Report Prepared for

Quake Centre
Delivering Industry Solutions

EQC
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The New Zealand Water & Wastes Association Waiora Aotearoa

IPWEA
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

Recommendations for the Revision of New Zealand Pipe Inspection Manual

December 2016

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ProjectMax
Optimising Pipeline Renewals

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Document Issue

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1. Executive Summary

The New Zealand Pipe Inspection Manual (NZPIM) was created in 1989 to provide the New Zealand water services industry with a standard approach and specification for the inspection of non-pressure pipes (typically public and private gravity stormwater and wastewater drains), the classification of the defects and features observed and the determination of an overall condition code.

The need for the manual at that time was driven by the increasing use of CCTV for pipeline inspections, the requirement to value, and depreciate, public assets and the increasing recognition of condition assessment as a key consideration in pipeline renewal planning. Those drivers are still relevant today and if anything the industry has increased its dependency on reliable condition information. A further emerging driver is the desire to be able to share information and learnings within New Zealand and with off-shore water services entities. The benefits of a consistent modern approach across the country leads to:

- Transparency in condition assessment and how this is reflected in the potential looming asset renewal bow wave. This will be of assistance both within the industry and to central government
- Value for money asset renewal and avoidance of premature replacement of assets
- Reduced dependency on individuals with unique in-house approaches to asset condition and a greater pool of experienced people to draw upon.

An overall framework intended to provide a range of relevant and useful reference documents, standard approaches and specifications for the New Zealand water services industry has been assembled through a multi-year collaboration of the University of Canterbury : Quake Centre, WaterNZ and the IPWEA. This framework is collectively known as 'Evidence Based Decision Making for the 3 Waters Networks (Pipe Renewals)' and has attracted initial funding from the Earthquake Commission.

An update of the NZPIM was identified as a priority project in relation to its relevance and its perceived relative ease of implementation.

ProjectMax was responsible for the 3rd Edition update of the NZPIM in 2006 and were engaged to define the depth and breadth of the next update to ensure that any changes aligned with industry needs and preferences. This report conveys the outcome of that investigation.

The 1989 NZPIM was largely based on the UK WRc (Water Research Centre at that time) 'Manual of Sewer Condition Classification' published in 1980. The overall approach adopted in the WRc manual has remained largely intact over the years, while been progressively improved to accommodate new technologies and fine-tuning of the processes and outcomes. There are now a number of documents in use around the world, including UK, Europe, USA, Australia and New Zealand that share these roots.

The NZPIM is the only document of its type in use in New Zealand and is supported by Council asset owners, CCTV contractors and industry suppliers. Any changes therefore require careful consideration to ensure they align with industry need and to ensure that the NZPIM remains the defacto standard for CCTV inspection and condition assessment.

The ProjectMax study progressed through a series of well defined steps :

1. Literature Review – A survey of relevant documentation and approaches from around the world, particularly countries that New Zealand has working relationships with such as Australia and the UK
2. Industry Survey – The literature review and ProjectMax's familiarity with the CCTV industry informed the generation of an extensive survey that was circulated electronically across the pipe inspection industry. This generated 54 responses, mainly from Local Government, which on the whole conveyed a very consistent view of the changes that were desired and the issues arising
3. Engagement of a Steering Group – This comprised 18 people perceived to be active, and prominent, in the industry who were engaged for guidance and comment as ProjectMax formulated the recommendations contained in this report. While the level of feedback received was sporadic at times there was broad consensus on all the issues and no objections to the recommendations of any consequence
4. Formulation of Recommendations – This report contains the overall recommendations arising from the above and, once approved, is intended to form the brief for the next phase which is actually generating the update.

The following table identifies the key issues that were addressed in the survey and which drive the structure of the report. Specific recommendations are included on each and align with the industry's desire to have a more comprehensive approach that incorporates both guidance and specific requirements i.e. providing a 'one-stop' solution.

1	**Format and general content of the existing Manual**
2	**Manhole Inspections**
3	**Pipe Cleaning**
4	**Methods of inspecting pipes and the quality of inspection equipment**
5	**Pressure Pipelines**
6	**Topic – Training / Qualifications and Data Quality Management**
7	**Inspection of Laterals Pipes (including private drains and sewers)**
8	**Acceptance Criteria for New/Rehabilitated Pipe**
9	**Pipe Condition Grading**
10	**Pipe Defect/Feature Classification (defect codes)**

In each case comprehensive changes are recommended that will improve the ability of the industry to scope the works required, undertake inspections to a consistent and high quality standard and then interpret the outcomes in relation to the maintenance and/or renewal of that asset in accordance with best asset management practices. The content will also recognise the new technologies that are now available and the way data is managed.

Specific mention is warranted for items 5 – Pressure Pipelines, 9 – Pipe Condition Grading and 10 – Pipe Defect Classification as the recommendations for these go beyond the relatively obvious opportunities for updating, expanding and improving the content of the current NZPIM.

Pressure Pipelines

The current NZPIM deals only with CCTV and its application to gravity drainage pipes, typically for stormwater and wastewater. No equivalent single document exists for the inspection and condition assessment of pressure pipes typically used for water supply and wastewater rising (pump) mains.

The survey revealed a clear desire for such a pressure pipe manual. While the overall principles are similar for both gravity and pressure pipes the technologies and approaches involved are quite different. It is therefore recommended that this proceed as a separate project.

Pipe Condition Grading

One of the most important outcomes of a pipe inspection is the overall assessment of its condition as it gradually deteriorates from '*As new*' to '*At end of useful working life*'. This decline is typically characterised by scores of 1-5 respectively and this is the basis of the proposed New Zealand Meta-data Standards and the ability to compare pipe condition with other water services entities across New Zealand and the world.

The pipe condition grading process in the current NZPIM does not yield outcomes that are well aligned with the IPWEA IIMM, or the Meta-data Standard, and it is recommended to implement a number of changes that will generate a better alignment.

This is considered to be one of the most fundamental improvement opportunities as the 1-5 grading directly relates to the condition, valuation and life expectancy of the current assets, and the associated likely timing of renewals.

Pipe Defect Classification

As noted the NZPIM shares similar roots to other prevalent asset inspection guidelines around the world and continues to use similar descriptions for similar defects and features. However, 'similar' is not sufficient if it is desired to be able to benchmark against countries using a slightly different pipe defect classification system. Any disruption to a one to one (or consistent many to one) structure will prevent direct comparison of outcomes.

The only way to ensure compatibility at this level is to adopt the classification used by the jurisdiction that we wish to compare ourselves with at this level of detail.

While this is possible it comes with a number of issues relating to the need to retrain the New Zealand inspection operators and engineers, comparison with past inspections would be difficult and the industry may fracture into 'old' and 'new' classification groups. New Zealand would potentially also lose control over the future evolution of the system.

However, if the recommendations on Pipe Condition Grading are accepted, and overall pipe condition is expressed using Meta-data Standards that are equivalent to other jurisdictions, this will still allow informed and valuable engagement with other world-wide entities. It is widely believed that this is the level of engagement that is most likely to occur and would be the most valuable.

In recognition of these points the recommendation is that New Zealand should continue with an enhanced and expanded version of the current NZPIM pipe defect classifications.

The specific recommendations relating to each of the major discussion topics are as follows :

1	**Format and general content of the existing Manual**
	The following general format improvements are suggested: 1. **Publishing Format** - The hardcopy format was not specifically identified as a problem, but a suggestion for an enabled electronic or web based version with a 'Keyword' search function that could be easily accessed and searched should be considered for easy reference and links to standard forms; 2. **Chain of Custody** – A description within the first section of the manual that describes where the NZPIM fits into the other Asset Management manuals, as part of the Introduction / overview of the manual 3. **General update of content** – Review and update information on technology under relevant sections including use of diagrams and worked examples where possible 4. **New content structure with clear defined manual sections** - Information relevant to that section contained only within that section, (or a clear reference provided to information contained within another section). • Incorporate an index section • Incorporate a Quick Reference Card containing summary list of codes • Incorporate a glossary of terms
2	**Manhole Inspections**
	1. **Section on Manhole Inspection** – Add a specific section on Manhole Inspection 2. **Modify and adopt codes and grading methodology** – Establish a set of codes and grading methodologies based on the defect and feature codes used for the inspection of pipes, adapting as necessary (e.g. referring the "Vertical Cracks" in place of "Longitudinal Cracks" etc.) 3. **Include a manhole inspection Specification** – Provide a manhole inspection specification as part of the standard appendices **4. Forms and Logsheets** - Update the manhole inspection form and manhole inspection logsheet report template form to align with the new inspection processes.
3	**Pipe Cleaning**
	The proposed improvements are aimed at providing additional guidance for pipe cleaning associated with the inspection of pipes as follows: 1. **Add additional guidelines for working with Jetters as part of the CCTV inspection** – This will include standard operating procedures (SOP) for the prevention of damage to pipes and surcharging (i.e. blow backs), based as the existing SOP's developed by SCIRT as part of the Canterbury Earthquake recovery

	2. **Define a specification for pressure limits and outcome focused definitions of different types of cleaning** - This could be based on the tables following (measures are arbitrary to illustrate intent) suggested by the steering group members. The key to this recommendation is to provide sufficiently detailed descriptions that would allow asset owner and contractors to determine the appropriate level of required cleaning and if it has been achieved. **3. Define pressure limits based on known or assumed pipe condition** – In addition to the above, it is recommended that pressure limit guidelines are determined, based on pipe condition, to avoid pipe damage. This could be based on the WRc Jetting Code of Practice and amended to align with best practice knowledge in New Zealand
4	**Methods of inspecting pipes and the quality of inspection equipment**
	1. **Update and expand information on the different inspection methods and equipment available**. 2. **Develop an inspection equipment classification system** – This would provide guidance on the selection of appropriate equipment and help with: I. Selection or specification of appropriate CCTV equipment for the specific project, including when alternative technology would provide benefits over CCTV II. Equipment capability (Range and limitations) **III.** Expected quality of image and data outputs, etc.
5	**Pressure Pipelines**
	1. **Not to include pressure pipe within the NZPIM** – The nationally consistent guideline document for the inspection of pressure pipe is an unmet need and it is recommended that consideration is given to the development of a separate companion manual focused on pressure pipe. **2. The title of the NZPIM be amended to limit the scope to non-pressure pipe** - Use a suggested title of “New Zealand Pipe Inspection Manual (Non-Pressure)”. A companion manual for pressure pipe could then be similarly referenced.
6	**Training / Qualifications and Data Quality Management**
	1. Specify within the revised NZPIM a graduated (based on role) level of minimum experience based on the proposed NZQA unit standards **2. Update the existing CCTV audit processes to include Camera Operator performance measures**
7	**Inspection of Laterals Pipes (including private drains and sewers)**

	1. **Provide a section within the revised NZPIM that covers the inspection of lateral pipes**. - The intent of the section is to augment the information covered under the public drains to cover for the specific differences. 2. **Provide a simplified set of domestic drain codes that can be utilised for the inspection of laterals by private drain owners and their contractors –** This could also be used by local authorities as part of an inflow and infiltration investigation. This is envisaged to be based on the simplified codes and grading methodology developed by SCIRT.
8	**Acceptance Criteria for New/Rehabilitated Pipe**
	1. **Provide two, separate, guidelines sections on the interpretation of inspection results to determine the acceptability of new/rehabilitated pipe** i. Assessing New Pipes ii. Assessing Rehabilitated Pipes The separate sections are a reflection on the specific differences that need to be considered between a new pipe and a pipe that has been lined
9	**Pipe Condition Grading**
	1. **Adopt the proposed NZ Metadata Standards Pipe Condition Grades –** We also recommend that the descriptions are expanded (using the other existing manuals) to assist with interpretation 2. **Modify the defect weighted scores and grading thresholds as necessary to align the structural and service grades derived from the CCTV observations to the NZ Metadata Standards**. - It is recommended that modified weighted scores are separately provided for both wastewater and stormwater. 3. **Amend the grading threshold process to specify the use of the peak score only** 4. **Provide additional guidance on pipe condition grading –** This should include worked examples and a guideline aimed at asset managers for interpreting CCTV pipe grades and reports as part of assessing remaining useful life.
10	**Pipe Defect/Feature Classification (defect codes)**
	1. **Maintain but modify the existing NZPIM defect/feature codes –** recommend that this is based on the proposed modified defect and feature codes included in the Appendix 8. This will address unmet needs, maintain backwards data compatibility while moving the NZPIM closer to alignment with international standards. 2. **Include a section within the revised NZPIM on coding principles** – to provide addition guidance of how defects are to be recorded and the application of severity bands etc.

2. A Time of Change

The public 3 waters industry (water supply, wastewater drainage and stormwater drainage) in New Zealand is dominated by Local Government. While there are some structural changes occurring within this sector, e.g., Wellington Water and the proposed CCO in the Waikato region, it is anticipated that Local Government will remain the primary delivery mechanism for the foreseeable future.

The industry does however face a number of significant challenges that will require changes to the way services are managed, delivered and funded. While technology will continue to evolve the primary challenges relate to increasing efficiency and funding the renewal of existing assets and networks while also providing for growth and ever increasing Levels of Service requirements and expectations.

Much of the current 3 waters networks was developed during a period of intense urbanisation and conversion to public servicing in the 1960s and 70s with ongoing urbanisation since then. These assets are now well into their useful working life with a 'bow-wave' of renewals expected to occur within the next 30 years. This co-incides with the 30 year forecasting period required by the Local Government Act 2002 for both the Infrastructure Strategy and the associated Financial Strategy. These documents respectively focus on what work will be required, and how that work will be funded, while staying within acceptable service and financial boundaries.

These challenges and obligations require the 3 waters industry to step-up to a higher level of planning and preparation and fundamental to that is more and better information, and improved processes for decision making.

3. Evidence Based Decision Making for the 3 Waters Networks (Pipe Renewals)

In response to the above challenges the 3 waters industry has now initiated a wide ranging programme of upgrading and updating of the tools and methodologies that are utilised. This is largely focussed through a multi-year collaboration agreement between the University of Canterbury : Quake Centre, Water New Zealand and the IPWEA. The approach has the overall title '*Evidence Based Decision Making for the 3 Waters Networks (Pipe Renewals)*' and the deliverables can be summarised as :

The Pipe Renewals Guidelines Programme initiated by UC Quake Centre, IPWEA and Water New Zealand (Water NZ) will develop guidance documents and tools to enable New Zealand's water organisations to make nationally consistent, evidence-based decisions in regards to pipe network operational and capital expenditure. The programme covers inspection, maintenance and renewal strategies for pipework in potable water, wastewater and storm water system

A wide range of projects are included in the approach and work has been undertaken to prioritise them and identify interdependencies. The sponsorship includes initial funding of some projects, plus funding from the Earthquake Commission, to ensure that the process gains initial momentum. An overview of the approach can be viewed on the WaterNZ website.

Included within the approach is a project (5.2) entitled '*Pipe Inspection Manual*' and this was identified as a high priority given its relative ease of implementation, level of importance and level of impact. This report is a significant milestone in the progression of this particular project.

4. The 'Pipe Inspection Manual' Project

The Pipe Inspection Manual project is focussed on providing the 3 waters industry with a tool that can be consistently utilised to inspect pipeline assets and assess their condition. The assessment of condition essentially compares the current condition to two different benchmarks. The first comparison is to when the asset was new to determine the extent to which it has deteriorated, and the second is to its expected condition when it has reached the end of its useful working life and is no longer able to provide the required level of service, at an acceptable level of risk or compliance.

The second comparison is the more critical as it heavily influences planning for the eventual renewal of the pipe and may also be required to justify the actual renewal when it is imminent.

For wastewater and stormwater pipes the New Zealand Pipe Inspection Manual (3rd Edition : 2006) (NZPIM hereafter) already meets much of this need and is widely utilised across the industry. This was seen to be a logical starting point for the development of a new and improved version that would take the industry forward.

ProjectMax generated the 3rd edition of the manual and were the logical choice to progress the update. In response to a request from the Quake Centre, ProjectMax proposed a 2 step process to define the exact nature of the changes required :

Step 1 – Determine the extent of change required to the current NZPIM based on consultation with the industry and a survey of international comparators

Step 2 – Upon finalisation of the extent of change, and confirmation of funding, progress the changes and generate a new Pipe Inspection Manual.

ProjectMax were engaged to implement Step 1. This report is the outcome of that investigation and includes specific recommendations on the extent of the changes that are considered to be desirable.

The funding and progression of Step 2 are not determined at this point in time.

5. Brief Background to Pipe Inspection in New Zealand

For wastewater and stormwater pipes the NZPIM is the most widely utilised approach for pipe inspection in New Zealand with no other approach having any significant usage. It is entirely focussed on visual inspection utilising either walk-through or CCTV based methods.

The NZPIM provides a comprehensive solution for the condition assessment of non-pressure pipes :

- It can be used to assess the condition of existing pipes, to undertake quality assurance for new and rehabilitated pipes, provide confirmation of the condition of a pipe prior to its planned renewal or repair and in situations such as build-overs.

- It provides an overview of pipe inspection in the context of asset management, practical guidance on the cleaning of pipes prior to inspection and the proper use of the CCTV camera. The most important content is the standardised schedule of features and defects together with rules for classifying their severity or magnitude. This provides the basis for a consistent outcome to be generated by all inspection contractors and for consistent interpretation by asset managers.
- A scoring system is included that allows the influence of a number of different defects along a particular pipeline to be combined into an overall score. This can be utilised to compare the pipe with other pipes to determine a condition hierarchy, to highlight which pipes require relatively immediate consideration of repair or renewal and to undertake planning for renewal in the medium to longer term.
- Nationwide training in the use of the NZPIM is available and there is a website based list of all operators who have been trained, and subsequently assessed for competence. The website allows the competency assessment to be valid for a two year period.
- All New Zealand contractors providing non-pressure pipe inspection services offer outcomes that comply with NZPIM and many asset owners simply reference compliance with the manual as their specification.

In virtually all cases the key outcome sought from pipe inspections is an assessment of the current condition of the pipe and an estimation of when its renewal might be required. The NZPIM includes a 1-5.8 scoring range and also criteria for a 'Fail' condition grading. This is frequently assumed to directly align with the International Infrastructure Management Manual (IIMM) wherein a grading of '1' indicates a pipe in 'as-new' condition while a '5' indicates a failing pipe requiring renewal in the near future. There is a growing recognition that this direct translation between NZPIM and IIMM is not appropriate and significantly overstates the extent of renewals required. There is also growing acceptance that IIMM scores are the most relevant for renewal planning and these are referenced in the development of Meta-data Standards.

Despite the water services industries familiarity with the NZPIM, and the readily available training, the overall quality of the outcomes from pipe inspections is highly variable. Poor outcomes can generally be attributed to inadequate specifications, untrained operators, lack of auditing of outcomes and inappropriate interpretation of the results. However, if these matters are properly addressed then use of the current NZPIM can generate excellent outcomes, robust planning for renewals and information that can be confidently shared with others. A steady improvement has been seen since the adoption of the 2006 Edition but there is still considerable scope for further improvement.

A consequence of the use of the NZPIM, and the typical approach adopted by CCTV contractors, is the generation of significant amounts of data encompassing video, still images and reports. For instance, SCIRT and CCC currently have 42TB of video data stored on servers from the earthquake recovery. The storage of this information and transfer of key outcomes to readily accessible asset management information systems is also an ongoing challenge for the industry.

The above comments largely relate to the use of CCTV inspections for (non-pressure) wastewater and stormwater pipelines. Laser and sonar inspections are increasingly being utilised for non-pressure pipelines, but there are no standard guidelines available for using these technologies or interpreting the outcomes.

While the use of the NZPIM is well established for the inspection of non-pressure pipes, there is no comparable current default option for the inspection and condition assessment of pressure pipes, including water supply, irrigation pipelines and wastewater rising mains. A variety of on-site and laboratory techniques are utilised for pressure pipes with the approach largely dependent on the equipment available to the inspection agency and proprietary assessment methodologies. This is a significant gap in the industry at a global level.

6. Opportunities and Drivers for Improvement

The current version of the NZPIM was adopted in 2006. A number of changes have occurred since that make it appropriate to review this document at this time. These changes include :

Change	Brief Description
CCTV Technology	Ongoing improvement in camera technology impacting on picture quality and the speed of data capture. There is now a much wider spread of capability and quality
Complementary technologies	Utilisation of laser and sonar to capture different types of condition information for non-pressure pipes. Ongoing evolution of invasive and non-invasive technologies for assessing condition of pressure pipes
Data format and storage	2006 marked a transition from paper based systems to electronic. We are now transitioning into system and data connectivity and 'cloud' based access, transmission and storage solutions. There is also increasing integration into Asset Management Information Systems
Interpretation of pipe condition	Recognition of the differences between NZPIM scores and IIMM grading
Canterbury Experience	The 2010 earthquakes required extensive implementation of the NZPIM as part of the rebuild and a number of learning became apparent
Progression of Asset Management	Asset Management increasingly recognised as a major driver for ongoing delivery of service and the associated costs
Ongoing Evolution of Other Guidelines	A number of other comparable standards around the world have continued to evolve and improve

Any update to our New Zealand approach should include consideration of all of the above influences to ensure that we remain at the leading edge and are utilising the best available approaches to optimising service and costs.

