping, intrusions, etc.) they will be deemed to have occurred during installation.

Table 1: Examples of Crack and Fracturing defects (continued)

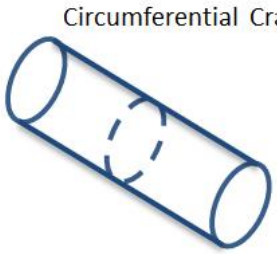
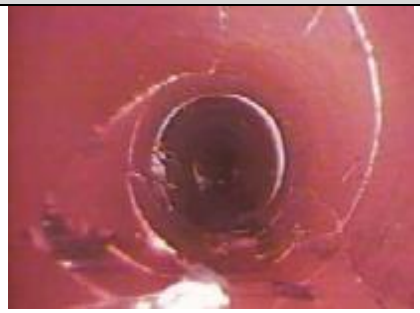
Defect Type	Failure Criteria		Examples
	Minor (Surface Cracking)	Major (Wall Cracking)	
Circumferential		Not Acceptable	   Longitudinal Fracturing 

Table 1: Examples of Crack and Fracturing defects (cont.)

Defect Type	Failure Criteria		Examples
	Minor (Surface Cracking)	Major (Wall Cracking)	
Helical/Spiral	0-30mm – to be documented and scored as per WSA02 guidelines and submitted to asset owner for review	Not Acceptable	
Multiple Defects		Not Acceptable	

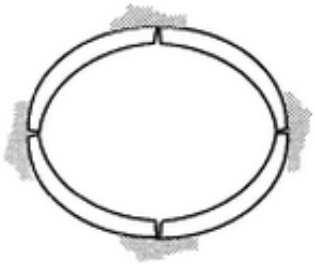
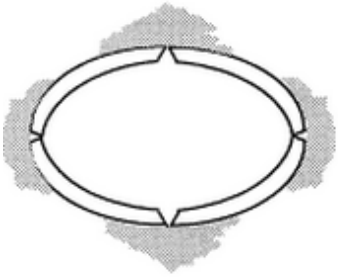
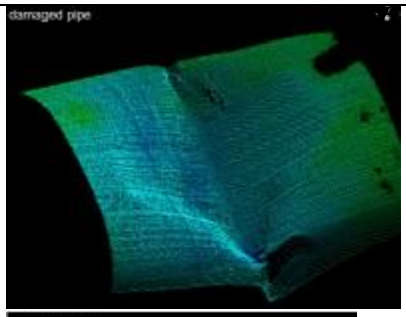
2. Deformed, Collapsed and Broken Pipes

Deformation of the stormwater pipe can be defined as a departure from the initial cross section of a pipe. This is often caused by dents or deflections within the pipe or in more extreme cases, the pipe deforming into an elliptical profile. The deformations of stormwater pipes into elliptical profiles are not common in RCP pipes, but become more common\ prevalent in flexible pipes. The more serious extension of this defect is the failure and collapse of the pipe structure. This sequence of the failure is shown in Table 2, along with other discrete causes of failures (breaks and punctures).

Table 2: Major failure types (deformation)

Defect Type	Failure Criteria	Example
Punctures	Not Acceptable	
Break	Not Acceptable	

Table 2: Major failure types (continued)

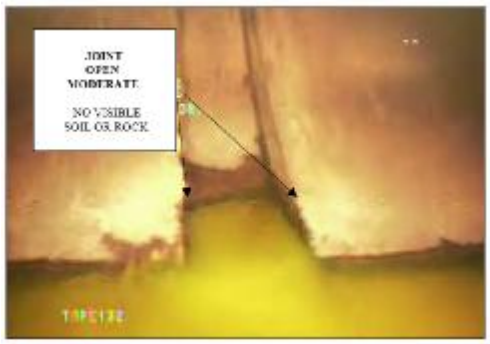
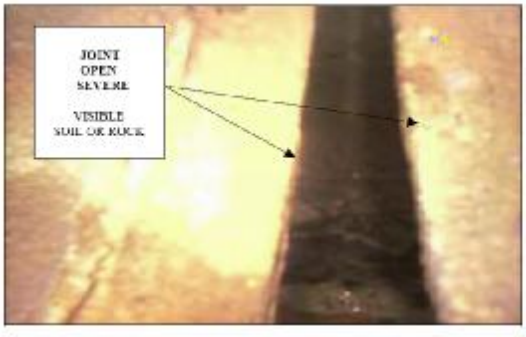
Defect Type	Failure Criteria	Example
Deflection/compression	>5% original measurement after 60 days, Not Acceptable	
Elliptical profile	>5% original measurement after 60 days, Not Acceptable	
Dents	Not Acceptable	 
Collapse	Not Acceptable	