7. Step 1 : Review Methodology

The intent of Step 1 is to determine the extent of the review that the industry believed is required and was largely centred around the current NZPIM and its use for non-pressure pipelines. Once this is determined, agreed and funded then the actual improvement process can be undertaken as Step 2.

Step 1, as proposed by ProjectMax encompasses 3 distinct stages :

Stage	Brief Description
Literature Review	A review of current approaches in other countries, particularly in Australia and Europe
Industry Consultation	A survey of asset owners, contractors, consultants and suppliers to ensure a robust understanding of the current situation and the opportunities for improvement
Recommendations on path forward	Bringing the issues and options together to form a clear view of what should be incorporated into the update. This step would utilise input from a Steering Group comprising leading representatives from the various sectors of the industry.

7.1 The Literature Review

All advanced nations around the world are having to respond to the same issues facing New Zealand and there are many commonalities apparent in the approaches adopted.

There were 2 primary purposes in undertaking the Literature Review :

- To see what approaches are being used internationally which could be modified and usefully incorporated into a New Zealand approach
- To see if there was a 'ready-made' solution, suitable for New Zealand, that could simply be adopted. A potential benefit of adopting an off-shore standard would be the ability to directly compare with information and learnings obtained from a larger market.

The literature review canvassed the large and wide range of documents listed in Appendix 1.

Of particular interest were 3 inter-related documents that are collectively utilised in Australia, the UK and western Europe. These were considered the most likely to be relevant to New Zealand and also to provide the highest likelihood for comparison / bench marking of outcomes if an international alignment approach was adopted.

The documents are :

Location	Guideline
Australia	WSA 05-2013 Conduit Inspection Reporting Code of Australia Version 3.1.

	This is generated by the Water Services Association of Australia and is focussed on gravity drainage and sewer systems. It includes the inspection of manholes.
United Kingdom	WRc – 2013 (5th Edition Manual of Sewer Condition Classification. Generated by the Water Research Centre and recently updated to reflect changes to the more widely adopted BS document.
Europe	BS EN 13508 – 2 Investigation and Assessment of Drain and Sewer Systems Outside Buildings. Visual Inspection Coding System.

Overall there were many similarities between the documents which is not surprising given the original NZPIM in 1989 was based on the WRc document of that era. Irrespective of location and pipe material, generally the same faults occur all around the world and would be similarly described.

All these documents are solely focussed on non-pressure pipes. While various documents exist around the work providing guidance on the condition assessment of pressure pipes none were considered to fulfil the need for a comprehensive industry standard in the same way that the current NZPIM does for non-pressure pipe.

Broad observations on the documents include :

- All follow a similar approach of classifying the faults and features that are observed and have a scoring system that allows faults to be ranked and combined into overall scores.
- Some include materials, such as brick lined sewers, that have specific faults, but are rarely encountered in New Zealand
- Additional codes and/or descriptors are included that could usefully enhance the current NZPIM document
- The WRc and WSAA codes include provision for manhole inspections that are not in the NZPIM
- They tend to include less guidance on establishing and running CCTV inspection programmes than the NZPIM.

Any of these standards could be utilised in New Zealand, largely without amendment, and would generally generate an improvement over the current NZPIM. They cover the materials used in New Zealand, the types of faults that occur, the inspection equipment that is used and can align with the reporting software utilised by most CCTV contractors.

The primary advantage of such an approach would be the ability to directly compare the outcomes of New Zealand inspections with larger overseas programmes and the ability to tap directly into their learning and development processes.

However, there are also a number of dis-advantages associated with such an adoption which primarily relate to a perceived loss of control, retraining, potential loss of compatibility with past surveys and ensuring a nationwide adoption of the new standard.

The benefits and dis-advantages of adoption of an off-shore standard are further discussed in Section 8.10.

7.2 Industry Consultation

The literature review, and ProjectMax's own experience in the field of CCTV and condition assessment, identified a range of issues and potential unmet needs, some significant and some relatively minor opportunities for improvement (refer to the Issue Register in Appendix 2).

The intent of the industry consultation was to seek a wider view of the benefits, and potential disadvantages, of incorporating these differences into the review. It also provided an opportunity for the industry to express their views on what was currently working well and any other matters that were of interest to them that were not directly already included in the survey.

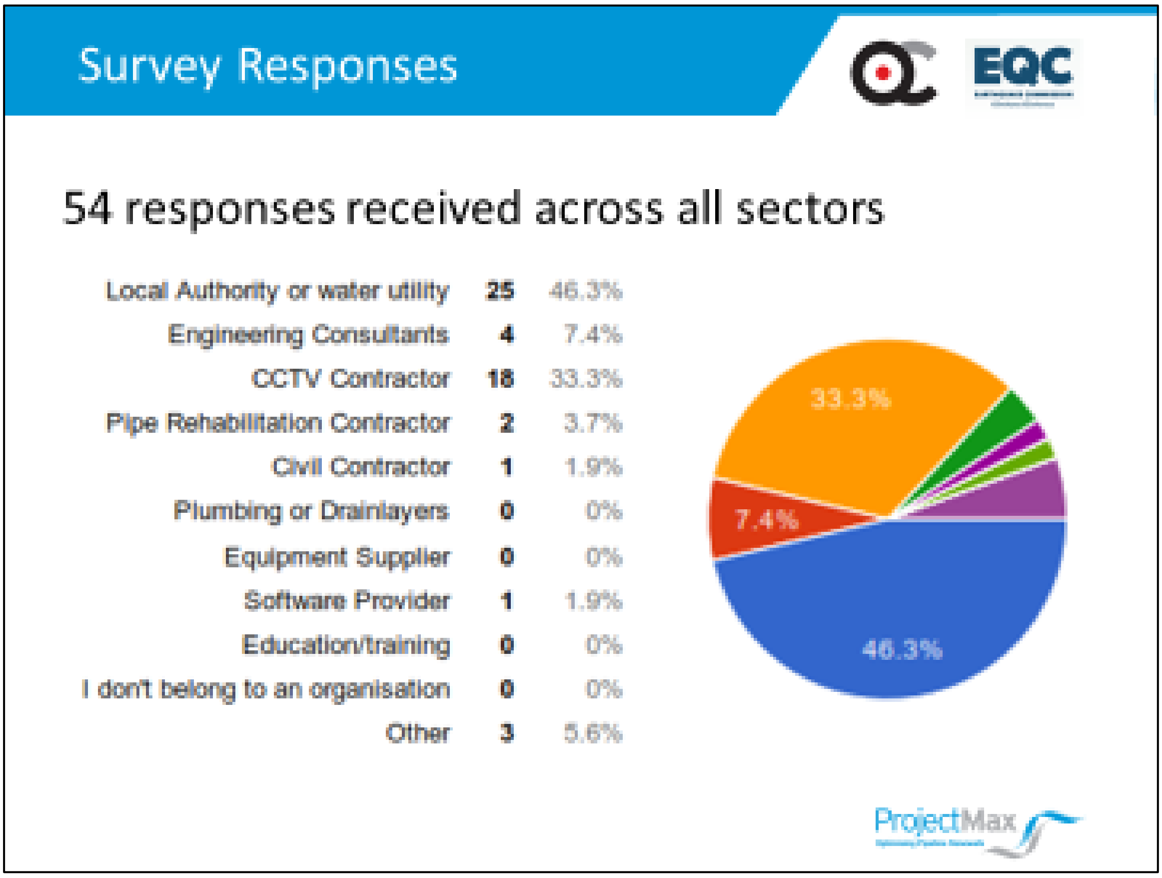
The survey was generally arranged around 'Key Issues Areas' and provided for both structured and free-form commentary.

The electronic survey was sent out to some 700 industry participants on 8 July 2016. In many cases a number of people in the same organisation would have been sent the survey and the intent was to ensure industry awareness of the initiative rather than an expectation of 700 responses. A link to the survey was also included in the WaterNZ Pipeline newsletter. A copy of the survey is attached as Appendix 3.

The address list was derived from an extensive industry database held by ProjectMax, used for advertising Trenchless Technology Forums and CCTV training. The lists include all Councils, contractors, consultants and suppliers known to be active in the CCTV inspection market.

The survey was constructed to provide respondents with the opportunity to comment on the adequacy of the NZPIM for their purposes, to specifically comment on opportunities and options identified from the Literature Review and to make general comments on any other changes they would with to see.

A total of 54 responses were received per the following slide presented at the WaterNZ conference in October 2016. The Local Authority and CCTV contractor groups provided almost 80% of the responses which is both useful and not surprising.



The overall response to the survey, in relation to the adequacy of the current NZPIM, was conveyed to the WaterNZ conference as follows :

"Yep - it needs updating but it's a good base to start from"

- Survey respondents overall comment

7.2.1 Summary of Key Themes from Literature Review and Survey

A compilation of observations arising from the ProjectMax's experience, the literature review and the survey is summarised in the following table (Refer 7.2.2). This includes the identification of 'Met' and 'Un-met' needs in relation to the current NZPIM :

7.2.2 Needs Analysis from Investigations

Needs Analysis		Need is : Met	Not met	Comment
Format of the existing Manual	How easy is the existing manual to follow?	Y		Industry survey indicates that the meets general needs, but feedback confirmed that there is a need to improve the format to make it easier to find information, and provide more specific guidance e.g. coding principals and information to be collected. Refer Comments
	How does existing manual meet your current needs?	Y		
	How is the existing manual in terms of the level of supporting information or guidance provided to undertake pipe inspections?		X	
Sample Forms	36% of respondents use Standard forms	Y		Most use electronic forms (CCTV inspection software reports) based on the current logsheet sample form, but there is still a substantial number of hand written form users. General update required to existing standard forms.
	Manhole Inspection		X	Current sample form for manhole inspection provides for visual inspection. New Manhole Inspection logsheet needed for coding process.
Manhole Inspections	The Manual should include specific manhole condition codes and grading methodologies		X	13/40 use NZPIM standard form only. 18/40 use in-house derived specification for inspection and method of assessment. No common national standard approach to full inspection and condition grading
Pipe Cleaning	How well does the existing manual cover pipe cleaning associated with pipeline inspections?		X	Survey indicated that the existing manual covers cleaning in general well, but feedback confirmed that additional guidance is needed to be included on the type of cleaning to be specified and how to avoid damage to the pipe (based on material type and pressure) should be addressed. See comments.

Needs Analysis		Need is :		Comment
		Met	Not met	
Quality of Deliverables	How well does the existing manual cover the requirements for deliverable quality	Y		Generally, needs met, but industry survey clearly identified that there is need to update the content to provide guidance on what can be expected from CCTV equipment outputs, in particular around video file quality and format.
	How well does the existing manual cover required equipment capability or output parameters	Y		
Methods of Inspection Pipes	How well does the existing manual cover methodologies for inspection pipes		X	The existing manual content on inspection methodologies is out of date and needed to be updated with new technology. Due to the number of different technologies now available some guidance is required to assist with understanding where the type of inspection equipment can/should be used. See comments
Pressure Pipelines	The inspection manual should cover the inspection and assessment of pressure pipes		X	The industry was a bit split by this issue, but the majority indicated that pressure pipes should be covered
Training and Qualifications	There should be a specified minimum level of experience or competency in the manual		X	The 3 unit standards currently under development by Connexis (to replace 22107) should be included in the manual under framework of minimum qualifications based on the role of the person (Operator/coder/reviewer/assessor)
Data Quality Management	How well does the existing manual serve the needs of data quality management?	Y		Mostly needs are met. Most issues raised are associated with levels of training and condition grading (see comments)
Standard Documents	How well do standard documents help prepare pipe inspection tender/contract documents	Y		Industry clearly indicated that the standard forms are an important part of the existing manual, and in general provide the basis preparing tender documents (44% said no updates required) although just over half of respondents said that the current standard documents need updating.
	Standard forms adequately cover all areas of pipe inspection		X	Add coverage for "small" jobs. Specification for manhole inspections and lateral inspections required

Needs Analysis		Need is : Met	Need is : Not met	Comment
Inspection of Laterals	How well does the existing manual cover the requirements for the inspection of lateral pipes		X	The industry survey respondents were evenly almost evenly split with almost half of respondents indicating that the manual did not adequately cover the inspection of lateral pipes.
Condition Codes	How adequately do the existing defect codes and severity bands classify all of the different types of pipe defects and features?	Y		The industry survey respondents very clearly indicated/confirmed that they thought that the existing defect codes and severity bands classified the different defects adequately. This seemed to reflect the adequacy of the way that the NZPIM classifies defects and features, as the respondents also indicated/confirmed the analysis that there is a need to add some additional codes to cover some pipe materials and some defects/features better.
	How well does the existing manual cover the condition classification for all variable materials, size ranges and uses? Are there any additional defect or future codes required?		X	
	Should there be other methods of defining or classifying pipe defects of features?	Y		
	How well does the existing manual guide the user on how or what condition codes should be recorded when completing a pipe inspection report?	Y		Industry survey respondents indicate that the existing manual provides adequate guidance on assigning and interpreting condition codes, however comments indicate that there is a need to provide some additional guidance in terms of formatting (refer to Manual Format) and improvements to defect photos and descriptions.
	How well does the existing manual guide the user on how to interpret what the condition codes mean when reviewing a pipe inspection report?	Y		
Assessing Pipe Condition	The manual's condition grading definitions and interpretation should be modified to align with other Asset Management Manuals.		X	The industry survey very clearly indicated/confirmed that the current grading descriptions and results do not align with expected pipe condition. The majority of respondents indicated that an appropriate grading system for the manual would the NZ Infrastructure Asset Grading Guidelines. Comments also identify that more guidance is required to understand how the scoring analysis and grading assignment is undertaken. Need is also identified to provide some

Needs Analysis		Need is : Met	Need is : Not met	Comment
	How well does the existing manual pipe grading provide for use in Asset Management and Renewal Planning?	Y		guidance to the interpretation of pipe condition information in assessing remaining life (separate manual section)
Assessing Inflow and Infiltration	There should be a specific method for assessing pipe leakiness provided in the manual.		X	Guidance required for use of CCTV for assessing I/I. Also refer to Inspection of laterals
Acceptance Criteria for New/rehabilitated Pipe	The manual should have a common set of CCTV acceptance criteria for new/rehabilitated pipe.		X	Confirmed need for guidelines to asset owners on the assessment of CCTV inspections as part of the process for accepting new or rehabilitated pipes. Additional guidance should also be given on interpretation of rehabilitated pipe).
Sharing and Bench Marking of Pipe Inspection Data	Inspection data can be shared or benchmarked within NZ	Y		
	Inspection data can be shared or benchmarked outside of NZ		X	Condition codes cannot be benchmarked internationally, but pipe condition grades can be following alignment of condition grades to Metadata standards.

7.3 The Steering Group

A key element of Step 1 was the utilisation of a Steering Group comprising persons who are considered to be active in the industry and collectively representing all interested sectors. They were used throughout the project, via email forums, to seek feedback on specific issues and to ensure that a balanced and broadly acceptable position was ultimately recommended.

The Steering Group comprised the following :

Name	Organisation	Sector
Philip McFarlane	Opus	Consultant
Husham Issa	Humes	Pipe Manufacturer
Marc Chiochetto	Laser Profiling Services	Specialist inspection Contractor
Pierre van Tonder	SECA	Equipment/Software provider
Sam Clive	Integroup	WaterNZ SIG/CCTV Contractor
Nina Sardareva	Auckland Council	Council
Darren Michealski	IBAK	Equipment/Software provider
Frank O'Callaghan	iPLEX	Pipe Manufacturer
Willem van Blerk	Tauranga City Council	Council
Daniela Murugesh	Christchurch City Council	Council
David Heiler	BECA	Consultant Formerly Data Assessment Lead for SCIRT
Robert Blakemore	Wellington Water	Water Utility
Darrin Lane	Dunedin City Council	Council
Nick Walmsley	WaterNZ	WaterNZ
Irmana Garcia-Sampedro	SCIRT	Canterbury earthquake
Raoul Davies	Mainland Pipe Inspections Ltd	CCTV Contractor
Justin Hall	PipeWorks	CCTV Contractor/Rehabilitation Formerly pipe assessment co-ordinator for SCIRT
Hugh Blake-Manson	City Care	Contractor/WaterNZ Board Member

8. Key Considerations Arising

The following key issues have been identified as largely defining the depth and breadth of the possible review of the NZPIM.

Each is considered in relation to the Background, Discussion, Advantages and Disadvantages and then recommendations are made on how best to proceed with the review.

The Recommendations collectively form an aligned overall proposal that could be implemented. Changing individual recommendations may require some consideration of the impact on other recommendations.

1	**Format and general content of the existing Manual**
2	**Manhole Inspections**
3	**Pipe Cleaning**
4	**Methods of inspecting pipes and the quality of inspection equipment**
5	**Pressure Pipelines**
6	**Topic – Training / Qualifications and Data Quality Management**
7	**Inspection of Laterals Pipes (including private drains and sewers)**
8	**Acceptance Criteria for New/Rehabilitated Pipe**
9	**Pipe Condition Grading**
10	**Pipe Defect/Feature Classification (defect codes)**

8.1 Topic - Format and general content of the existing Manual

Background

How the information within the NZPIM is set out and how the content of the information is presented is very important to the usability and value of the manual.

The current version of the NZPIM adopts a more discussion / information style than a strict specification, with the content structured in seven (7) sections made up of the following:

Section 1 – The Role of CCTV Inspections (*Provides an overview of the tasks that can be completed using CCTV and how these activities can be used to manage wastewater and stormwater assets)*

Section 2 – Good Practice *(Outlines practices for cleaning pipes, carrying out CCTV inspections and logging inspections. Quality assurance and health and safety are also discussed)*

Section 3 – The Tools *(Provides an overview of CCTV equipment, recording media and CCTV software. New developments in CCTV (circa 2006) equipment are also discussed)*

Section 4 – CCTV and Asset Management *(Discusses the role of CCTV in proactively managing wastewater and stormwater systems. The section covers issues that need to be considered when developing a CCTV programme and analysing the information produced)*

Section 5 – Standard Documents *(Provides a model specification for CCTV contracts.)*

Section 6 – Condition Codes *(Provides details of the defect and feature codes that should be used to log CCTV inspections)*

Section 7 – Sample Forms *(Contains sample forms for recording and auditing CCTV inspections. A sample form for manhole inspections is also included)*

In comparison with other international manuals, the existing NZPIM contains more information relating to carrying out inspections and the use of the information in asset management. The manual also includes a CCTV specification; which other international manuals do not contain.

Discussion

"*Yep it needs updating but it's a good base to start on*" specific feedback from survey respondent but also an overall summary.

The research identified the current format and content of the NZPIM has largely met the needs of its users over the last 10 years. The content of the manual, according to the survey, appears to be well received. Some 90% of respondents scored it between 5 and 10 (with 1 being Very Poor and 10 being Excellent) in terms of readability, usability and guidance for undertaking inspection.

There was also some need for improvement clearly identified, which includes the following identified issues:

- Finding specific things within the manual could be difficult ("*you have to hunt for stuff*"). It can take time to find what a certain standard is, as it may be written within a sentence.
- Some information appears in multiple sections, which makes it more difficult to get the information quickly or easily;

- There are a lot of abbreviations and acronyms throughout the manual, which are not obviously referenced, creating some confusion or lack of understanding. Technical terminology in some cases is also used without explanation;
- Some sections are a too long and verbose to be followed easily.
- Lack of guidance for understanding technical items such as, how to record defects, and interpretation of data from an asset management perspective;
- The WRc MSCC contains more diagrams and worked examples
- It is not clear where the NZPIM fits within the Asset Management framework

Benefits of Change

- Improve access and find relevant information more easily
- Provide better guidance to interpreting acronyms and technical terms and cross-referencing to other manuals with consistent terminology
- Update to align with current technology

Dis-advantages of Change

None identified

Recommendation

The following general format improvements are suggested:

1. **Publishing Format** - The hardcopy format was not specifically identified as a problem, but a suggestion for an enabled electronic or web based version with a 'Keyword' search function that could be easily accessed and searched should be considered for easy reference and links to standard forms;
2. **Chain of Custody** – A description within the first section of the manual that describes where the NZPIM fits into the other Asset Management manuals, as part of the Introduction / overview of the manual
3. **General update of content** – Review and update information on technology under relevant sections including use of diagrams and worked examples where possible
4. **New content structure with clear defined manual sections** - Information relevant to that section contained only within that section, (or a clear reference provided to information contained within another section).

- Incorporate an index section
- Incorporate a Quick Reference Card containing summary list of codes
- Incorporate a glossary of terms

A suggested modified manual structure, with description of proposed content and how the existing information would re-organised is referenced in Appendix 4

8.2 Topic - Manhole Inspections

Background

Manholes form part of the pipe network and serve to provide access to the pipelines for maintenance and connecting the pipe sections together. The inspection of manholes is often undertaken as part of the inspection of pipelines. Manholes are a significant part of the overall system in terms of their functionality, as a source of inflow and infiltration, safety issues and the cost of renewal.

The current edition of the NZPIM added a standard form for the visual inspection of manhole structures, but did not provide a specification for assessing the condition of the structures (the 1st and 2nd editions of the NZPIM did not reference manhole inspections at all). The NZ Infrastructure Asset Grading Guidelines, (NZWWA, 1999) set out structural and performance grading definitions for manhole structures, but not an inspection methodology. Currently there is no commonly used process for the inspection and assessment of manhole condition in New Zealand although some 'in-house' systems exist in various councils.

The other international manuals, including the WRc MSCC and the Australian WSA05 both contain a section with manhole defect and feature codes and condition grading which are a variation on the pipe codes. Christchurch City Council (CCC) are currently in the process of developing their own methodology along similar lines as the WRc by adapting the NZPIM pipe codes.

Discussion

The industry survey confirmed that coverage of manhole inspections, as part of the pipeline inspections, is an unmet need. 91% of respondents to the survey agreed, to strongly agreed, with the proposal that the '*NZPIM should include specific manhole condition codes and grading methodologies'*.

To ensure a consistent approach, the modification and adoption of codes used for pipe inspection, as used in other international manuals and the current approach of CCC, provides the best method of developing and incorporating a national approach to manhole codes and grades.

Given the range of issues that can occur the inspection would include the base and benching, chamber risers, internal droppers, chamber lid, the access lid and associated risers, rungs/ladders/platforms and where relevant the surface environment.

Benefits of Change

- Implements specific manhole codes and grading methodologies to satisfy the unmet need.
- The proposed approach is consistent with other international manuals, and is familiar to the pipe inspectors who use the pipe codes and grades
- Modification of the pipe codes and grading methodologies enables the alignment of the Structural and Performance Grades with the existing NZ Infrastructure Asset Grading Manual and proposed Metadata standards
- Asset owners would have the option of surveying pipes, manholes, or both, and having clearly defined processes for doing so

Dis-advantages of Change
None identified
Recommendation
1. **Section on Manhole Inspection** – Add a specific section on Manhole Inspection 2. **Modify and adopt codes and grading methodology** – Establish a set of codes and grading methodologies based on the defect and feature codes used for the inspection of pipes, adapting as necessary (e.g. referring the “Vertical Cracks” in place of “Longitudinal Cracks” etc.) 3. **Include a manhole inspection Specification** – Provide a manhole inspection specification as part of the standard appendices 4. **Forms and Logsheets** - Update the manhole inspection form and manhole inspection logsheet report template form to align with the new inspection processes.

8.3 Topic – Pipe Cleaning

Background

The NZPIM covers recommended cleaning, and basic machine capability (in particular for light cleaning) within the "Good Practice" section, (section 2). The model specification (section 5, Standard Documents) provides some guidance on cleaning pipes and cleaning of pipes in poor condition, but the coverage overall is limited. The NZPIM is the only document in New Zealand that covers pipe cleaning, and typically CCTV contract specifications require pipe cleaning '_ _ *to be carried out as per the New Zealand Pipe Inspection Manual'*. The coverage within the manual on this basis does not provide sufficient guidance to adequately meet this need.

CCTV Contactors' comments indicate that there are often issues arising from different expectations between the specified "light" cleaning and "heavy" cleaning as part of CCTV inspections. Asset owners have also reported occurrences where pipes have been damaged by excessive water pressure, or poor operation of cleaning equipment, particularly when cleaning certain pipe materials, such as Asbestos Cement, or where the pipe was already in poor condition prior to cleaning and inspection.

Other international manuals do not include coverage of pipe cleaning. However, in the UK, the WRc does have a separate guideline document titled the 'Sewer Jetting Code of Practice', which sets out a process for applying pressure limits based on pipe condition and material (but no guidance on working with CCTV inspections). Queensland Urban Utilities, (QUU) have developed their own guideline for the cleaning of pipes in support of general pipe cleaning and CCTV inspection.

Discussion

The industry survey sought to determine how well the existing manual covered the cleaning of pipes as part of a CCTV inspection and whether any improvements in this area were required. There was a wide distribution of results from respondents on this topic, with the majority reporting that the existing manual coverage has between sufficient and adequate coverage. However, the feedback did indicate that there is a general need for improvements on this issue.

The feedback identified general improvements such as:

- NZPIM should describe the desired outcomes for levels of cleaning. This includes defining what is meant by 'light cleaning' and 'heavy cleaning' to augment the existing content
- Operating parameters should be defined, such as maximum pump or nozzle pressures for different pipe materials, pipe conditions and operating procedures to avoid pipe damage, surcharging or flooding resulting from the pipe cleaning
- Methodologies for cameras working with hydro-jetters, e.g. removal of water from dips, and avoidance of 'blow backs" are needed.

It is important that any content added to the pipe cleaning section and specification should not be too prescriptive, and that it remains focused on cleaning in association with CCTV and not becoming a de-facto cleaning guideline. Consideration should be given, outside of the NZPIM update to developing a separate pipe cleaning guideline, with associated training/qualifications, that can be referenced to improve the industry performance.

Benefits of Change

Augmenting the existing content will improve current guidance and specifications to meet required needs, including the prevention of damage to pipelines.

Dis-advantages of Change

- Risk of 'scope creep' beyond the pipe inspection focus to become a defacto pipe cleaning guideline, which will need to be managed.
- No other dis-advantages identified

Recommendation

The proposed improvements are aimed at providing additional guidance for pipe cleaning associated with the inspection of pipes as follows:

1. **Add additional guidelines for working with Jetters as part of the CCTV inspection –** This will include standard operating procedures (SOP) for the prevention of damage to pipes and surcharging (i.e. blow backs), based as the existing SOP's developed by SCIRT as part of the Canterbury Earthquake recovery
2. **Define a specification for pressure limits and outcome focused definitions of different types of cleaning** - This could be based on the tables following (measures are arbitrary to illustrate intent) suggested by the steering group members.

Table 1 - Example of possible outcome based guideline to defining cleaning types

Type of Clean	Material that Should be Removed	Material that Would Probably Not Be Removed	Implications for CCTV	Implications for Pipe	Typical Methodology
Light	Most FOG (Fats, Oils, Grease), fine roots	Heavy roots, heavy gravels	Some evidence of root intrusion remains. Some surface features may be concealed by residual FOG	Minimal impact on fundamentally sound pipe	Two passes with jetting unit one up and one back.
Heavy	All roots, FOG, gravel and debris. Potential to see erosion of some weaker pipe materials and removal of bedding/surrounds where openings to outside occur. Standing water in dips would be flushed through	Intrusions that are pipe material	Left with clean pipe and all cracks, defects should be apparent. There will be no residual evidence of root intrusion, staining from infiltration may be removed – depends on pipe material	Potential for damage to softened pipes and accelerated failure. Areas where cracking or holes evident may be scoured out. Potential for displacement of sealing rings	As many passes as required to achieve 90% bore

Table 2 - Example pressure guideline

Pipe Size	Flow rate	PSI	Pass L/C	Pass H/C
150 - 300	140 - 220	2200	2	90% Bore
300 - 600	220 -400	2200	2	90% Bore
600 - 900	400 - 620	2200	2	90% Bore
900 >	620 >	2200	2	90% Bore

The key to this recommendation is to provide sufficiently detailed descriptions that would allow asset owner and contractors to determine the appropriate level of required cleaning and if it has been achieved.

3. **Define pressure limits based on known or assumed pipe condition** – In addition to the above, it is recommended that pressure limit guidelines are determined, based on pipe condition, to avoid pipe damage. This could be based on the WRc Jetting Code of Practice and amended to align with best practice knowledge in New Zealand.

8.4 Topic – Methods of Inspecting Pipes and the Quality of Inspection Equipment

Background

The capability of the inspection equipment plays a significant role in the quality of pipe inspection outputs (e.g. video) and therefore the quality of the reporting and decisions that can be determined from the inspections. There are two elements that govern the inspection equipment output:

1. The selection/type of inspection equipment – suitability of the equipment to collect the information that is needed.
2. The information that can be obtained from the equipment i.e. the limitations of the equipment

Over the last 10 years the equipment and the technology available to inspect pipes has changed substantially. Since the current NZPIM was published in 2006, VHS cassettes are no longer used, the use of DVDs has substantially diminished. There is now a preference for external hard drives, cloud storage and streaming of video which is now becoming widely available. New equipment has LED lighting and HD video recording.

The range and type of inspection equipment in common, or emerging, usage has also increased, with remote leakage sensing, gyroscopic measurements of equipment position and laser and sonar profiling.

The challenge for most asset owners is determining what type and quality of equipment is suitable for the type of pipe inspection required and specifying appropriate minimum standards.

The existing manual has limited information on inspection equipment and the quality of the outputs:

Section 3 – The Tools provides an overview of the types of CCTV equipment, giving a brief description (such as push rod or tractor mounted pan and tilt camera plus '*other tools*') in relation to the technology of the day. It does not discuss the range of inspection equipment available in terms of their alignment with the client's needs.

The CCTV specification under *Section 5 – Standard Documents* provides qualitative descriptions of the required output, such as: '*The picture should be sufficiently sharp*' or '*sufficient lighting*' and '*If not acceptable to the Engineer*' etc. The only quantitative equipment accuracy requirement in the NZPIM refers to the accuracy of measurement along the pipe (*+/- 2% or 300mm, whichever is greater*). The existing manual does not specify any other quantitative parameters for the inspection equipment such as, the video format or capture rate.

Section 2 – Good Practice provides examples of poor quality, such as, fog, cobwebs, debris on the camera lens, speed to fast etc.

The industry survey responses confirmed issues relating to pipe inspection equipment needed to be addressed, which in summary included:

- Technology has changed a lot and there are more options available for the inspection of pipes. However, clients and contractors do not always know what technology is appropriate and when to use it

- The minimum quality requirements for inspection equipment should be specified. This generally relates to the quality of the deliverable outputs. For cameras this relates to image clarity; sharpness and light
- Recording formats and deliverable formats - what are the best formats for different situations?

The WRc MSCC (5th Edition) and the Hong Kong CCTV guidelines both include sections on testing and calibration procedures for CCTV cameras. This includes the Marconi Resolution Chart and Test box for checking picture resolution and lighting (refer to MSCC Part A sections 1.0 to 1.4).

Australia's WSA05 has limited coverage. It simply specifies:

'the camera manufacturer's accredited agent shall provide a declaration, at least annually and after any necessary repairs or modifications, that the camera has been adjusted correctly for:
(a) white balance for the lighting systems used;
(b) linearity;
(c) focus distance/range; and
(d) video signal."
Some organisations are now specifying the acceptable formats for the delivery of the inspection videos. CCC (in the Earthquake Recovery Specifications) specifies individual video files to be provided in '*MPEG-2 Part 2 video, 720 x 576 pixels 9.8 Mbit/sec'*. Others who venture into this aspect vary with higher and lower requirements, however there is no standard or consistent approach to measurement or specifying equipment or output quality in New Zealand.

Discussion

The feedback and observations clearly indicate that the manual needs to provide more guidance on the range of equipment that is available, the outputs that can be achieved and aspects such as video file quality and format. As the current content does not contain quantifiable parameters there is merit in including this in the revision.

There are three areas that need to addressed as part of updating the information to ensure that issues relating to inspection equipment are adequately covered:

1. **Outlining / summarising the various different types of internal pipe inspection equipment now available** – This would include their applications and limitations, i.e. where do they fit into the inspection tool box, what information they can provide, their range and limitations.
2. **Defining the minimum camera equipment quality standards**.

Specify standards for optimal and consistent video deliverable format(s). The methods of testing the quality and clarity of the CCTV camera equipment, outlined in the WRc and Hong Kong manuals, (described above) have merit, in particular the Camera Cable Calibration tests (Part A Section1.4). However, the video image and lighting tests using the Marconi Resolution Chart Number 1 and test box, are considered to be archaic, and not widely used since the 1990's. The required equipment is unlikely to be available. The specification within WSA05, while suggesting a 'warrant of fitness' type certification, does not specify a measurable means of determining that the current output meets a specific output related standard. It largely references the factory quality standards, which may be less than the desirable minimum standard.

In reality the achievable quality output will vary considerably depending the type of equipment that is used. Typically, a Push-Cam will produce a much lower resolution and more restricted vision than a full-spec tractor-cam. Both have their appropriate specific applications, and it is not reasonable to specify the same video image or information output. Sonar and laser profiling generate quite different information to CCTV but are entirely suitable in the right circumstances.

Therefore, the required equipment standard should be 'fit for purpose' and not be based on a single standard. A CCTV equipment classification system can be developed. This would be a simple system to classify the types of camera, their capability, the types of information they provide, and it would include the acceptable minimum image/video quality (resolution) standard. This would make it easier for asset owners to specify the level or type of equipment that they want to be used on their project, and also for contractors to be able to describe the type of equipment, and capability, they are able to provide to the asset owner.

Similarly, additional information can be provided on laser and sonar profiling although this is currently a very small part of the pipe inspection industry.

Benefits of Change

- Provide quantifiable means of specifying and measuring CCTV equipment output quality
- Provide a guideline to asset owners to help select appropriate equipment to suit the type of inspection that is required.
- Drive better quality outcomes

Dis-advantages of Change

None identified

Recommendation

1. **Update and expand information on the different inspection methods and equipment available**.
2. **Develop an inspection equipment classification system** – This would provide guidance on the selection of appropriate equipment and help with:
    i. Selection or specification of appropriate CCTV equipment for the specific project, including when alternative technology would provide benefits over CCTV
    ii. Equipment capability (Range and limitations)
    iii. Expected quality of image and data outputs, etc.

8.5 Topic – Pressure Pipelines

Background

The inspection and condition assessment of pressure pipe uses quite different equipment and methods compared to the inspection of gravity (non-pressure) pipes. The current NZPIM does not cover the inspection of pressure pipes and asset owners use a range of different guidelines for the inspection of pressure pipe. The industry survey respondents that did carry out inspection of pressure pipe reported using either the IPWEA Condition Assessment and Asset Performance Manual or the NZ Asbestos Cement Watermain Manual.

Technology for non-destructive testing (NDT) is becoming more available to asset owners. The nature of the technology and methods for inspection tend to be quite variable and specific to the particular technology. The means of assessment using NDT is also specific to the technology.

The NZ Asbestos Cement Watermain Manual is currently under review.

Discussion

The industry survey sought comment on including the inspection of pressure pipes within the NZPIM. The majority of respondents agreed that pressure pipes should be covered.

However, the comments indicate that this opinion is somewhat ‘mixed’ and largely reflects a desire for a document similar to the NZPIM for pressure pipe inspection. Feedback included comments to the effect that there are substantial differences in the inspection of pressure pipes and non-pressure pipes, and although a nationally consistent guideline is required, a separate manual would be preferable.

The nature of the types of material failure and the variable technology and analysis could potentially make inclusion of pressure pipe inspections into the NZPIM unwieldy.

Consideration would also need to be given to a likely cross-over with the update of the NZ AC Watermain Manual and that the NZPIM to date has been principally focused on CCTV driven inspections.

Benefits of Change

Would provide a ‘one stop shop’ for pipeline inspection

Dis-advantages of Change

- The range and type of inspections of pressure pipe is substantially different to those of non-pressure and the manual may become unwieldy and lose focus
- While the update of the NZPIM is starting from a well proven base the pressure component is not as well defined and may delay the project

Recommendation
1. **Not to include pressure pipe within the NZPIM** – The nationally consistent guideline document for the inspection of pressure pipe is an unmet need and it is recommended that consideration is given to the development of a separate companion manual focused on pressure pipe. 2. **The title of the NZPIM be amended to limit the scope to non-pressure pipe** - Use a suggested title of “New Zealand Pipe Inspection Manual (Non-Pressure)”. A companion manual for pressure pipe could then be similarly referenced.

8.6 Topic – Training / Qualifications and Data Quality Management

Background

In 2005, as part of the industry survey prior to the revision of the 2nd edition of the NZPIM, 42% of the surveyed Local Authorities and water utilities were not satisfied with the general quality of the CCTV data being provided. The industry survey undertaken as part of this scoping project included provision to compare the satisfaction results between 2006 and 2016. The 2016 survey identified that there had been an improvement in satisfaction with only 14% of Local Authorities and water utilities now not satisfied the general quality of CCTV data (a 28% shift). This improvement is likely to be due to the increased implementation of good practice processes detailed in the 3rd Edition of the NZPIM and also due to the increased level of training provided during this period (including the ProjectMax training courses and competency assessments).

Whilst the general quality satisfaction has increased amongst the councils and utilities surveyed, a 14% dis-satisfaction rate is still considered to be high. In addition, our experience of auditing CCTV inspections throughout New Zealand anecdotally indicates that there are still many inspections that do not achieve a standard that would provide an acceptable level of confidence in the information for the asset owners.

The current NZPIM outlines some of the key elements of quality management, the responsibilities of Councils and Contractors in undertaking inspections and what checks should be undertaken. It does not, however, specify a minimum level of experience or qualifications for CCTV operators, or people involved in the pipe inspection and condition assessment. The manual recommends that prior to award of a contract the client should check that the Contractor has the experience, training and equipment to complete the work. The general specification with *Section 5 – Standard Documents* states that *"It shall be the Contractor's responsibility to ensure that Operators are familiar with the requirements of the New Zealand Pipe Inspection Manual*." There is no further detail to define what would be an acceptable minimum.

By comparison some other international manuals outline defined minimum qualifications or experience required. The Hong Kong Guidelines have a very specific description of the required experience and training for all personnel (Project Leader to Operator). The Australian WSA05 specifies minimum recognised operator qualifications (unit standards) and skills required for persons responsible for identifying and recoding defects and features.

Currently the only NZQA qualification for CCTV is unit standard 22107. This is aimed at supervisors to demonstrate knowledge on the selection of pipes to inspect and procedures for the inspection and recording of pipe conditions. The current unit standard does not cover competence of people to report on pipe conditions or carry out the CCTV inspections. Connexis (the Infrastructure Industry Training Organisation) are currently reviewing this unit standard and developing new unit standards for people involved in CCTV inspections (with input from ProjectMax).

The second element to quality assurance is the auditing of CCTV inspections. The process for auditing has been in place within the NZPIM since at least the 2nd Edition of the manual, and is based on the WRc MSCC. The focus of the auditing is on the accuracy of the condition reporting and has a 95% minimum threshold to pass the quality audit. Councils (and SCIRT) have in some cases amended the threshold to 90%. However, the NZPIM audit process only reviews the recorded outcomes of the inspection. It does not review the camera operator's performance in relation to the good practice standards, such as camera speed, outlined within the NZPIM. It is expected that where the operation of the CCTV camera is poor, the extent and/or accuracy of the condition reporting is also likely to be poor.

As part of the audit process the NZPIM recommends that the contractor undertake internal audits of the inspection prior to submission to the client, and the client then undertakes a further audit, either themselves or using experienced independent reviewers. Where these steps are all implemented it is possible to obtain very high quality and consistent outcomes. Where the audit trail is not in place the quality if the outcomes tends to be highly variable and some very poor outcomes have been observed.

Discussion

The industry survey indicates that the current NZPIM meets the needs for quality data management but showed strong agreement with the proposal that there should be a minimum specified level of experience and/or competency in the manual.

Feedback indicated that the level of experience and/or qualifications could vary depending on the role of the person involved within the inspection process.

The new unit standards being developed by Connexis are as follows (refer to Appendix 5 – draft NZQA CCTV unit standards):

1. **Demonstrate knowledge of CCTV inspection of non-pressure water services assets (CCDKO)** - People credited with this unit standard are able to: describe the role of closed circuit television (CCTV) in non-pressure water services asset management; describe the preparation of assets for survey by CCTV; and describe procedures for the survey of assets using CCTV, and recording and/or coding pipe conditions.
2. **Carry out CCTV inspection of non-pressure water services assets (CCPRA)** - People credited with this unit standard are able to prepare to carry out closed circuit television (CCTV) inspection of non-pressure water services assets; select and set up CCTV and equipment for inspection of non-pressure water services assets; and carry out a CCTV inspection of non-pressure water services assets.
3. **Report on pipe condition for a CCTV inspection of non-pressure water services assets (CCREP)** - People credited with this unit standard are able to complete closed circuit television (CCTV) inspection header information; and report pipe defects and features from a CCTV inspection of non-pressure water services assets.