		 05-21-97 collapsed , heavy , impassable distance A: 222.84 f

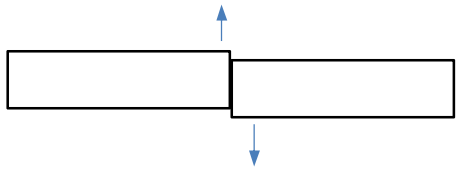
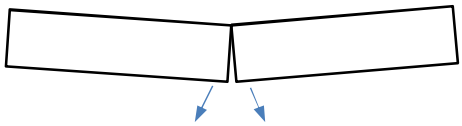
3. Displaced and Open Joints

Joints which are displaced and / or misaligned allow water and debris to pass between bedding material and the internal stormwater pipe. Table 3, shows examples open or displaced joints.

Table 3 – Causes of failure, resulting from open or displaced joints.

Defect Type	Failure Criteria	Example
Extension of Gap in Joint (minor)	General Guide[5]: >5mm for <250mmø Pipes >10mm for 250mmø to 500mmø >15-20mm for >500mmø	  Pipes end not right or sealed on same level.
Extension of Gap In Joint (major – Bedding material Exposed)	Not Acceptable	 Pipes do not abut completely (or at all) on same level.

[5] Tolerances levels set outside of those nominated by the general guide shall be accepted by Council on the basis of conformation of compliance with the tolerance limits set by the pipe manufacturer. In such cases a copy of the manufacturer's most recent documentation detailing the tolerable limits shall be provided to support the claim.

Defect Type	Failure Criteria	Example
Lateral Displacement (Offset Pipes)	Not Acceptable	  Joint level-shifts – no joint match.  Joint side-shifts – no joint match.
Dropped Invert (Mis-alignment)	Not Acceptable	

4. Surface Damage

The two most common forms of surface damage are:

1) Exposed steel reinforcement, and
2) Visible or protruding aggregate in the finish of the concrete pipes.

The consequential corrosion of the exposed reinforcement is also considered a defect. If the CCTV footage identifies evidence of corrosion of exposed reinforcement, Council will consider this a defect. Table 4 shows examples of these forms of defects

Table 4 – Surface defects of concrete stormwater pipes.

Defect Type	Failure Criteria	Example
Exposed Reinforcement	Not Acceptable	  Wall material lost exposing entire reinforcement.

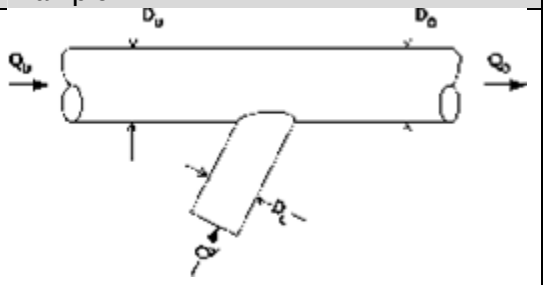
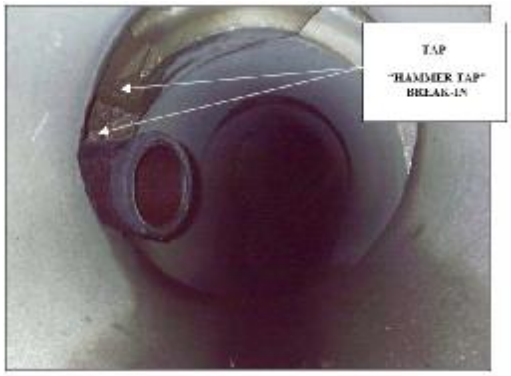
Table 4 – Surface defects of concrete stormwater pipes (continued)

Defect Type	Failure Criteria	Example
Exposed Aggregate	Not Acceptable	 

5. Connections

Nominally, all changes of direction or connection to existing pipes should be done with the construction of a manhole. Mid line connections such as the one shown in Table 5 are not acceptable.