This unit standards would apply to basically 3 types of candidate:

1. CCTV Operator who carries out the reporting/coding of inspected pipelines
2. A candidate who carries out only the reporting/coding of inspected pipelines, who is not a CCTV Operator (typically employed by Contractors and working in the office to code inspections completed by others)
3. Candidates who review or audit inspections (similar to point above) – there were (still are) a number of people engaged following the Canterbury earthquakes whose role was to review the incoming inspection reports/videos or audit the reports for completeness. There is also a need for skills within the industry to maintain the quality of inspections and to be able to interpret pipeline condition reports for use in asset management. The Candidate may be a technician or could be an Engineer or even an asset manager involved in the coordination/interpretation of CCTV inspections. The skill required is the identification and quantification of pipe defects based on the pipe material

The candidate qualification profile for these unit standards as follows:

	CCTV Operator Technician	Coding Technician / Auditor / Reviewer	Engineer / Asset Manager
CCDKO	Required	Required	Optional (Recommended)
CCPRA	Required	Not Required	Not Required
CCREP	Required	Required	Required

The proposed unit standards would provide suitable coverage to specify the minimum level of experience for people involved across the inspection of pipe.

The additional periodic reassessment of operator / reviewer competency (as currently informally monitored) after gaining the minimum qualifications would ensure that skills are maintained within the industry to best practice.

The addition of auditing the operator performance, in addition to ensuring coding accuracy, would ensure sufficient monitoring of the quality of deliverables. The auditing criteria to be assessed could be based on the ProjectMax current audit schedule which includes the following:

Water level in the pipeline is more than the specified amount with no reason given (every 10m of pipe is considered as one entry)
Picture quality not acceptable or is not in focus or light intensity is not acceptable (every 10m of pipe is considered as one entry)
Camera speed too fast or too slow (every 10m of pipe is considered as one entry)
Camera does not stop at a defect (per defect)
Inadequate panning of defects (per defect)
Screen header is incorrect or missing (per inspection)
Continuous information displayed incorrectly (per inspection)
There is not a clear view of the camera entering the pipe (per inspection)
Camera not aligned in the centre of the pipeline (per inspection)
Pipe cleaning not to standard (if known, every 10m of pipe is considered as one entry)

Benefits of Change
• Specified minimum levels of qualification and experience would assist asset owners to specify nationally consistent standards to be employed • Would improve the overall coverage of quality management up to international best practice
Dis-advantages of Change
Existing operators would not currently hold the proposed standards and would need to go through a process of engagement and assessment with Connexis.
Recommendation
1. Specify within the revised NZPIM a graduated (based on role) level of minimum experience based on the proposed NZQA unit standards 2. **Update the existing CCTV audit processes to include Camera Operator performance measures**

8.7 Topic – Inspection of Laterals Pipes (including private drains and sewers)

Background

In principle, the inspection of lateral pipes (which are also commonly referred to as private drains and public laterals) is the same as the inspection of public 'mainlines'. There are however aspects that make lateral pipes quite different. These principally are:

- Pipe diameter – typically 100mm (smaller that most tractor cameras can fit into)
- Bends – lateral pipes typically have a number of bends, up to 90 degrees
- Access – entry into lateral pipes is often limited to gully traps, downpipes, Buchan traps and buried inspection access points
- Equipment – the type of camera equipment is limited to fixed head, push rod cameras
- Ownership – a substantial amount of the lateral pipes that are inspected are privately owned by property owners and not local authority.

Because of these differences there are additional or different considerations for the inspection laterals, that do not need to be covered for the inspection of mainlines.

Local authorities do carry out inspections of both public laterals and private laterals. Private lateral inspections by local authorities have been undertaken principally as part of inflow and infiltration (I/I) investigations to identify sources of ground water infiltration and identifying defective laterals that require repair. North Shore City Council and Waitakere City Council carried out extensive CCTV inspections of private and public laterals as part of their I/I investigations. For these investigations a particular specification for the inspections was developed. The standard NZPIM weighted defect scores and grading methods were amended to generate pipe condition grades that were considered to be equivalent to hydrostatic test results and confirmed pipe leakiness.

Stronger Christchurch Infrastructure Rebuild Team (SCIRT) also undertook a significant programme of inspecting private and public laterals to identify damage from the Canterbury earthquakes that were sources of infiltration and required repair. SCIRT developed a simplified condition code and grading methodology to facilitate these inspections. Its purpose was to simplify the coding so that untrained operators such as drain layers could undertake the inspections and also to make it simpler for property owners to interpret the results.

Other international manuals do not generally contain specific guidance on the inspection of lateral pipes. The WRc MSCC does provide a list of domestic drain and inspection chamber codes, which is a smaller, simpler, set of codes compared to the public drain and sewer codes. The WRc has also published a separate manual called the "Drain Repair Book" which covers the repair of 75mm to 250mm diameter drains and is split into four sections. These provide guidance on the inspection and condition assessment of drains, a materials selection for cured-in-place repair systems, treatment including septic tanks and a new section on small package treatment plants.

Discussion
The result of the industry survey on the NZPIM coverage of the inspection of laterals was widely spread, with just over half rating the coverage between inadequate and acceptable. Many of those surveyed were not involved in the inspection of laterals, but those that were acknowledged the need for additional coverage or guidance for the inspection of laterals. Consideration also needs to be given to providing guidance for private drain owners and their plumber / drainlayer contractors, with a standard approach that is appropriate to the inspection of private drains and aligns with the inspection and testing requirements of the Building Act. As part of the research into the scope of required changes to the NZPIM, the issue of providing guidance to assessing sources of inflow and infiltration was identified as an unmet need. From a local authority perspective, private and public laterals are predominantly inspected as part of the I/I program, and therefore providing a national approach aimed at these inspections would be entirely appropriate.
Benefits of Change
• Provide private drain owners an appropriate set of guidelines for the inspection of private drains, which have different requirements to public mainlines • Provide a condition assessment framework that can be used by local authorities for the source detection of inflow and infiltration, and evidence of repair to satisfy the requirements of the Local Government Act
Dis-advantages of Change
None perceived
Recommendation
1. **Provide a section within the revised NZPIM that covers the inspection of lateral pipes**. - The intent of the section is to augment the information covered under the public drains to cover for the specific differences. 2. **Provide a simplified set of domestic drain codes that can be utilised for the inspection of laterals by private drain owners and their contractors** – This could also be used by local authorities as part of an inflow and infiltration investigation. This is envisaged to be based on the simplified codes and grading methodology developed by SCIRT.

8.8 Topic – Acceptance Criteria for New/Rehabilitated Pipe

Background

CCTV inspections are often carried out following the construction of new pipelines, or the rehabilitation of an existing pipeline, to determine whether the works meet the required standard. Often the criteria for acceptance is simply that the new or rehabilitated pipe be "defect free" - the presence of any noted defects in the inspection logsheet would result in remedial work before the pipe will be accepted.

Practically speaking, there should be a level of defect acceptance to ensure that features and minor faults, observed in new or rehabilitated pipes which have no material impact on the life of the pipe, do not trigger inappropriate and unnecessary remedial works. The challenge is providing a guideline, or set of criteria, to help asset owners interpret the information from CCTV inspections to enable them (and the developer/contractor) to evaluate the acceptability of the inspected pipeline.

The NZPIM does not cover acceptance criteria for new or rehabilitated pipe. Over time individual local authorities and utilities have developed their own criteria for determining what defects or features in new pipelines are acceptable or not. There is no nationally consistent set of parameters or guidelines for the interpretation of CCTV inspections of new or rehabilitated pipe that asset owners can base their acceptance criteria on. This generates a lack of clarity, and associated problems, for the constructor / contractor, the pipeline CCTV inspector and the asset owner, and is subject to regular redefinition.

Rehabilitated pipes have specific/special requirements for interpreting how defects or features are coded in comparison to new pipelines. Due to the large quantity of pipe rehabilitation, undertaken as part of the Canterbury earthquake recovery, SCIRT has developed a guideline document (authored with the assistance by ProjectMax) for interpreting the CCTV inspections of lined/rehabilitated pipe.

In addition, some international manuals have criteria for determining if defects or features observed in the pipe are acceptable or not. Australia's WSA05 contains a section on acceptance criteria, outlining a pass/fail criteria based on observed defects from CCTV inspections. The Power and Water Corporation, (PWC) Northern Territories Australia, has a pipe inspection guideline that outlines the acceptance criteria for newly constructed rigid and flexible sewers. It specifies structural and service grading thresholds that are acceptable to PWC for new pipes (and some existing pipes older than 10 years).

Various US transportation agencies, including the Indiana State Transportation Agency, have published guidelines for acceptance of new concrete pipe that provide practical visual inspection tools for the assessment of new pipe. The Concrete Pipe Association of Australasia (CPAA) has also published technical guidelines on Crack (CC & CL) acceptance criteria and repair assessment.

The availability of specific guidelines for interpreting the information from CCTV inspections of new/rehabilitated pipes provides a useful base for a consistent assessment of acceptability. This is valuable to asset owners and the contractors constructing or rehabilitating pipes.

Discussion
The industry survey showed a clear support for the proposal that a common set of CCTV acceptance criteria should be included in the revised NZPIM. The feedback that we received, confirmed by our own opinion, indicates that the acceptance criteria are best set by the asset owners. The focus should therefore be on providing guidelines to assist with the interpretation of the CCTV inspection data to assist asset owners (and contractors) determine compliance with local development standards and specifications. This is considered to be more acceptable and achievable than attempting to determine specific acceptable standards to be applied across the entire country. It is envisaged that the guidelines would be based on the concept of the SCIRT Lining As-built Coding Guidelines, for interpreting CCTV inspection reports, and outline key considerations (e.g. width and location of longitudinal cracking in concrete pipes) and recommended additional inspections, based on pipe material, e.g. quantifying acceptable pipe defection/ovality in PVC/PE pipes etc.
Benefits of Change
• Establishment of a common set of acceptance criteria guidelines that would help asset owners interpret CCTV inspection reports as part of the process for determining the acceptability of new or rehabilitated pipes against local development standards and specifications • Provide developers and CCTV contractors with a consistent approach and understanding of how the pipe condition reporting will be evaluated as part of the as-built and signoff process. • Form a basis for specifying condition and performance criteria in local specifications and development standards
Dis-advantages of Change
May conflict with current local interpretation and enforcement of pipe acceptance criteria
Recommendation
1. Provide two, separate, guidelines sections on the interpretation of inspection results to determine the acceptability of new/rehabilitated pipe i. Assessing New Pipes ii. Assessing Rehabilitated Pipes The separate sections are a reflection on the specific differences that need to be considered between a new pipe and a pipe that has been lined.

8.9 Topic – Pipe Condition Grading

Background

The condition grading process associated with CCTV inspections plays an important role as an initial indicator of the likelihood of service or structural failure of the pipes. the outcomes feed directly into asset management and renewal planning of non-pressure water services assets. The pipe condition grading process consists of two parts:

i. Scoring Analysis – Assigning weighted scores to pipe defects and then the calculation of peak and mean scores
ii. Grading definitions – Aligning the resulting score to a scale of 1 to 5.8 that is widely regarded as the 'summary overall score' used for maintenance and renewal planning

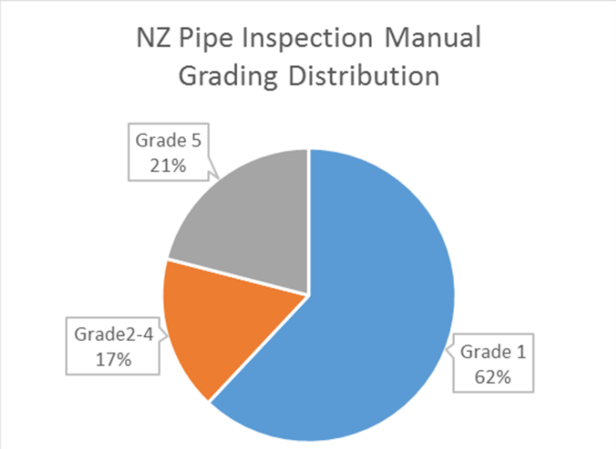
The process we use in New Zealand is broadly the same approach as used worldwide, with the exception being the UK, where the WRc Sewer Risk Management website uses the peak score only to determine the pipe grade.

The industry survey sought feedback and discussion on the existing NZPIM grading definitions and their use in asset management. The responses confirmed the original research which identified:

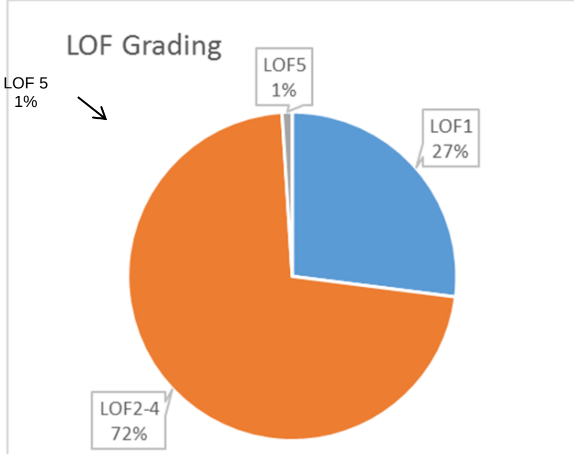
- The condition grades (1 – 5.8) outlined in the existing manual are not defined in the same way as other infrastructure asset management manuals which are defined as only 1 to 5, (e.g. International Infrastructure Management Manual (IIMM), NZ Infrastructure Asset Grading Guidelines (NZWWA, 1999) etc.)
- The grades are not expressed in relation to expected remaining pipe life or possible actions required. For example, the manual refers to a pipe with a grading of 5 or more as being a 'fail', but what this means is not defined. In our experience it is clearly not the same as a '5' in the IIMM
- In many cases the grades produced from the NZPIM scoring analysis do not reflect the actual functioning condition of the pipe. Many networks contain a significant proportion of pipes with grade 5 that are still functioning quite adequately.

The survey results found that most people (93%) agree, to strongly agree, that the current grading system should be modified to align with other asset management manuals. When asked which manual it should aligned to, the responses confirmed preferences to the IIMM (38%), the NZ Infrastructure Asset Grading Guidelines (50%) and the Meta-Data Standards (8%). While small differences exist these 3 alternatives are very similar.

Research by ProjectMax into the distribution of NZPIM pipe grades, revealed that the pipe grades do not reflect the actual condition of the pipe network with respect to Likelihood of Failure when assessed by an experienced engineer. This means that when using the NZPIM standard weighted condition scores and grading thresholds, councils are likely to determine that more of their inspected pipes are in a very poor and "fail' condition than there actually are. This directly impacts on their ability to accurately and consistently report on their network condition and plan pipe renewals. The following charts are based on ProjectMax research and show the typical NZPIM grading distribution and corresponding distribution of the assessed pipe condition grades, based on the likelihood of the pipes actually failing.



NZ Pipe Inspection Manual Grading Distribution



LOF Grading Comparison Distribution

In recent times, Auckland Council, Tauranga City Council and SCIRT have modified the standard weighted scores and grading methodology to better align the calculated pipe condition grades to the IIMM grades as part of their condition assessment strategies and long term renewal planning. SCIRT undertook the modification of the scores to determine a closer assessment of the pipe condition grade to the expected likelihood of failure. This was more focused on estimating the net reduction in asset life of the Christchurch wastewater network resulting from the Canterbury earthquakes.

Discussion

What is the difference between the grading definitions used in the manuals suggested by the industry survey respondents as a replacement for the existing NZPIM? To understand this, ProjectMax has prepared a table comparing all of the alternative grade definitions, (refer to Appendix 6) which shows that, in general, they all relatively align with one another. The main difference is the level of detail in the definitions. More detail incorporated into the definition allows for better understanding of what the grades produced should represent. The definitions from the Australian WSA05 manual are also included in the comparison table, (which is noted to also align with the other definitions). WSAA include a separate definition of the service grade as well. All of the other manuals (except NZ Infrastructure Asset Grading Guideline) only describe structural failure. We note also that the draft Meta-data standard is the only document using the term "adequate" for grade 3 (and in the opinion of ProjectMax this needs further consideration).

Ultimately the Pipe Inspection Manual should align with the NZ Data-Standards, on the basis that the standardisation of asset information across all guidelines is ultimately the best approach. However, the definitions could be expanded to include content from some of the other manuals as additional supporting text.

The current NZPIM methodology for combining the individual weighted defect scores to determine the overall pipe grade uses the higher of the peak or mean score. In our view the mean score can 'skew' the grading where there are continuous defects, or if the pipe is relatively short. This is one of the reasons why the NZPIM condition grades frequently do not accurately reflect the pipe condition. The use of the peak score alone, without consideration of the mean score, to determine the condition grade is considered the best approach for accurately and consistently determining the pipe condition, i.e. the same approach as used by the WRc.

The weighted scores associated with the defects and the grading thresholds also need adjusting to provide better alignment of the grades. Additional consideration should also be given to the fact that the NZPIM only provides a single set of defect weighted scores to cover all materials and services, where in reality, the effect of some defects has a greater impact on the level of service, or likelihood of failure, for different utilities. For instance, the effect of a dip or displacement may have a greater effect on the serviceability of a wastewater pipe than the same severity defect in a stormwater pipe.

A suggested basis for the update would be the relatively recent modifications to the codes and scoring made by Tauranga City Council and SCIRT.

Benefits of Change

- Better align the pipe grades produced from CCTV inspection with expected pipe condition;
- Align the grading definitions with the proposed New Zealand Meta Data Standards;
- Enable benchmarking of pipe condition both within New Zealand as well as other countries (in particular Australia)

Dis-advantages of Change

- None identified
- If overall NZPIM score from past inspections recorded in Asset Management Information System this would not be comparable with scores from new inspections. They could be recalculated if log-sheet data also held.

Recommendation

1. **Adopt the proposed NZ Metadata Standards Pipe Condition Grades** – We also recommend that the descriptions are expanded (using the other existing manuals) to assist with interpretation
2. **Modify the defect weighted scores and grading thresholds as necessary to align the structural and service grades derived from the CCTV observations to the NZ Metadata Standards**. - It is recommended that modified weighted scores are separately provided for both wastewater and stormwater.
3. **Amend the grading threshold process to specify the use of the peak score only**
4. **Provide additional guidance on pipe condition grading** – This should include worked examples and a guideline aimed at asset managers for interpreting CCTV pipe grades and reports as part of assessing remaining useful life.

8.10 Topic – Pipe Defect/Feature Classification (defect codes)

Background

The Pipe Defect / Feature Classifications (Defect Codes) are the fundamental building block of the CCTV inspection system in relation to the ability to accurately assess the condition of the pipe, compare information with previous surveys and to share detailed data with other entities. These are the observations that the CCTV operator makes in relation to both their type and their severity and are recorded for analysis and reporting in asset management software and logsheets. The adequacy and accuracy of the end outputs is wholly dependent on this information being captured in a consistent manner by all CCTV operators.

The first document to detail a set of standard codes to describe pipe defects and features was the original WRc (National Water Council, UK) Manual of Sewer Condition Classification, (MSCC) which was published in 1980.

A British and European Standard, BS EN 13508-2:2003 + A1:2011 *Investigation and Assessment of Drain and Sewer Systems Outside Buildings. Visual Inspection Grading System* (based on the MSCC) has evolved from this to overcome the problem of codes in multiple languages within Europe. The latest WRc 5th edition of the MSCC is compatible with this standard. Outside of Europe, other countries have adopted and adapted the WRc manual to suit their circumstances with usage licences held by NASSCO (USA) for North America, IEWM:Malaysia for South East Asia and, the Indian Society for Trenchless Technology (IndSTT) for India. This closely aligned family of standards is termed the 'WRc approach' hereafter.

The Water Services Association of Australia (WSAA), has also recently updated its condition classification manual, *WSA05 (Conduit Inspection Reporting Code of Australia)* to align with WRc approach. This was partially driven by a desire to take advantage of software developments emanating from Europe and the perception that Europe was at the forefront of technological development in the general area of sewer condition investigation, logging, analysis and repair.

The first edition of the NZPIM in 1989 was also based on the original WRc document and it is therefore not surprising that there is a 'family resemblance' between all the common international codes.

The NZPIM has 39 defect and feature codes. Along with the severity bands (Small, Medium and Large) these are used to classify pipe structural and service conditions. Aside from minor additions and changes, a standardised list of defect codes has been in place since 1989 and all compliant inspections can be compared on a consistent basis. While the New Zealand codes describe similar defects to the WRC approach documents the codes are not directly translatable electronically. To achieve the ability to directly translate would require New Zealand to adopt defect codes more closely aligned with the current WRc standard.

The industry survey asked a number of questions exploring how adequately the existing NZPIM defect codes and severity bands classify the different types of pipe defects and features including coverage of the different pipe material types. Overall the respondents very clearly indicated that they thought that the existing defect codes and severity bands classified the different defects adequately or better - 65% of the respondents thought that the current coding system classified defects between 'Well' to 'Very Well'. Almost all respondents (93%) scored the current coding system between 'Adequate' to 'Very Well'.

Our research, and the survey feedback, however, identified that there some gaps and unmet needs associated with the existing codes These include:

- Need for better coverage of specific items related to different materials, (e.g. PE welds)
- Need for better coverage of defects in rehabilitated (lined) pipe
- Differentiation of defect types where a single defect code does not adequately cover the situation (e.g. surface damage which covers multiple types of damage to the surface)
- Provide coverage of defects or features that are not presently covered under the existing codes (e.g. defects in brick pipes and depth of flow)
- Provide more guidance/clarity on coding principles

We believe that these unmet needs could all be addressed by modifying the existing NZPIM defect codes while maintaining the ability to directly compare past and present inspections. However, this would be a New Zealand specific solution that would not allow direct comparison, at a defect level, with inspections undertaken in other countries.

The survey also explored the importance of being able to share data within New Zealand and with other countries of interest to our industry, such as Australia. Not unsurprisingly, responses were very strongly in favour of being able to share inspection data within New Zealand. Opinions were more divided on the importance of being able to share inspection data with water network operators in other countries. However, the majority still indicated that this was important.

Sharing data within New Zealand can be easily undertaken using the current, or a revised, NZPIM. It could also be easily undertaken for new inspections if the New Zealand industry adopted the WRc approach.

Sharing of data, at a detailed observation level, with other countries is much more difficult if the NZPIM defect codes are retained. We compared the various international defect classification systems, as represented by WSA05, with that of the NZPIM, (refer to Appendix 7) and concluded while there were many overall similarities between the two approaches there was not sufficient one to one alignment to allow direct electronic conversion. If international data sharing, at a detailed observation level is desired then New Zealand would need to adopt the WRc approach defect codes.

Logically, if this path was to be pursued New Zealand should align with the Australian WSA05 interpretation of the WRc approach. This reflects the similarities in materials and conditions between the countries, the opportunity for sharing of knowledge at conferences and the like and the contractors working in both countries.

There are some peculiarities with the Australian approach as WSAA considered that in a number of specific areas, the WRc approach ignored significant data of interest to Australian pipe asset owners. and there were real and immediate disadvantages to the total adoption of the WRc approach requirements. Therefore, although WSAA considered that it was essential to be able to convert data to European equivalents when required, (such as to take advantage of the software, or benchmarking) WSA05 was launched with an augmented set of codes that preserved the Australian specific data of interest. A consequence of this is that once the data set is converted to the WRc approach equivalence for data sharing, any Australian augmentation is lost, and cannot be reclaimed. Likewise, data obtained from Europe or UK would not include any of the Australian augmented data – just the base

European dataset. However, these issues are not considered to be a fundamental barrier to the adoption of the WSAA approach for New Zealand.

However, adoption of the WRc approach codes for New Zealand, would have the undesirable consequence of making any existing observation and condition data that was collected using the existing NZPIM effectively redundant for the purpose of benchmarking or comparison with inspection data going forward. The change would also have significant consequences in relation to retraining the New Zealand CCTV operators.

It is important to note that the above discussion is focussed on comparison of data at a detailed inspection level. While the NZPIM is not be directly translatable to the WRc approach at this level this does not preclude the potential for the overall condition of pipes in various different countries to be compared at the Meta-data standard level. A pipe in condition '5' in Europe would also be a '5' in New Zealand and the discussion about the circumstances that led to that level of deterioration, and the most appropriate asset management responses, is arguably far more important than information relating to the prevalence of a particular defect. It should also be noted that while the UK, Europe and Australia are largely able to compare data at a defect level we are not aware of any significant initiatives to actually do so.

Discussion

The key question is whether to continue to develop the NZPIM condition coding system, including the necessary changes to meet the identified unmet needs, or alternatively completely change the defect classification system to align to the WRc approach, such as the adoption of the WSAA WSA05, with all the potential benefits and drawbacks that come with this significant decision.

Three primary options have emerged :

1. Effectively a 'Do Nothing' option and continue with current NZPIM
2. Modify the NZPIM to provide for as many 'un-met' needs as possible
3. Adopt an off-shore standard closely aligned with Australia, UK and Europe

Key considerations in determining which option is best seem to hinge around the following issues :

1. Ability to utilise past investigations and scoring
2. Control of the process
3. Retraining and industry disruption
4. Software and technology compatibility
5. Include solution for unmet needs
6. Ability to benchmark defect/feature observations and compare

A comparison of key advantages and disadvantages of each approach in relation to the considerations follows :

Consideration	Do Nothing	Modify NZPIM	Adopt Off-shore Standard
Utilise Past CCTV Investigations	**Advantages**: No disruption to current data	**Advantages**: Would be designed to allow compatibility	**Advantages**: Nil
	Disadvantages: Nil	**Disadvantages**: Nil	**Disadvantages**: Past data would not be compatible
Control of Process	**Advantages**: NZ controls process	**Advantages**: NZ controls process	**Advantages**: Nil
	Disadvantages: Nil	**Disadvantages**: Nil	**Disadvantages**: Future process updates controlled by international bodies with limited influence from NZ
Retraining and Industry Disruption	**Advantages**: Current training, equipment and capability continue	**Advantages**: • Current training, equipment and capability continue • Clients could opt for 'old' or 'new' version	**Advantages**: CCTV operator and engineers who frequently travel and work in both countries would be familiar with the classification system
	Disadvantages: Current incompatibility with Australian market remains	**Disadvantages**: Some retraining required but fundamentals remain unchanged	**Disadvantages**: • All current capability no longer relevant. • Potential for split in industry between current NZPIM and new standard • Training/qualifications would be similar but not the same
Software and Technology Compatibility	**Advantages**: Current capability continues. No apparent issues	**Advantages**: Current capability continues. No apparent issues	**Advantages**: Can directly deploy offshore developments that align with standard that is adopted

Consideration	Do Nothing	Modify NZPIM	Adopt Off-shore Standard
	Disadvantages: Cannot directly deploy offshore developments	**Disadvantages:** Cannot directly deploy offshore developments	**Disadvantages**: Some current software and technology would become redundant
Provide for Unmet needs	**Advantages**: Nil	**Advantages**: Can achieve most un-met needs	**Advantages**: Some un-met needs would be accommodated
	Disadvantages: Significant - does not achieve un-met needs	**Disadvantages:** Would not directly address desire for benchmarking defect observation codes	**Disadvantages**: • Not all needs met • Some would be partially met but not necessarily as NZ would want
Ability to Benchmark and Compare	**Advantages**: • Current situation continues • Benchmarking achievable in NZ but with imitations of current approach	**Advantages**: • Current situation continues • Benchmarking in NZ would be enhanced by improved processes and translation to improved asset condition grading	**Advantages**: There should be an ability to directly compare at a detailed level
	Disadvantages: Cannot compare internationally at a detailed level but can still compare overall learnings about cohorts of pipes and what influences them	**Disadvantages**: Cannot compare internationally at a detailed observation code level but can still compare overall learnings about cohorts of pipes and what influences them	**Disadvantages:** While there should be an ability to directly compare at a detailed level there is still variation within countries of interest and benchmarking not well established. May be limited relevance of materials and operating conditions

Discussion Continued

Further commentary on two of the issues that would seem to be crucial in the above includes :

Utilise Past CCTV Investigations

One significant drawback on a change of defect Classification systems is that existing pipe observation data would not be directly comparable, and therefore would not be able to be used directly for comparing or benchmarking condition changes over time, (this was a key factor in Christchurch for considering remaining life as part of the earthquake recovery).

Software and Technology Compatibility

One of the principal reasons for WSAA's decision to change their coding system, was to take advantage of software developments emanating from Europe. Although Australia has been able to utilise the software development from Europe, particularly with the adoption of WinCan, and digital camera technology, (such as Panaramo) New Zealand has also, been able to adopt the same technology without complying with the WRc approach.

Provide for Unmet needs

To provide sufficient information on the options to modify and retain the NZPIM defect classification system, or change to align with the common WRc approach, a schedule (see Appendix 8) has been prepared presenting a proposed 'modified' list of pipe inspection manual codes that could be implemented if WaterNZ elected to not to change to an International Classification System. This proposed modified list addresses the identified unmet needs of the NZPIM codes, and represents a shift in the NZ Pipe Inspection Manual codes to bring it closer to the other international standards, particularly the WSA05. This can be achieved without changing the interpretation of the existing NZPIM coded inspections, thus retaining the ability to continue using the existing inspection data, and minimising the industry retraining and software changes required.

The modified NZPIM defect/feature code list includes:

- Recommended new/additional codes that cover areas where the existing codes do not provide coverage, such as brick pipes, or 'gaps' in the codes such as pipe repairs, water level and general photographs.
- Changes to existing codes to provide better definition. These recommended changes include providing better coverage and differentiation of lining defects, Joint faults, lateral faults and surface damage.

Where new codes have been added, these have been taken from the WSA05 manual, largely unchanged) as they provide an existing already defined code (in line with WRc approach).

Where the proposed modified codes have made changes to the existing NZPIM codes, they have largely done so by adding an additional characterisation code, i.e. adding one or more mnemonic codes onto the end of the existing code. For example, where a joint is faulty due to broken pipe within the joint zone a "B" is added to the 'JF' code to identify this (JFB). This differentiates the broken pipe defect from a sealing fault, which would attract additional 'SX' characters, indicating a faulty seal (JFSX). Under the existing pipe inspection manual, both of these defects would be coded as just JF, and the type of defect noted in the remarks. This makes it difficult to differentiate between the 2 defects and they attract the same weighted score, even though they may have different risks of pipe failure. Adding additional characterisation codes is in line with how the other international manuals manage similar scenarios, while maintaining familiar codes and the same means of interpretation. In most cases, the additional characterisation code(s) has been influenced or borrowed from WSA05, where appropriate and possible (refer to the notes in Appendix 8). The same approach has been applied to LF, LX and Surface Damage.

In all cases, where ever changes have been made, the modifications do not affect the ability of the existing inspection data to be used alongside the changes – the changes serve to add to the data going forward, but does not change the interpretation of the existing coded inspections. The changes/modifications from the existing NZ Pipe Inspection Manual codes are highlighted yellow – comments on the basis of the changes are provided

Ability to Benchmark and Compare

The fundamental reason to shift away from the existing NZPIM, which has wide acceptance and use, would be for New Zealand to align with the rest of the world, make it easier to take advantage of software developments and sharing or benchmarking of inspection observation data with other countries.

The active sharing of comparable data is generally thought to be beneficial to developing a better understanding of life expectancies or deterioration modelling and the more information that is available to analyse, the better the results. For this purpose, we consider it likely that the sharing of pipe condition based on cohorts (i.e. pipes of similar material, age, operating environment) is the key outcome desired, rather than data on specific types of defects such as 'aggregate protruding'. Alignment with the WRc approach strictly for specific defect comparisons would likely be very limited.

If the pipe condition grading is aligned with the NZ Meta Data Standards, as proposed (refer the discussion and recommendation within the Pipe Condition topic) then it would be possible to compare condition data irrespective of the defect and feature code system that has been used to get to that point.

It was noted during the literature review and discussions, that the WRc approach has its shortfalls, and WSSA augmented their own additional codes into WSA05. Since the adoption of the WSA05 utilities within Australia, such as Queensland Urban Utilities (QUU), have made their own further modifications to the WSA05 codes to better provide for their needs. In effect there are now multiple versions of the WSA05 system in operation that are not directly comparable (in fact QUU are still operating to a modified WSA05:2008 when the last version is WSA05:2013). Localised versions such as the QUU modification potentially undermine the opportunity to be able to directly compare defect observation level data.

Overall Assessment of Advantages and Disadvantages of Change

While 'Do Nothing' is always an option it is not considered to be a desirable path forward at this time. The survey, and our own industry knowledge, have identified a raft of opportunities for improvement. Virtually all of these can be achieved with modification to the existing NZPIM and with minimal disruption to the industry and with usability of previous data.

The key decision then becomes whether to build on the current NZPIM, which moves to a much closer alignment with an international standard, whilst retaining compatibility with existing data, or completely align to the prevalent European standard, such as the adoption of the WSAA WSA05 defect and feature codes.

The overseas coding standards share a common DNA with the NZPIM and there are no outstanding differences in the way they approach the broad subject. All contain their own issues and will continue to evolve over time which potentially creates issues for New Zealand in the future as we are unlikely to have a large influence in these change processes. We effectively become an interested user rather than a driver.

There are differences at detailed level between the various countries we would be interested in benchmarking with and as noted, even within those countries. As discussed the key outcome of international learnings to exchange information at the ''knowledge' level where the conversation is more about the major trends and ways of differentiating between the various pipes and their operating environments. Trying to compare at a very detailed level is unlikely to yield beneficial outcomes and may in fact confuse things.

Of greater value will be the ability to benchmark within New Zealand at a detailed level while having confidence that the data we are working with is consistent and accurate.

In consideration of all of the above our recommendation would be to undertake a major revision of the current NZPIM to address the unmet needs while maintaining stability in the industry and the usability of past data.

Recommendation

1. Maintain but modify the existing NZPIM defect/feature codes – recommend that this is based on the proposed modified defect and feature codes included in the Appendix.8 This will address unmet needs, maintain backwards data compatibility while moving the NZPIM closer to alignment with international standards.
2. Include a section within the revised NZPIM on coding principles – to provide addition guidance of how defects are to be recorded and the application of severity bands etc.

9. Progression, Timeline and Indicative Budget

ProjectMax believes Step 1 is now complete and the process can now move to confirming the scope of Step 2 i.e. actually generating the update. There is now a clear understanding of how the industry feels about the current NZPIM and the opportunities that they see for improvement.

Several points stand out in relation to how the project should progress :

- The update should be limited to non-pressure pipe which means that it essentially becomes a replacement for the NZPIM. While there is a clear need for a companion document covering condition assessment of pressure pipelines it is also clear that there are very few overlaps with the approach required for non-pressure pipe. Progressing both within one document would delay and complicate the process while adding very little value.
- Many of the functionalities sought by users could be accommodated within an update of the NZPIM or within an appendix to any one of the international approaches. This would primarily be additional material as it is considered that there would be little, if any, content that would need to removed / cancelled.
- The primary question as detailed above relates to the issue of international benchmarking and the extent to which this determines whether Step 2 is an update of the current NZPIM or the wholesale adoption of one of the off-shore standards as the base document.

While all these points require clarification the last is considered to be most potentially contentious.

It is important that this decision is owned by the industry and our recommendation would be that WaterNZ take responsibility for progressing this to an outcome. Logically this might be done through the Water Services Managers Group and ProjectMax would be pleased to facilitate that debate.

We understand that this group will first meet in April 2017 and this would be a practical timeline to allow this matter to be circulated and considered.

While the outcome of this decision making process should not be regarded as a formality ProjectMax is of the view that an update to the current NZPIM, incorporating all the met and unmet needs would represent a significant step forward for the industry while retaining the knowledge and data that have been gathered to date.

Subject to further refinement, once the scope is settled for an update of the current NZPIM, it is our belief that the project can be brought to a conclusion within a period of 6 months with a budget in the order of $100,000 - $112,000 (excl GST) made up of the following predicted costs :

Item	Recommended Budget
Revision of Manual (per content discussed above)	$80,000 – $90,000
Format/Design/Type Setting (ready for printing or publishing to web)	$12,000
Suggested disbursements	$8,000 - $10,000
Total Indicative Budget	**$100,000 - $112,000**

It should be noted that this prediction was generated for early budgeting purposes and would be subject to revision once the overall extent of the changes has been confirmed. It anticipates that all the recommendations contained in this report are adopted.

10. Conclusions

The New Zealand Pipe Inspection Manual - 3rd Edition 2006 (NZPIM) is the primary tool used within the New Zealand 3 waters industry for the assessment and reporting of the condition of non-pressure wastewater and stormwater pipes. It is effectively 'owned' by Water NZ and is freely available on their website.

It is used by asset owners to specify the inspection work to be done, by contractors undertaking and reporting on the inspections, by equipment suppliers serving the New Zealand market and by asset managers and consultants analysing the outcomes and planning the repair and renewal of pipes. It is also supported by training and competency assessment processes.

Since its last update in 2006 a number of changes have occurred in the technology that make an update desirable. The bigger challenge is a collective desire by central and local government to lift the overall performance of the industry in relation to delivering quality service and improving efficiency. This is particularly focussed on better managing and funding the extent of renewals that will be required over the next 30 years, and beyond.

Condition assessment is a critical tool in understanding the gradual deterioration of water services assets and planning for their renewal.

Within this overall context a collaboration of the University of Canterbury – Quake Centre, WaterNZ and IPWEA have facilitated the progression of a number of projects, one of which is a review and updating of the Pipe Inspection Manual.

ProjectMax were engaged to determine the scope of the update and a literature review, industry survey and input from a steering group were utilised to identify options, seek the views of users and understand the implications of change. The intent is that an agreed scope will then become a second project for the actual generation of an updated manual.

The current NZPIM relates only to non-pressure pipes (gravity drains) and there is a need for a companion document relating to condition assessment of pressure pipes. However, there was a clear consensus that there was insufficient overlap of technologies and approaches between the two pipe types to justify a combined solution. It is therefore recommended that the pressure pipe manual progress as a separate project.

It was apparent that users of the manual appreciate the somewhat wider coverage that is included compared to some similar off-shore versions. The current manual provides advice on establishing a programme, procurement, equipment utilisation, etc. and there are perceived to be benefits in having this information in one place. The process identified a number of improvements that could be made and it is recommended that the manual retain this wide coverage of the subject.

The key question emerging from the scoping study relates to the continuing use of the condition codes that the New Zealand industry is familiar with Vs adopting the codes used in one of the international alternatives. While the international codes are similar to the New Zealand codes in many cases it is not possible to do a one to one mapping between the systems. While adoption of an international system would allow direct benchmarking with off-shore comparators it would have implications for training and the ability to utilise data collected over many years.

While ProjectMax is of the view that an update of the current manual would serve the industry well, and this view is shared by many industry participants, this decision should properly be determined by the ‘owner of the manual i.e. WaterNZ, most likely through the Water Services Managers Group.

The specific recommendations made for each major topic area in relation to the review of the current NZPIM are as follows :

1	**Format and general content of the existing Manual**
	The following general format improvements are suggested: 1. **Publishing Format** - The hardcopy format was not specifically identified as a problem, but a suggestion for an enabled electronic or web based version with a ‘Keyword‘ search function that could be easily accessed and searched should be considered for easy reference and links to standard forms; 2. **Chain of Custody** – A description within the first section of the manual that describes where the NZPIM fits into the other Asset Management manuals, as part of the Introduction / overview of the manual 3. **General update of content** – Review and update information on technology under relevant sections including use of diagrams and worked examples where possible 4. **New content structure with clear defined manual sections** - Information relevant to that section contained only within that section, (or a clear reference provided to information contained within another section). • Incorporate an index section • Incorporate a Quick Reference Card containing summary list of codes • Incorporate a glossary of terms
2	**Manhole Inspections**
	1. **Section on Manhole Inspection** – Add a specific section on Manhole Inspection 2. **Modify and adopt codes and grading methodology** – Establish a set of codes and grading methodologies based on the defect and feature codes used for the inspection of pipes, adapting as necessary (e.g. referring the “Vertical Cracks” in place of “Longitudinal Cracks” etc.) 3. **Include a manhole inspection Specification** – Provide a manhole inspection specification as part of the standard appendices 4. **Forms and Logsheets** - Update the manhole inspection form and manhole inspection logsheet report template form to align with the new inspection processes.

3	**Pipe Cleaning**
	The proposed improvements are aimed at providing additional guidance for pipe cleaning associated with the inspection of pipes as follows: 1. **Add additional guidelines for working with Jetters as part of the CCTV inspection –** This will include standard operating procedures (SOP) for the prevention of damage to pipes and surcharging (i.e. blow backs), based as the existing SOP's developed by SCIRT as part of the Canterbury Earthquake recovery 2. **Define a specification for pressure limits and outcome focused definitions of different types of cleaning** - This could be based on the tables following (measures are arbitrary to illustrate intent) suggested by the steering group members. The key to this recommendation is to provide sufficiently detailed descriptions that would allow asset owner and contractors to determine the appropriate level of required cleaning and if it has been achieved. **4. Define pressure limits based on known or assumed pipe condition** – In addition to the above, it is recommended that pressure limit guidelines are determined, based on pipe condition, to avoid pipe damage. This could be based on the WRc Jetting Code of Practice and amended to align with best practice knowledge in New Zealand
4	**Methods of inspecting pipes and the quality of inspection equipment**
	1. **Update and expand information on the different inspection methods and equipment available**. 2. **Develop an inspection equipment classification system** – This would provide guidance on the selection of appropriate equipment and help with: a) Selection or specification of appropriate CCTV equipment for the specific project, including when alternative technology would provide benefits over CCTV b) Equipment capability (Range and limitations) **c)** Expected quality of image and data outputs, etc.
5	**Pressure Pipelines**
	1. **Not to include pressure pipe within the NZPIM** – The nationally consistent guideline document for the inspection of pressure pipe is an unmet need and it is recommended that consideration is given to the development of a separate companion manual focused on pressure pipe. **2. The title of the NZPIM be amended to limit the scope to non-pressure pipe** - Use a suggested title of "New Zealand Pipe Inspection Manual (Non-Pressure)". A companion manual for pressure pipe could then be similarly referenced.