Table 5 :Stormwater connection defects

Defect Type	Failure Criteria	Example
Break-In Type Connections	Not Acceptable	 

6. Debris, Silt and Obstructions

Debris, silt and other foreign obstructions reduce the hydraulic capacity of the stormwater drainage network. The reduction of the capacity may lead to the back-up or blockage of stormwater and cause additional risk &/or damage to people and property. (Refer Table 6)

Table 6 – Obstruction defects in Stormwater pipes

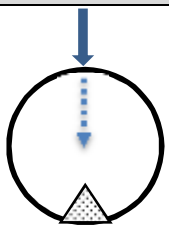
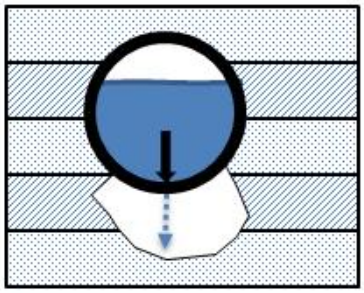
Defect Type	Failure Criteria	Example
Silt Build up	Not Acceptable on new installations	
Debris or Alternative Service Blockages	Not Acceptable on new installations	 
Joint seal material	Not Acceptable on new intallations	

7. Infiltration

Where opportunity exists for groundwater to infiltrate the stormwater network (from selected defects listed here), it may lead to the secondary defects. These may include the:

- erosion of bedding material,
- failure of the bedding trench, and
- consequential failure(s) of adjacent material(s) affected by the areas of scour and/ or erosion.. Figures showing the defects are shown below (Table 7).

Table 7: Secondary defects caused by Infiltration

Defect Type	Failure Criteria	Example
Deposits	Cause to be determined, report/remediation plan prepared and submitted to Asset owner for Acceptance determination	
Water infiltration within pipe structure[6]	Not Acceptable (Ag drains within the bedding trench shall be utilized for the drainage of the bedding trench)	
Bedding material erosion	Not Acceptable	

[6] This does not include sites where specific design consideration has been given to ground water infiltration, which is to be approved by the LGA on a case by case basis.

8. Root Infiltration

Root infiltration occurs when stormwater infrastructure is installed in close proximity to trees or other vegetation (Figure 8), whose roots may infiltrate the structure of the stormwater pipe and cause various levels of blockages as shown in Table 8.

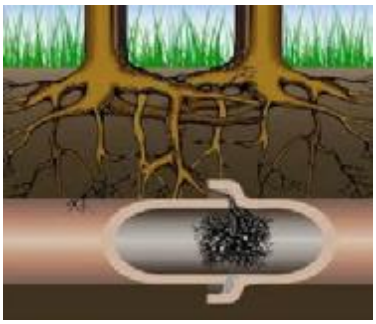
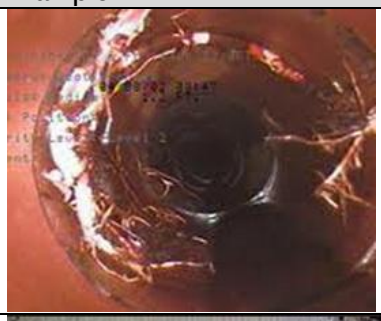


Figure 8: Schematic of root infiltration.

Table 8.1: Root infiltration defects

Defect Type	Failure Criteria	Example
Root infiltration (minor) <20% Blockage	Not Acceptable – Refer to Joint Failure Criteria for acceptable limits on joint separation	
Root infiltration (Major) 20% - 70% Blockage		
Root infiltration (Total Blockage) >70% Blockage[7]		

[7] It is noted that this extent of root infiltration and blockage is not expected to occur prior to the Works acceptance or final works acceptance inspections. It provided as an example only.

9.Encrustation and Scale and Physical Damage

Physical defects associated with concrete works such as scaling, spalling, chipping, erosion (chemical or otherwise) and encrustation with various foreign material are also defects which can reduce the performance and or design life of stormwater infrastructure. Typical defects have been identified in Table 9.

Table 9 Physical Defects (Stormwater Infrastructure)

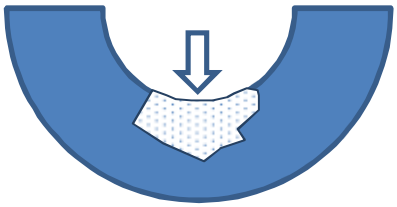
Defect Type	Failure Criteria	Example
Erosion of Pipe Lining	Cause to be determined, remediation plan prepared and submitted to Asset owner for Acceptance determination	
Lip/Lining Chipping	Not Acceptable	
Puncturing	Not Acceptable	
Breakage/Collapse	Not Acceptable	

Table 9 Physical Defects (Stormwater Infrastructure) continued.

Defect Type	Failure Criteria	Example
Concrete Slurry/Aggregate deposition from construction	To be submitted to asset owner for Acceptance determination	

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