6	**Training / Qualifications and Data Quality Management**
	1. **Specify within the revised NZPIM a graduated (based on role) level of minimum experience based on the proposed NZQA unit standards** 2. **Update the existing CCTV audit processes to include Camera Operator performance measures**
7	**Inspection of Laterals Pipes (including private drains and sewers)**
	1. **Provide a section within the revised NZPIM that covers the inspection of lateral pipes**. - The intent of the section is to augment the information covered under the public drains to cover for the specific differences. 2. **Provide a simplified set of domestic drain codes that can be utilised for the inspection of laterals by private drain owners and their contractors** – This could also be used by local authorities as part of an inflow and infiltration investigation. This is envisaged to be based on the simplified codes and grading methodology developed by SCIRT.
8	**Acceptance Criteria for New/Rehabilitated Pipe**
	1. **Provide two, separate, guidelines sections on the interpretation of inspection results to determine the acceptability of new/rehabilitated pipe** iii. Assessing New Pipes iv. Assessing Rehabilitated Pipes The separate sections are a reflection on the specific differences that need to be considered between a new pipe and a pipe that has been lined
9	**Pipe Condition Grading**
	1. **Adopt the proposed NZ Metadata Standards Pipe Condition Grades** – We also recommend that the descriptions are expanded (using the other existing manuals) to assist with interpretation 2. **Modify the defect weighted scores and grading thresholds as necessary to align the structural and service grades derived from the CCTV observations to the NZ Metadata Standards**. - It is recommended that modified weighted scores are separately provided for both wastewater and stormwater. 3. **Amend the grading threshold process to specify the use of the peak score only** 4. **Provide additional guidance on pipe condition grading** – This should include worked examples and a guideline aimed at asset managers for interpreting CCTV pipe grades and reports as part of assessing remaining useful life.

10	**Pipe Defect/Feature Classification (defect codes)**
	1. **Maintain but modify the existing NZPIM defect/feature codes** – recommend that this is based on the proposed modified defect and feature codes included in Appendix 8. This will address unmet needs, maintain backwards data compatibility while moving the NZPIM closer to alignment with international standards. 2. **Include a section within the revised NZPIM on coding principles –** to provide addition guidance of how defects are to be recorded and the application of severity bands etc.

Appendices.

Appendix 1 - Literature Research Bibliography

Ref	Author	Date	Title	version	Publisher	Type	Purpose
1	J Lambert, NR Orman, J Cant, J Trew, F Moy, A Drinkwater	Aug-05	Sewer Jetting Code of Practice	Second Edition	WRc	Industry Guideline	Code of practice provides guidance on good working practice when using high pressure water jetting equipment for the removal of blockages and sediments from drains and sewers.
2	Plastics Industry Pipe Association of Australia (PIPA)	12-Jul-09	Water Jet Cleaning of Plastic Pipes (POP205)	Issue 1.2	PIPA	Industry Guideline	Guideline prepared for the jetting of plastic pipe systems to provide information based on experience and research as the maximum pressures that may be used to avoid damage to plastic pipes in good condition.
3	NZWWA	Mar-99	New Zealand Pipe Inspection Manual	Second Edition	NZWWA	Industry Guideline	
4	NZWWA	May-06	New Zealand Pipe Inspection Manual	Third Edition	NZWWA	Industry Guideline	
5	WRc	Sep-13	Manual of Sewer Condition Classification	Fifth Edition	WRc	Industry Guideline	Describes the coding systems for drains and sewers. It provides additional guidance on the use of CCTV inspection together with guidance on the use of the coding system for condition inspection of manholes and inspection chambers
26	WRc	Jan-04	Manual of Sewer Condition Classification	Fourth Edition	WRc	Industry Guideline	Describes the coding systems for drains and sewers. It provides additional guidance on the use of CCTV inspection together with guidance on the use of the coding system for condition inspection of manholes and inspection chambers
6	Ir Dr. King Wong, L.M. Chung, C.C. Chui, C.W. Hui, W.Y. So, Ir Kai Man Ko	May-11	Guide to Conduit Condition Evaluation (Using CCTV in Hong Kong)		Utility Training Institute	Industry Guideline	Provides good practice of using CCTV Survey in conduit condition evaluation. It states the whole process and specification of conducting CCTV survey from planning to finishing stages and intended to be used by all personnel involved in the works.
7	Power and Water Corporation (NT, Australia)		Guidelines for closed Circuit television (CCTV) inspection of newly constructed sewers		Power and Water Corporation (PWC)	Local Guideline	Guidelines outline inspection, reporting and acceptance requirements for newly constructed rigid and flexible sewers
8	IPWEA - NAMS.AU		Condition Assessment and Asset Performance Guidelines (Preamble Document)		IPWEA - NAMS.AU	Practice Notes	Sets out the generic principals applicable to all types of assets. It covers the basic concepts of condition assessment, performance measurement, risk management and data management.
9	S. Rahman, D.J. Vanier	Sep-04	An Evaluation of Condition Assessment Protocols for Sewer Management		National Research Council Canada (NRC)	Report	Reviews various aspects of a condition assessment protocol developed by the WRc and compares this protocol with guidelines developed by the NRC and others used by Canadian Councils and Utilities
10	John Nazimek (Water Coproration), David Cox (WSAA NSW), Andy Best (Water Corporation)		Scoring and Storing Defect Codes of Sewer Maintenance Structures			Technical Paper	This paper reviews the process used to develop a system to score maintenance Structures and upload the defect data into the corporate system
11	Patrick V McGuire Executive Director CPAA, Norwood L Harrison Technical Support Manager Humes		Concrete Stormwater Drainage Pipelines - Acceptance Using CCTV Inspection			Technical Paper	This paper reviews action taken to address serviceability issues with installed pipelines, together with experience and scientific evidence in relation to cracking of steel reinforced concrete. Criteria are proposed for acceptance of pipelines constructed from steel reinforced concrete pipe.
12	Christchurch City Council/SCIRT	15/04/2014	CCTV for Christchurch City Council Earthquake Recovery	Version 8	Christchurch City Council/SCIRT	Specification	Specification set out for the Canterbury earthquake recovery
13	City Care/SCIRT	1/02/2012	Closed Circuit Television (CCTV) Activity	First Issue	City Care/SCIRT	Quality Manual	SCIRT quality Manual for the CCTV workflow
14	Christchurch City Council	7/10/2011	Infrastructure Recovery Technical Standards and Guidelines	Version 1.2 Final Draft	Christchurch City Council	Local Standards & Guideline	Record actions to date and provide technical standards and guidance for the organisations and individuals that will assist Council to undertake the restoration process associated with these networks. The document addresses issues associated with eh required works, prioritisation, reporting and information sharing.
15	City Care/SCIRT	7/02/2013	SCIRT CCTV Works: As-Built Survey	V2_UR final draft2	City Care/SCIRT	Standard Operating Procedure	Standard Operating procedure (SOP) details the procedures for carrying out As-built CCTV inspections of gravity storm and waste water pipes greater than or equal to 150mm diameter

Ref	Author	Date	Title	version	Publisher	Type	Purpose
16	S. Apeldoorn, ProjectMax	8/11/2013	Guidelines for As-Built CCTV Inspections of Lined/Rehabilitated Pipe	Version 3	Christchurch City Council	Local Guideline	Provides CCTV Operators, Reviewers, SCIRT Delivery Teams and CCC, guidance on the assignment and interpretation of feature and defect codes for the as-built inspection of lined/rehabilitated pipe as part of the Christchurch earthquake recovery
17	SCIRT		New Pipe/Replacement Pipe Acceptance Criterial	1st Draft	SCIRT	Schedule	Schedule of As-built defects the require repair. Based on WSAA (WSA 05?) criteria (amended).
18	S. Apeldorn, ProjectMax	22/10/2013	Guidelines for the Interpretation of Condition Codes for Private Lateral Inspections	Version 2	SCIRT	Local Guideline	Produced to provide CCTV Operators, SCIRT Delivery Teams and CCC, guidance on the assignment and interpretation of feature and defect codes (condition codes) for the inspection and condition assessment of private laterals that to be connected to Vacuum or Pressure Wastewater systems as part of the Christchurch earthquake recovery
19	Water Services Association of Australia (WSAA)	2008	Conduit Inspection Reporting Code of Australia (WSA 05)	Version 2.2	Water Services Association of Australia (WSAA)	Industry Guideline	This Code details the condition assessment of conduit systems, principally but not limited to sewers and subsoil drains, by internal inspection, status codification and consideration of external factors and other information. The Code specifies a coding system for the description of the internal features of conduits and maintenance structures identified through visual inspection. Where appropriate it may also be used for pressure and vacuum conduit systems in accordance with the requirements of the asset owner. This Code does not specify contractual requirements for carrying out inspections.
20	Thomas Schmitz, Bruce Thompson, Queensland Urban Utilities (QUU)	Jul-13	CCTV Inspection Guide for Sewers	Version 6.1	Queensland Urban Utilities (QUU)	Local Guideline	Purpose is to ensure that all CCTV inspections and Preliminary Condition Assessments are carried out for QUU comply with the latest version of WAS 05 and this guideline. QUU requires contractors to comply with the guideline (as QUU have modified some WSA 05 requirements) in the first instance and then to WSA 05.
21	Queensland Urban Utilities (QUU)	Oct-10	Cleaning Guidelines for Sewers	Version 1 Draft	Queensland Urban Utilities (QUU)	Local Guideline	A suit of guidelines and supporting information provided to assist pipeline cleaning contractors engaged by QUU in gravity and pressure sewer pipeline cleaning services.
22	Garrie McAlister, Gavin Blakey, Brisbane City Council	10/08/2010	Stormwater Assets Pipe Survey CCTV - Specification & Guideline	Version 0.2	Brisbane City Council (City	Local Guideline	Outlines the requirements of the Brisbane City Council in relation to Close Circuit TV (CCTV) pipe survey and give guidance to the recording of defects and other conditions found during stormwater pipe surveys.
23	James C Thomson, Paul Hayward, Glyn Hazelden, Robert S Morrison, Tom Sangster (Jason Consultants International Inc) Damon S Williams, Richard Kopchynski (Damon S Williams Associates)	2004	An Examination of Innovative Method Used in the Inspection of Wastewater Systems		WERF/IWA Publishing	Report	The report brings together a body of information on the characteristics of the wastewater pipe network and the most common defects encountered. The technologies and method utilities use to investigate these defects for the purposes of condition assessment are identified along with what the perceived unmet needs.
24	Sunil K Sinha, Nisha Thuruty (Virginia Tech), Kevin Hadden (Orange County Sanitation District), Rick Nelson (CH2M Hill), Lawerence Jaworski (Brown & Caldwell), Kendal Jacob (Cobb County Water System), Matt Stolte (Town of Blacksburg Virginia)	2013	Condition Assessment for Wastewater Pipelines		WERF/WaterID	Report	The research results presented in the report were compiled to provide a clearer understanding of the state of the technology for wastewater pipeline condition assessment methodologies and technologies focused primarily in the USA.
25	Jerry Sunarho Sydney Water Corporation	Jul-08	Use of Laser Profiler for Inspection of Concrete Sewer Corrosion	Final report	Sydney Water	Report	Discusses status of the technology (laser profiling) its features and limitations. It also recommends the inclusion of laser profiling into the utilities CCTV inspection programme for their gravity concrete sewer mains.
27	Hayden Read, Programme Director - Asset Metadata (Shared Data) Standard	7/07/2016	New Zealand Assets Metadata Standard: Volume 1.1	Draft A	NZ Treasury	Working Paper/Specification	Metadata Standard. Specifically, the standard establishes a common understanding of the meaning or semantics of asset data, and it ensures the correct and proper use and interpretation of the data for all Stakeholders

Ref	Author	Date	Title	version	Publisher	Type	Purpose
28	Colin W Black	20/05/2013	Data Exchange Utility - Inspections Contract Information: Pipe Data Export/Import Requirements	4.8.3.0	NEZTEK Systems Limited	Specification	The Purpose of this document is to provide details of what information is provided via the Data Exchange Utility, for inclusion in contract documents.
29	WRc	2009	Sewerage Risk Management Website		WRc	Guideline	Industry guideline website that provides data and assistance in decision making for Pipe Renewal
30	Andrew DuFresne		Practical Steps to Maximise the Value of Your Concrete Pipe Assets			Technical Paper	Discuss some general principals involved in managing stormwater assets to perform to the required standard and not fail at critical times, and to highlight procedures to ensure future generations of ratepayers are not made liable for major expenditure as a result of substandard installation or post-installation damage
31	David Heiler (SCIRT Data Assessment Lead), Steve Apeldoorn (SCIRT Pipe Condition Assessment Specialist)	2015	Assessing the impact of Earthquakes on the remaining life of gravity WW pipes			Technical Paper	This paper describes the methodology and presents results for its application on gravity wastewater pipes in Christchurch
32	David Heiler (SCIRT Data Assessment Lead)	13/09/2013	Assessment of changes in remaining asset life in the gravity WW Network		SCIRT	Memorandum	To present a methodology for estimating the change in remaining asset life caused by earthquake damage and SCRIT rebuild works
33	Kyle Twidale	18/10/2007	LCR High Pressure Water Jetting Test Report (Condensed)	18/10/2007	Interflow	Report	The purpose of this report is to provide a technical summary of the results witnessed during high pressure water jet testing of the existing LCR - DrainPlus sock and the redesigned Interfit PVC sock
34	NZQA	21/07/2011	Unit Standard 22107 - Prepare for and setup CCTV and describe procedures for CCTV survey of water reticulation assets	Version 3	NZQA	Unit Standard	NZQA unit standard for people who supervise maintenance and operations in water reticulation and people who work in specialist water reticulation activities.
35	Indiana Department of Transportation	May-14	Inspection Manual for Precast Concrete Pipes and Structures		IDOT	Industry Guideline	Guideline document for the inspection, acceptance and regjection of concrete pipes and manholes
36	CPAA		Deflection of Flexible Plastic Pipes		CPAA	Technical Brief	Publication produced to provide information on the technical characteristics of plastic pipes
37	North Shore City Council		WWSC Testing and Inspections	V1.2	NSCC	Specification	This Technical Specification covers the hydrostatic testing of private Wastewater Service Connections (WWSC's), and inspections of public and private WWSC's with a CCTV camera

Appendix 2 - Issues Register

Issue	Related to	Bibliography Ref.	Note	Issues
Acceptance Criteria	Acceptance Criteria	7, 11, 17	The purpose of the PWC guideline is to outline the acceptance criteria for newly constructed rigid and flexible sewers. It specifies structural and service grading thresholds that are acceptable to pWC for new pipes (and some existing pipes older than 10 years). WSA 05 (WSAA) contains a section on acceptance criteria. SCIRT drafted acceptance criteria for new and replacement pipe based on WSAA CPAA has published guidelines on Crack (CC & CL) acceptance criteria Various US transportation agencies have published general guidelines for Acceptance of new concrete pipe NZPIM does not cover acceptance criteria. Specifying acceptance criteria maybe challenging to get agreement on. At the moment every council has its own variation on what is acceptable or not. This causes a lot of problems with developers and CCTV contractors to know what is required.	Should the NZPIM cover acceptance criteria for new or rehabilitated pipe? Consider including a section on Acceptance Criteria for newly constructed pipes.
Should As-Built Surveys be treated differently?	Manual Format	15, 16	As-built surveys are undertaken generally as part of the testing/acceptance process for new or rehabilitated pipe. They may have their own specification e.g. City Care/SCIRT have their own separate SOP for as-built surveys and the SCIRT CCTV specification has a separate section on as-built surveys. Rehabilitated pipe have specific/special requirements for interpreting how defects or features are coded - SCIRT has a separate guideline document (authored by ProjectMax) for lined/rehabilitated pipe	Give Consideration to coverage of As-built inspections - should this be related to any section that is created for Acceptance Criteria Give Consideration to adding commentary or guideline on the interpretation/coding of Lined/Rehabilitated pipe
Identifying and capturing pipe attribute data	Manual Format	22	NZPIM covers some content on what is an asset (asset description) mostly in terms of pipes, and some information on what information is collected within the logsheet header. There is little information on the various pipe attributes where information is to be collected and how the information is to be measured (or what to do if it cannot be measured). The Brisbane City CouncilStormwater CCTV guideline provides more information on network assets and components. It has a chart on how to measure various different pipe shapes.	Consider expanding the information on "Assets" to provide more on the different network components and what asset attribute information needs to be collected and how
Material specific codes	Condition Classification	5, 16, 19	The WRc and WSAA have defect codes specifically for some types of pipe material e.g. Brick sewers or Plastic pipes. NZPIM only 2 specific codes based on material; PF (Deformed plastic pipe) and PL (Pipe Liner Defective) - no coverage for brick sewers and limited coverage of rehabilitated pipe. SCIRT has developed guidelines on the use/interpretation of codes for post rehabilitation of pipes.	Consider the need of the introduction of more material specific codes, such as for Brick sewers - is there enough need? Potential for the need for material specific weighted defect scores. Could adopt the WSA05 brick sewer codes without conflict the existing condition classification system.
Not everyone has their own Manual	Condition Classification	9	A number of Countries do not have their own manual and utilise other manuals such as the WRc or NASSCO. Others have devised their own manuals based on the WRc (NASSCO is essentially based on the WRc itself). Canada, according to the NRC report, 2004, reported that Canada does not have their own manual - a survey found 68% of councils utilised the WRc or have developed local manuals based on the WRc or NASSCO.	

Issue	Related to	Bibliography Ref.	Note	Issues
JF, Joint Faulty can include lots of things	Condition Classification	4	Joint Faulty (JF) covers all structural defects that occur only within the Joint Zone - a 200mm long pipe section (100mm either side of the joint). This could be a leaking joint seal or could be a case that the pipe wall is broken around the joint. The severity may describe both occurrences. Both may have different affects on the Likelihood of Failure, but there is no way to determine the difference when calculating the pipe grade using scoring analysis. The WRc and the other derivative manuals (including WSAA's WSA 05) simply use a pipe defect code with a designation that it is associated with a joint. This arrangement may solve the problem. The Joint zone plays an important role in that structural defects like cracking that only occur within the joint zone and not beyond it can indicate a lower risk than those that extend further down the pipe and are usually only related to the jointing system itself. This issue maybe addressed also if there is some alignment with the BS EN 13508-2	Need to consider an appropriate way of determining structural defects that occur only within the joint zone but differentiate them from simple joint sealing faults.
Benchmarking against other countries	Condition Classification	4, 5, 19	UK, Europe, USA (via WRc) and Australia condition classification systems are aligned the European standard EN 13508-2. The coding and quantification are similar but not the same as the NZPIM and there is no direct conversion. If the Condition grades are aligned with the metadata standards/IIMM then benchmarking can be completed through benchmarking condition, but not via individual defects.	How important is benchmarking with other countries to the NZ industry? To enable direct benchmarking of defects, consideration would need to be given to the alignment of our classification system with the BS EN 13508-2 standard, or the adoption of the WRc or WSAA or similar in place of the existing NZPIM condition classification system. Changing the classification system would have several impacts - backwards compatibility with existing pipe data; modified software would be required and re-training.
Measuring can be difficult	Condition Classification	5, 19	Some dimension in the WSAA & WRc codes maybe difficult to quantify. WSA 05 specifies recording the measurement of cracks in mm - this cannot be undertaken with most (if not all) CCTV equipment, and form our experience the operators assessment is wildly in accurate. Other dimension measurements may only be able to be measured using some equipment, but not all types of equipment which may then need to be estimated (again the assessment ability may be wholly inaccurate).	Need to consider the value in accurately measuring something against our current band range (dimensions within a range of sizes or as a %)
Additional Codes	Condition Classification		The number of condition and feature codes in the NZPIM is relatively small compared to the international alternatives. This means that we often have to make use of feature codes such as General Comment (GC) to describe things in the remarks. The Remarks field is not searchable so requires analysis of the remarks field and clear notes from operators. In some cases defect codes that are perhaps 'greater' than what is required are used where perhaps they are not suitable, e.g. the Use of Tomo (TM) when soil is visible through a defect.	What does industry think about the current coverage of the condition codes. There should be some consideration given to adding/adopting additional codes to clarify the recording of defects and features. What effect does changing the condition classification system have on using the existing condition data? Consider adding more Defect and Feature codes to provide better classification.
Mismatch between NZPIM grading and LOF	Condition Grading	4,9, 29, 27	The condition grades do not generally reflect the actual condition or IIMM/Metadata standards condition grades & description. The method of using the highest of the Peak and Mean Score is flawed as the Mean score will generate a variable result dependent on the length of the pipe. WRc Sewerage Risk Management Website says the grade should be assessed using the Peak Score only.	The weighted defects scores and grading thresholds need to be modified to enable the alignment of the condition scores with the metadata standards. Also change methodology for calculating the condition grade by using the Peak only. Mean becomes and alternative 'indicator'. What does the industry currently use to determine pipe condition?

Issue	Related to	Bibliography Ref.	Note	Issues
Aligning Grade based on risks relating to soils	Condition Grading	9	City of Winnipeg determined the pipe grade based on scoring analysis, and the converted the grade to 'final' performance grade based on risks related to soil type and frequency of surcharges. Adding factors such as soil types and maintenance history maybe difficult depending on the information available and there maybe some valid questions regarding whether this is something that should be included in a "pipe inspection manual" or better covered under risk management manuals such as IIMM.	Should there be consideration to incorporating other factors such as surcharge/maintenance history or soil types etc.? This is likely to be outside of what could expected of the manual. Consider whether some guidance notes could be included within the manual suggesting that the type of soil should be considered as part of an overall pipe condition assessment undertaken by a professional assessment person.
Use of CCTV for private drainage & II investigations	Condition Grading	18	CCTV has been used for I/I investigations of private drainage - extensively at NSCC and Waitakere City Council. In these cases this was done by amending the weighted defect scores and grading method. This process aimed at generating a result similar to hydrostatic test results. Generally this ends up with most pipes failing. For SCIRT a simplified condition code and grading method was developed by ProjectMax. It purpose was to simplify the coding so that untrained operators such as drain layers could undertake the inspections and to make it simpler for property owners to interpret. This specifically targeted the defects that contribute Infiltration. The NZPIM had a case study and published the NSCC modified scores. Research done while ProjectMax was preparing a review of the NSCC grades for Watercare identified that the NSCC scores failed pipes that on review possibly does not contribute II. The scores were modified and results compared for watercare. The WRc has published a manual call the "Drain Repair Book" covers the repair of 75mm to 250mm diameter drains and is split into four sections, offering guidance on the inspection and condition assessment of drains, a materials selection for cured-in-place repair systems, treatment including septic tanks and a new section on small package treatment plant.	Who has used the NSCC guidelines? Give consideration covering I/I inspections in greater details and alternatives such as: 1/ Alternative weighted defect scores and grading methodology for I/I investigations; and/or 2/ Modified codes for private drainage investigations
Camera Equipment testing & Calibration	Equipment	5,6, 26, 19	WRc (5th Edition) & Hong Kong guideline manual both include sections on testing & calibration procedures for CCTV cameras - NZPIM does not have any information on Testing & Calibration of equipment. Both the WRc and Hong Kong manuals specify the use of the Marconi Resolution Chart and test box - Does anyone in the world still use the Marconi Resolution Chart and Test boc for check picture resolution? What other methods are there for determining camera resolution? WSA05 requires that camera manufacturer or agent certifies camera output following servicing - this may cater for quality at the time of service, but what about in between? There are some contractors using cameras that have very poor picture quality - is there any current means of determining or defining video quality including light levels? Current model specifications only have 'subjective' based descriptions for picture quality such as "sufficiently sharp" or "if not acceptable to the Engineer" and "Insufficient or excessive lighting" etc.	Is there a need to provided a "quantitative" means of specifying and assessing equipment output quality and measurement accuracy etc.?

Issue	Related to	Bibliography Ref.	Note	Issues
Defect & feature codes for manhole inspection	Manholes	5, 10, 19	Both WRc and WSAA have manhole defect and feature codes for the inspection of manhole structures - a variation on the pipe codes. The NZPIM has a manhole inspection form template that provides descriptions and fields for describing manhole component damage, but does not have a coding or grading system for manholes.	What does industry currently do with regard to manhole inspection. Consider the need for specific manhole condition codes (and Condition grading).
Coding Principals	Manual Format	5, 4, 16, 18, 20	WRc has a section (section 2) specifically on Coding Principals - describing how to interpret and record the defect codes including worked examples of different scenarios. NZPIM 2nd & 3rd edition does not contain a guide to the interpretation of the defect codes or, importantly, on defect severity. After the 3rd edition was published ProjectMax came up with the "2 Philosophy's" for determining severity. There are also no examples as a guide.	How well does the current coverage (or lack there of) provide for the industry? Is there a need to give consideration to having a section on Coding principals to guide all users to the information that needs to be reported and reviewed.
Casual Format	Manual Format		NZPIM 3rd Edition has a more 'casual' tone and format style than the WRc and WSAA. A balance is required in the manual content - it needs to be state the particular needs to be satisfied in undertaking an inspection (as it is the basis for undertaking inspections and therefore a reference manual and part specification) and it also needs to provide guidance or instruction on how to do tasks.	How does the industry interpret the format of the current pipe inspection manual. Is there a need to change the format?
Pressure Pipelines	Manual Scope		The NZPIM (and all of the other condition classification manuals) only cover internal inspection of gravity pipes. There are now more methodologies involving the internal inspection of pressure pipelines. Should the NZPIM include the inspection of pressure mains? For pressure mains is there sufficient, non supplier specific, methodologies to have a specific coverage. Pressure mains do not have generic condition classification codes and scoring methodology to determine the condition grade? There are already other manuals such as the AC manual	Consider whether the NZPIM should include the internal investigation of pressure mains.
Other inspection techniques	Manual Scope		There are a number of investigation methods for the internal inspection of pipelines other than CCTV. Common varieties in gravity pipes include Laser Profiling & Sonar Profiling. We have used gyro investigation (duct runner) to determine the center line position of pipes. For Pressure pipes the range of investigation techniques is much greater, and in some cases provider specific. 3D inspection technologies, such as Panaramo are becoming more widely used in place of the standard CCTV inspection systems. The software they use is compatible with the BS EN 13508-2 standard. The same software can be used using the NZPIM coding system by manual operator input. Laser profiling (and Sonar in the bigger pipes with more than 1/4 flow depth) are 'related' to CCTV as they are undertaken at the same time or in conjunction with CCTV. Other techniques tend to be 'stand alone' techniques in that they are not undertaken with CCTV A key element for consideration for this maybe what is the final "delivered" output and how is this translated into pipe condition, rather than the inspection techniques themselves (which can be supplier specific).	How many and to what level should the internal inspection techniques be covered? Consideration should be given to what is the scope or purpose of the manual.

Issue	Related to	Bibliography Ref.	Note	Issues
Pipe Cleaning method, pressure, flow rates	Pipe Cleaning	1,2,3,4, 21, 33	NZPIM 3rd Edition briefly covers recommended cleaning, considerations and basic machine capability within the "Good Practice" section. The general specification also covers some Cleaning (including flow & pressure for "light cleaning") and note on Cleaning pipes in poor condition. NZPIM Second edition did not covering cleaning, except in the model specification which has essentially the same text as the 3rd Edition. There is no Sewer jetting guideline or code of practice in NZ and no guidance to use of jetting with CCTV QUU have a Separate Cleaning Guideline for Sewers - this is not only for CCTV but in sewer cleaning in general.	How well does the current coverage of cleaning provide for the industry? Is there a need to give consideration for adding more guidance on Cleaning of pipelines with CCTV, with comment or methodology for working with jetters e.g. on removal of water & obstructions in front of camera, avoid damage to pipe or pipe repairs and recommended maximum operating pressures?
Condition Assessment & Risk Management Principals	Role in Asset Management	8	NZPIM has a section titled "CCTV and Asset Management" and this covers a brief description of Asset management, developing an inspection programme and basis of condition assessment. The introduction section called "The Role of CCTV Inspections" also covers a little bit about the information that can be obtained for asset a management. This information is OK, and generally aligns with IIMM, but it is "light" principally providing good information for contractors/Operators but perhaps could be strengthen and better aligned with the IIMM. it would not be ideal to 'duplicate' the IIMM content but could be along the lines of the IPWEA - NAMS.AU Condition Assessment and Asset Performance Guidelines (Preamble Document).	Consider updating/aligning the Asset Management text to IIMM
Specifications	Standard Documents		The NZPIM contains a general and specific CCTV specification and basis of payment. This has been used in many contracts through out NZ. This only covers 'planned inspections' and does not cover other types of CCTV inspection. Elements need to be updated. Other international manuals do not contain specifications.	Are standard documents still an important element of the NZPIM. How well does the NZ industry rate the existing specs for preparing contracts. Should they retained or updated. What would need updating? If retaining consideration should be given to expanding the specification to include provision for reactive inspection, build over inspections and as-built inspections.
Hand written Logsheet template	Templates	4	WSA05 & WRc have templates for CCTV logsheets, (and manhole inspection logsheets) but do not have any other template forms. NZPIM has templates for CCTV logsheet, Manhole inspection, summary reports.	Does anyone still use the hand written logsheet template? Query and consider whether hand written templates like the logsheet are still relevant or used

Issue	Related to	Bibliography Ref.	Note	Issues
Personnel Experience and Training	Training	6, 7, 19, 34	The Hong Kong Guidelines have very specific description of the required experience and training for all personnel (Project Leader to Operator) - contained in a table. PWC specify that CCTV Operators are required to hold a Statement of Attainment in NWP331B 'Perform conduit condition evaluation' issued by a RTO and based on WSA 05 WSA 05 suggests a minimum recognized operator qualifications and skills required for others. The NZPIM does not specify any specific qualifications or experience. Its only reference is under the "Good Practice Section", "What Checks Should the Client Undertake" where is suggest - "Prior to award – that the contractor has the experience and capability to carry out the work. The competence of the proposed operators should also be checked." Current NZQA qualifications for CCTV is unit standard 22107 - which is aimed at supervisors. The only training course is the ProjectMax courses and competency assessment.	Should there be a specified minimum level of experience or competency in the manual? Do we have an adequate nationally recognized (NZQA) unit standard (s) that could be specified. Consider including specify levels of experience and a definition of Competence. Query Conexis on updating/improving current unit standards for inclusion into update version.
Training certification programmes	Training	9	NAAPI offers a CCTV operator certification course	

From: Steven Apeldoorn
Sent: Friday, 8 July 2016 1:10 p.m.
To: Steven Apeldoorn
Subject: NZ Pipe Inspection Manual Survey

Greetings All,

Further to my email sent out yesterday, this email contains a link to the web-based industry survey form. The survey will take up to 15 - 20 minutes to complete. The purpose of the survey is to gain an understanding of how well the 3rd Edition of the New Zealand Pipe Inspection Manual (the manual) meets the water industry needs and identify potential areas of improvement, or expanded content that could be addressed during the revision of the existing manual.

The survey covers a number of topic sections

- Content Of The Existing Manual
- Sample Forms
- Manhole Inspections
- Pipe Cleaning
- Quality Of Deliverables
- Methods Of Inspecting Pipes
- Pressure Pipelines
- Training And Qualifications
- Data Quality Management
- Standard Documents
- Inspection Of Laterals
- Condition Codes
- Assessing Pipe Condition
- Assessing Inflow And Infiltration
- Acceptance Criteria For New/Rehabilitated Pipe
- Sharing And Bench Marking Of Pipe Inspection Data

All of the questions on these sections are optional. If you feel that you cannot answer the questions within any of the sections, you may move onto the next question. All of the sections also have space for general feedback, and we would encourage you to provide some comment in each section.

To complete the survey click on this link: http://goo.gl/forms/IwWunkxrIWYC4hJF3

If, for any reason, you are unable to access the web-based form, via the link above, please click here.

Please feel free to forward this email on to colleagues if you think there is someone who has not received an invitation to this survey that should have.

We ask that the survey is completed by Friday 22nd of July.

We will provide feedback once the results have been collated. Following the survey, the information collected will the provide guidance on the issues to be addressed by an industry steering group.

In addition to the survey, we will shortly provide a link to a website where additional feedback on the issues raised in the survey can be provided. Alternatively, please feel free to give any general feedback via email.

Thank you for your feedback. If you do not wish to participate in the survey, or received other emails about the survey, please click here to unsubscribe.

Regards

Steven Apeldoorn
Director

New Zealand Pipe Inspection Manual Survey

The purpose of this industry survey is to gain an understanding of how well the 3rd Edition of the New Zealand Pipe Inspection Manual (the manual) meets the water industry needs and identify areas of improvement, or expanded content, that could be addressed during revision of the existing manual

* Required

Information about you

The following information will help us to understand what role you and your organisation play within the industry

1. **Your name**

....

2. **Your organisation's name**

....

3. **What is the type of organisation?** *

Mark only one oval.

- ( ) Local Authority or water utility
- ( ) Engineering Consultants
- ( ) CCTV Contractor
- ( ) Pipe Rehabilitation Contractor
- ( ) Civil Contractor
- ( ) Plumbing or Drainlayers
- ( ) Equipment Supplier
- ( ) Software Provider
- ( ) Education/training
- ( ) I don't belong to an organisation
- ( ) Other

4. **What is your primary role in the organisation?** *
   Mark only one oval.

   - Owner
   - Manager
   - Asset Manager
   - Contracts Manager
   - Project Manager
   - CCTV Operator
   - Civil Engineer
   - Consultant
   - Operations Engineer
   - Software Engineer
   - Sales/Marketing
   - Other

5. **Are you answering this survey:** *
   Mark only one oval.

   - As an individual
   - On behalf of your organisation

Content of the Existing Manual

Thinking about the general content and layout of the information in the existing manual

6. **Rate the existing manual in terms of readability - how easy is it to follow?**
   Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very Poor											Excellent

7. **Rate the existing manual in terms of usability - does it meet your current needs?**
   Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very Poor											Excellent

8. **Rate the existing manual in terms of the level of supporting information or guidance provided to undertake pipe inspections**
   Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very Poor											Excellent

9. **What is unclear or confusing?**

10. **Tell us what you think overall could be improved or what is covered well.**

Sample Forms

Since the existing manual was published, in 2006, a lot of changes have occurred particularly in the uptake and use of software for capturing and reporting pipe inspections. The existing manual has a set of sample forms designed to enable capturing and reporting pipe inspection information using 'hand written' templates.

11. **Do you use any of the sample forms in the manual?**
    Check all that apply.
    - [ ] Yes
    - [ ] No

12. **If you answered yes, which sample form(s) do you use?**
    Check all that apply.
    - [ ] CCTV Inspection Logsheet (and Continuation Page)
    - [ ] Video Summary Sheet
    - [ ] CCTV Inspection Audit Report
    - [ ] Manhole Inspection Report

13. **Do you capture/manage inspection information electronically?**
    Mark only one oval.
    - ( ) Yes
    - ( ) No

14. **Are there any other types of sample forms that are not currently included in the manual that should be?**
    Mark only one oval.
    - ( ) Yes (please provide comment below)
    - ( ) No

15. **What other sample forms should be included in the manual?**

16. **Provide comment on how the sample forms could be improved or any alternative suggestions**

17. **If you use electronic forms for collecting/providing field data or reports, what format of e-form do you use?**
Check all that apply.

- [ ] Tablets/phone using inhouse or custom software
- [ ] Microsoft Office document (e.g. word or excel)
- [ ] Pdf form
- [ ] Cleanflow
- [ ] Wincan
- [ ] Other:

18. **If you use a mixture of 'hand-written' sample forms and e-forms what would be the approximate mix of hand-written to e-form?**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
All hand-written	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	All electronic

Manhole Inspections

One of the manual sample forms is for the inspection of manholes. The manual does not have a specified manhole inspection process or condition grades. The WRc and Australia's Manual for Sewer Condition Classification (WSA -05: 2008) both have specific sections relating to the inspection of manholes/chambers and have specific manhole defect and feature codes that have been adapted from the pipe codes.

19. **The manual should include specific manhole condition codes and grading methodologies**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Strongly Dissagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

20. **If you undertake manhole inspections, what processes or alternative manuals/guidelines do you use to assess the structural/service condition of structure?**
Check all that apply.

- [ ] New Zealand Pipe Inspection Manual sample form only
- [ ] NZWWA Visual Assessment of Utility Assets Guideline
- [ ] Internal developed specification and forms
- [ ] Other: ....

21. **Provide comment on what you suggest for the inspection and assessment of manholes or other structures (which could include inlets/outlets)**

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Pipe Cleaning

The existing manual has limited content regarding cleaning of pipelines prior to CCTV inspection. It does provide recommendations on when pipes should be cleaned, the timing prior to inspection, and other considerations prior to cleaning. By comparison, the WRc has a 42 page Sewer Jetting Code of Practice

22. **Rate the existing manual in terms of coverage of pipe cleaning associated with pipeline inspections**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
insufficient Coverage	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Adequate Coverage

23. **Provide comments on what could be improved regarding the cleaning of pipes**

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Quality of Deliverables

The quality of the deliverables supplied as part of a pipe inspection, for example the CCTV video image, is very important to ensure accurate reporting and assessment. The existing manual provides qualitative descriptions of the required output, such as: "The picture should sufficiently sharp" or "sufficient lighting" and "If not acceptable to the Engineer" etc. A list of examples of poor quality is also provided, such as , fog, cobwebs, debris on the camera lens, speed to fast etc.
The inspection equipment used for the pipe inspection also contributes to the level of quality. The accuracy of the inspection equipment currently only refers to the accuracy of measurement along the pipe (+/- 2% or 300mm, whichever is greater).The existing manual does not specify any other parameters for the inspection equipment.

24. **Rate the existing manual in terms of its coverage of the required quality of deliverables.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Inadequate covered	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Well covered

25. **Provide comment on what you believe could be improved with regard to defining and quantifying the minimum standards of quality outputs.**

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....

26. **Rate the existing manual in terms of its coverage of specifying required equipment capability or operating parameters.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Inadequate covered	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Well covered

27. **Provide comment on what you believe could be improved with regard to defining the level/range of equipment capability required.**

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Methods of Inspecting Pipes

The technology and methods available for the inspection and assessment of pipelines has increased over time. This includes laser profiling, sonar, electroscan, and 3D panoramic digital camera equipment.

28. **Please rate the existing manual's coverage of existing inspection methodologies.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Poorly Covered											Well Covered

29. **What inspection methodologies are not covered, or not covered adequately, that should be included in the manual?**

Pressure Pipelines

The inspection and condition assessment of pressure pipe uses quite different equipment and methods compared to the inspection of gravity pipes. The existing manual does not cover the inspection of pressure pipes.

30. **What guidelines do you currently use for the inspection and assessment of pressure Pipelines?**
Check all that apply.

- [ ] We don't carry out inspections of pressure pipelines
- [ ] NZ Asbestos Cement Watermain Manual
- [ ] IPWEA Condition Assessment and Asset Performance Manual
- [ ] We don't use a guideline
- [ ] Other:

31. **The inspection manual should cover the inspection and assessment of pressure pipes.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Strongly Dissagree											Strongly Agree

32. **Please provide your comments on the inclusion (or not) of inspection of pressure pipe as part of the pipe inspection manual.**

Training and Qualifications

The existing manual does not specify a minimum level of experience or qualifications for CCTV operators or people involved in the pipe inspection and condition assessment. The manual outlines that the Contractor needs to ensure that their staff "Have the experience, training and equipment to complete the work". By comparison some other international manuals outline defined minimum qualifications or experience required.

33. **There should there be a specified minimum level of experience or competency in the manual?**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Strongly Dissagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

34. **If a minimum level of skill or competency is specified, how would the level of skill or competency be defined. Would this vary depending on the role of the person or the size of the pipe?**

Data Quality Management

in 2005, as part of the industry survey prior to the revision of the 2nd edition of the manual, 42% of the surveyed Local Authorities or water utilities were not satisfied with the general quality of the CCTV data being provided. The existing manual outlines some of the key elements of quality management, the responsibilities of Councils and Contractors in undertaking inspections and what checks should be undertaken.

35. **How well overall does the existing manual serve the needs of data quality management?**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Does not meet the requirements	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	meets the requirements well

36. **To compare the survey results of 2005 in 2016, rate your satisfaction with the general quality of CCTV data being provided now.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very Dissatisfied	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very Satisfied

37. **What software is your organisation using to manage the storage and assessment of CCTV data?**
Check all that apply.

- [ ] Not using software to manage CCTV data
- [ ] Hansen/Infor
- [ ] AssetFinda
- [ ] Infonet
- [ ] Cleanflow
- [ ] Wincan
- [ ] Huefner
- [ ] SAP
- [ ] Other: ....

38. **Provide comment on what improvements could be made to data quality management.**

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Standard Documents

Standard documents in the manual, such as the Particular and General Specifications, Basis of Payment and Schedule of Prices have formed the backbone of most CCTV contracts in New Zealand,

39. **Standard documents are an important part of the manual.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Strongly Dissagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

40. **Rate how well the existing manual's standard documents provide for basis of preparing an pipe inspection tender document.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Does not meet our needs	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Meets our needs well

41. **Which document(s) do you think need updating to better provide a good template document for Councils to use in preparing tender documents?**
Check all that apply.

- [ ] Particular Specification
- [ ] General Specification
- [ ] Basis of Payment
- [ ] Schedule of Prices
- [ ] None of the documents, they all are adequate template documents

42. **Provide comment on what you think could be improved.**

Inspection of Laterals

The inspection of laterals pipes between between the house and the public main has specific challenges due to the size of pipe, limited access and bends that make it quite different to inspecting the mainline.

43. **Rate how well the existing manual covers the requirements for the inspection of laterals.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very Poorly	○	○	○	○	○	○	○	○	○	○	Very Well

44. **Provide comment on what you think could improve the coverage of the inspection of laterals?**

Condition Codes

The existing manual has 39 defect and feature codes. Along with the severity based (Small, Medium and Large) these are used to classify pipe structural and service condition..

45. **Please rate how adequately the existing defect codes and severity bands classify all of the different types of pipe defects and features.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not Very Well	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very Well

46. **Different pipe materials, pipe sizes and uses can affect how the pipe deteriorates and its Likelihood of Failure. Rate how well the existing manual covers the condition classification for all of the variable materials, size ranges and uses.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Could Do Better	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Covers it Adequately

47. **Are there any additional defect or feature codes required?**
Mark only one oval.

◯ Yes
◯ No

48. **What types of defects or features do you think require additional codes?**

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....
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49. **Aside from codes and severity bands, should there be other methods of defining/classifying pipe defects or features?**
Mark only one oval.

◯ Yes
◯ No

50. **What other methods of classifying defects of features should be used alongside the condition codes?**

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....
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51. **How well does the existing manual guide the user on how or what condition codes should be recorded when completing a pipe inspection report?**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very Poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very Well

52. **How well does the existing manual guide the user on how to interpret what the condition codes mean when reviewing a pipe inspection report?**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very Poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very Well

53. **Provide comment on what you think needs improving.**

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....

Assessing pipe Condition

The condition grades (1 – 5.8) outlined in the existing manual are not defined in the same way as other infrastructure asset management manuals, (e.g. International Infrastructure Management Manual (IIMM), NZ Infrastructure Asset Grading Guidelines (NZWWA) etc) . The grades are not defined in relation to expected remaining pipe life or possible actions required. For example, the manual refers to a pipe with a grading of 5 or more as being a ‘fail', but what is meant by a ‘fail’ is not defined. Many networks contain a significant proportion of pipes with this grading that are still functioning quite adequately..

54. **The manual's condition grading definitions and interpretation should be modified to align with other Asset Management Manuals.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Strongly Dissagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

55. **Rate the existing manual's pipe condition grading for use in asset management and renewal planning.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very Poor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very Good

56. **If the grading was to be aligned with another asset management manual, which manual or system would be the most appropriate.**

Mark only one oval.

- IIMM
- NZ Infrastructure Asset Grading Guidelines
- Other: ....

57. **Provide comments on how the manual's coverage of condition assessment could be improved or changed.**

....

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....

Assessing Inflow and Infiltration

One of the reason for carrying out CCTV pipe inspections in wastewater pipes is to identify sources of stormwater inflow and ground water infiltration. Some Councils have modified the condition codes or weighted defect scores to assess the 'leakiness' of laterals and mainlines. Some Councils have also used other, non CCTV inspection methods as part of the investigation

58. **Has your organisation used the North Shore City Council case study (refer section 4-11 of the existing manual), or a similar approach, to modify the scores and assessment criteria to determine pass or fail of laterals for infiltration ?**

Mark only one oval.

- Yes
- NO

59. **If you answered yes to the above, please rate how well the modified scores and assessment criteria performed for assessing the level of leakiness.**

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Poorly	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very Well

60. **Do you use other methods for identifying inflow/infiltration into pipelines?**

Mark only one oval.

- Yes
- No

61. **What other methods for identifying inflow/infiltration do you use?**

62. **There should be a specific method for assessing pipe leakiness provided in the manual.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Strongly Dissagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

Acceptance Criteria for New/Rehabilitated PIpe

Pipelines are also often inspected following the construction or rehabilitation of a pipeline to determine whether the construction meets the required standard. Some international manuals have criteria for determining if defects or features observed in the pipe are acceptable or not. The existing manual does not cover the acceptance criteria for new or rehabilitated pipe. Individual Councils and organisations such as SCIRT have developed their own criteria for determining what defects or features in new pipelines are acceptable or not.

63. **The manual should have a common set of CCTV acceptance criteria for new/rehabilitated pipe.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Strongly Dissagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

64. **Provide your comment on the inspection and assessment of new/rehabilitated pipe acceptability using CCTV. How can this be improved?**

Sharing and Bench marking of Pipe Inspection Data

Standardisation of pipe inspection reporting provides the ability to compare pipe condition over time across a network and share data or benchmarking of pipe condition with other water network operators

65. **Please rate the importance of the ability to share inspection data or benchmark pipe inspection data with other water networks operators within New Zealand.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not Important	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Very Important

66. **Please rate the importance of the ability to share inspection data or benchmark pipe inspection data with other water networks operators outside New Zealand (e.g. with Australian water utilities or European water utilities).**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not Important	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	Very Important

67. **Provide comment on sharing and bench marking of pipe inspection data.**

General Feedback

Are there any other issues or comments that you would like to add?

68. **Provide any additional comments on the issues discussed or on anything not covered in the survey.**

Thank you for completing the survey.

The information that you have provide through this survey will inform the revision of the New Zealand Pipe Inspection Manual.

Appendix 4 - Proposed Layout of Revised Manual

Manual Section & Title		Intent of the content and how the existing NZPIM could be re-organised
Part A - Introduction/General Requirements		
A1	Foreword	
A2	Chain of Custody Guide	New item describing where the NZPIM fits into the other Asset Management manuals
A3	Role for CCTV Inspections	Material previously included under the 'The Role of CCTV Inspections' covering 'What' do we mean by CCTV inspections and 'Why' CCTV inspections are undertaken.
Part B - Public Drains and Sewers		
B1	Requirements for Inspection of Drains and Sewers	
B1.1	Inspection Methods	Previously covered under 'The Tools' section (3). This section requires full revision and expansion to cover all inspection methods - a synopsis outlining the what each inspection method is for and its limitations.
B1.2	Inspection Equipment and Capability	This is a new section. This section will cover the range of inspection equipment in common use in NZ. This be a classification system so that Councils can specify the type of equipment required and its range. Also understand the expected level/quality of information that is expected to be received.
B1.3	Preparation of Drains and Sewers for Inspection	New section covering cleaning and preparation of the sewers for inspection. Cleaning is currently covered under "Good Practice" section (2). This section will expand on the cleaning giving guidance on the level of cleaning required for different types of inspections, based on measurable / quantifiable outcomes. In particular maximum pump pressures and flow rates to achieve outcomes while minimising damage to conduits, processes for preventing blow backs, better description of light and heavy cleaning. Will also cover other items such as information required prior to undertaking inspection, notifications prior to cleaning etc.
B1.4	CCTV Camera Operation	Previously covered under 'Good Practice' section (2). This section requires a revision / updating of the current content to provide guidance on the operation of the CCTV equipment including more diagrams and images to guide operators, including setup of cameras at start of inspection / end of inspection, and guidance on

		operation of cameras during inspection including stopping at defects, panning, tilting, taking of photographs etc. Other guidance would include removal of water and avoidance of other issues that may affect the view/inspection of the pipe.
B2	The description and Reporting of Inspection Observations	
B2.1	Coding Principals	Previously covered under 'Good Practice' section (2). This section is intended to outline the how the recording of defects, including means of measuring their quantification. This is a revision and expansion of the existing content.
B2.2	Header Information	Previously covered under 'Good Practice' section (2). This section specifically contains the information required for the inspection headers. This is a revision/updating of existing content. No particular changes are required other than rationalisation of fields for the modern context.
B2.3	Condition Codes	Previously covered under 'Condition Codes' section (6). This requires updating existing photos and descriptions. Also include more examples for lined/ rehabilitated pipe. Additional codes to be added.
B3	Interpretation of Inspection Results	
B3.1	Scoring Analysis	Previously under "CCTV and Asset Management" section (4). Requires modification to weighted scores and grading threshold tables to (i) align peak scores with condition grading, (ii) remove mean score for assigning condition grade.
B3.2	Condition Grading	Previously under "CCTV and Asset Management" section (4). Requires modication of grading descriptions to align with Meta Data standards / IIMM / NZ Asset grading
B3.3	Assessment of Remaining Life	New section and content giving AM guidance to assessment of remaining life from inspection data
B3.4	Assessment of New Pipe	New section and content giving AM guidance to lined / rehabilitated pipe acceptance assessment based on pipe inspection
B3.5	Assessment of Rehabilitated Pipe	New section and content giving AM guidance to new pipe acceptance assessment based on pipe inspection
B3.6	Assessment of Infiltration	New Section and content giving AM guidance on assessment of infiltration/pipe leakiness based on pipe inspection data

<table>
<tr><td colspan="3">Part C - Private Drains & Sewers</td></tr>
<tr><td></td><td colspan="2"><u>Entirely new section and content</u> to cover the inspection of private drains and sewers. This section will cover specific differences with the private sewers (including bends, fittings, material specific issues). Condition coding to be based on the Public Drains and Sewers section. Provide examples, weighted scores for assessment of infiltration / leakiness surveys</td></tr>
<tr><td colspan="3">Part D - Manholes and Chambers</td></tr>
<tr><td>D1</td><td>Requirements for Inspection of Manholes and Chambers</td><td rowspan="17"><u>Entirely new section and content</u> to cover the inspection of manholes. This provides for a set of condition codes to assess structural condition (same as pipe) by treating the manhole as a vertical pipe. Codes and processes based on what Christchurch City Council has developed and similar to WRc and WSA05. Format to follow the same as the Public Drains and Sewers</td></tr>
<tr><td>D1.1</td><td>Inspection Methods</td></tr>
<tr><td>D1.2</td><td>Inspection Equipment and Capability</td></tr>
<tr><td>D1.3</td><td>Preparation of Manholes and Chambers for Inspection</td></tr>
<tr><td>D1.4</td><td>Inspection Operation</td></tr>
<tr><td>D2</td><td>The description and Reporting of Inspection Observations</td></tr>
<tr><td>D2.1</td><td>Coding Principals</td></tr>
<tr><td>D2.2</td><td>Header Information</td></tr>
<tr><td>D2.3</td><td>Condition Codes</td></tr>
<tr><td>D3</td><td>Interpretation of Inspection Results</td></tr>
<tr><td>D3.1</td><td>Scoring Analysis</td></tr>
<tr><td>D3.2</td><td>Condition Grading</td></tr>
<tr><td>D3.3</td><td>Assessment of Remaining Life</td></tr>
<tr><td>D3.4</td><td>Assessment of New Manholes and Chambers</td></tr>
<tr><td>D3.5</td><td>Assessment of Rehabilitated Manholes</td></tr>
<tr><td>D3.6</td><td>Assessment of Infiltration</td></tr>
</table>

Part E - Quality Control and Management		
	Previously covered under ‘Good Practice’ section (2) under item 2.5. Requires updating and expansion to include (i) the auditing of Operator/camera operation (in addition to coding accuracy); (ii) Operator Training and qualifications/competency, (iii) field checks, (iv) Equipment quality checks. This part shall also include the general Health and Safety sections that were also under ‘Good Practice’ section (2) under chapter 2.6 Being Safe.	
Part F - Planning Inspections		
	Previously covered under "The Role of CCTV Inspections" section (1) and ‘CCTV and Asset Management’ chapters 4.1 and 4.2. Requires revision / update to guide AM on planning pipe inspections for various drivers.	
Appendices		
Appendix 1	Model Specification	Previously covered under ‘Standard Document’ section (5). Current content requires updating. A new specification is required for the Manhole and Chamber inspections and inspection of Private Drains and Sewers (Laterals).
Appendix 2	Sample Forms	Previously covered under ‘Sample Forms’ section (7). Current sample forms need updating. Update requires replacement of the existing manhole inspection form with a form that aligns with the new Manhole and Chamber Inspection requirements and specification. Similar to a CCTV Logsheet (based on CCC report / WSA05 manhole inspection report). [*If the condition (classification) coding system was to change to WSA05 the CCTV Logsheet and CCTV Logsheet Continuation page would need to be completely revised*.]
Appendix 3	Acronyms	This is new component
Appendix 4	Glossary of Terms	Update content originally within the existing manual Glossary

Title	**Demonstrate knowledge of CCTV inspection of non-pressure water services assets**		
Level	**3**	**Credits**	**4**

Purpose	People credited with this unit standard are able to: describe the role of closed circuit television (CCTV) in non-pressure water services asset management; describe the preparation of assets for survey by CCTV; and describe procedures for survey of assets using a CCTV, and recording and/or coding pipe conditions.

Classification	Water Industry > Water Reticulation

Available grade	Achieved

Entry information	
Critical health and safety prerequisites	[Only appears if populated.]
Recommended skills and knowledge	[Only appears if populated.]

Criteria for Merit	[Only appears if populated.]

Criteria for Excellence	[Only appears if populated.]

Explanatory notes

1 Legislation and references relevant to this unit standard include: Local Government Act 2002, Resource Management Act 1991, and Health and Safety at Work Act 2015, and subsequent amendments;
New Zealand Pipe Inspection Manual (current edition), available from http://www.waternz.org.nz.

2 Definitions
Organisational procedures – instructions to staff and procedures which are documented in memo or manual format and are available in the workplace. These procedures include but are not limited to – site specific procedures, laboratory procedures, manufacturers' specifications, product quality specifications and reference to legislative or regulatory procedures relevant to the industry.

Non-pressure water services – in this context refers to all pipe systems, pumping systems, and components that contribute to the collection and disposal of wastewater and stormwater.

Outcomes and evidence requirements

Outcome 1

Describe the role of closed circuit television (CCTV) in non-pressure water services asset management.

Evidence requirements

1.1 CCTV inspection is described in terms of its uses and limitations, and the types of assets that can be inspected.

1.2 CCTV inspection is described in terms of the types of information that can and cannot be determined from an inspection.

1.3 Information determined from CCTV inspection is described in terms of its applications in non-pressure water services asset management.

1.4 CCTV inspection is described in terms of considerations for ensuring inspections serve their intended purpose.

Outcome 2

Describe the preparation of assets for survey by CCTV.

Evidence requirements

2.1 Hazards associated with CCTV inspection of assets are described in terms of organisational procedures for their mitigation.

2.2 Considerations for determining whether a pipe should be cleaned in preparation for inspection by CCTV are described in accordance with organisational procedures.

2.3 Processes for cleaning pipes in preparation for CCTV inspection are described in terms of protection of pipes and adjacent assets and removal of debris.

2.4 Provisions for flow management while inspection is carried out with CCTV are described in accordance with site conditions.

2.5 Inspection using CCTV is described in terms of the relationship between pipe cleaning and accuracy of results.

Outcome 3

Describe procedures for survey of assets using a CCTV, and recording and/or coding pipe conditions.

Evidence requirements

3.1 Procedures for survey of assets in a systematic manner are described in accordance with organisational procedures.

Range planning, direction and speed of camera in relation to pipe size, start and finish location, required picture quality, screen header contents, on-screen displays.

3.2 Procedures for recording and identifying pipe material, pipe sizes, joint spacing, pipe use, and depth to invert are described in accordance with organisational procedures.

3.4 Procedures for recording and/or coding pipe defects or features are described in accordance with organisational procedures.

Replacement information	This unit standard replaced unit standard nnnnn. [Only appears if populated.]

Planned review date	31 December 2021

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1		

Consent and Moderation Requirements (CMR) reference	0101

This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.

Please note
Providers must be granted consent to assess against standards (accredited) by NZQA, before they can report credits from assessment against unit standards or deliver courses of study leading to that assessment.

Industry Training Organisations must be granted consent to assess against standards by NZQA before they can register credits from assessment against unit standards.

Providers and Industry Training Organisations, which have been granted consent and which are assessing against unit standards must engage with the moderation system that applies to those standards.

Requirements for consent to assess and an outline of the moderation system that applies to this standard are outlined in the Consent and Moderation Requirements (CMRs). The CMR also includes useful information about special requirements for organisations wishing to develop education and training programmes, such as minimum qualifications for tutors and assessors, and special resource requirements.

Comments on this unit standard

Please contact the Infrastructure Industry Training Organisation qualifications@connexis.org.nz if you wish to suggest changes to the content of this unit standard.

Title	**Carry out CCTV inspection of non-pressure water services assets**		
Level	**4**	**Credits**	**6**

Purpose	People credited with this unit standard are able to: prepare to carry out closed circuit television (CCTV) inspection of non-pressure water services assets; select and set up CCTV equipment for inspection of non-pressure water services assets; and carry out a CCTV inspection of non-pressure water services assets.

Classification	Water Industry > Water Reticulation

Available grade	Achieved

Entry information	
Critical health and safety prerequisites	[Only appears if populated.]
Recommended skills and knowledge	[Only appears if populated.]

Criteria for Merit	[Only appears if populated.]

Criteria for Excellence	[Only appears if populated.]

Explanatory notes

1 Legislation and references relevant to this unit standard include: Local Government Act 2002, Resource Management Act 1991, and Health and Safety at Work Act 2015, and subsequent amendments;
New Zealand Pipe Inspection Manual (current edition), available from http://www.waternz.org.nz.

2 Definitions
Organisational procedures – instructions to staff and procedures which are documented in memo or manual format and are available in the workplace. These procedures include but are not limited to – site specific procedures, laboratory

procedures, manufacturers' specifications, product quality specifications and reference to legislative or regulatory procedures relevant to the industry.
Non-pressure water services – in this context refers to all pipe systems, pumping systems, and components that contribute to the collection and disposal of wastewater and stormwater.

Outcomes and evidence requirements

Outcome 1

Prepare to carry out closed circuit television (CCTV) inspection of non-pressure water services assets.

Evidence requirements

1.1 Planning for inspection is carried out in accordance with organisational procedures.

Range access, notifications, pipe cleaning, equipment, work instructions, known history/problems.

1.2 Provisions for ensuring safety during CCTV inspection are implemented in accordance with organisational procedures.

1.3 Provisions for managing flow during CCTV inspection are implemented in accordance with organisational procedures.

Outcome 2

Select and set up CCTV equipment for inspection of non-pressure water services assets.

Evidence requirements

2.1 CCTV and equipment are selected in accordance with pipe size, type, and length, depth of manhole, and flow conditions.

2.2 CCTV is positioned in the manhole or pipe in accordance with pipe size, type, and length, depth of manhole, and flow conditions.

2.3 CCTV settings are adjusted in accordance with site conditions.

Range recording, lighting, focus lens angle, camera head, screen header information, preset distance.

Outcome 3

Carry out a CCTV inspection of non-pressure water services assets.

Evidence requirements

3.1 View of manhole and entry into the pipe is recorded at the start of the inspection in accordance with organisational procedures.

3.2 Camera speed, alignment, distance measurement counter and camera head position are maintained in accordance with organisational procedures.

3.3 Conditions in pipe that might affect the inspection, and camera settings, are monitored to ensure the required inspection quality is met in accordance with organisational procedures.

Range debris, fat, roots, cobwebs, fog, grease or water on lens flow depth, lighting.

3.4 All pipe defects and features are identified and recorded in accordance with organisational procedures.

Range position of camera to view the defect/feature, stationary time, still images, pan and tilt.

3.5 Inspection is ended with recording of correct screen header in accordance with organisational procedures.

Replacement information	This unit standard replaced unit standard nnnnn. [Only appears if populated.]

Planned review date	31 December 2021

Status information and last date for assessment for superseded versions

Process	**Version**	**Date**	**Last Date for Assessment**
Registration	1		

Consent and Moderation Requirements (CMR) reference	0101

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Requirements for consent to assess and an outline of the moderation system that applies to this standard are outlined in the Consent and Moderation Requirements (CMRs). The

CMR also includes useful information about special requirements for organisations wishing to develop education and training programmes, such as minimum qualifications for tutors and assessors, and special resource requirements.

Comments on this unit standard

Please contact the Infrastructure Industry Training Organisation qualifications@connexis.org.nz if you wish to suggest changes to the content of this unit standard.

Title	Report on pipe condition for a CCTV inspection of non-pressure water services assets		
Level	4	Credits	4

Purpose	People credited with this unit standard are able to, for non-pressure water services assets: complete closed circuit television (CCTV) inspection header information; and identify and code defects and features within non-pressure water services assets.

Classification	Water Industry > Water Reticulation

Available grade	Achieved

Entry information	
Critical health and safety prerequisites	[Only appears if populated.]
Recommended skills and knowledge	[Only appears if populated.]

Criteria for Merit	[Only appears if populated.]

Criteria for Excellence	[Only appears if populated.]

Explanatory notes

1 Legislation and references relevant to this unit standard include: Local Government Act 2002, Resource Management Act 1991, and Health and Safety at Work Act 2015, and subsequent amendments;
New Zealand Pipe Inspection Manual (current edition), available from http://www.waternz.org.nz.

2 Definitions
Organisational procedures – instructions to staff and procedures which are documented in memo or manual format and are available in the workplace. These procedures include but are not limited to – site specific procedures, laboratory procedures, manufacturers' specifications, product quality specifications and reference to legislative or regulatory procedures relevant to the industry.

Non-pressure water services – in this context refers to all pipe systems and components that contribute to the collection and disposal of wastewater and stormwater.

3 The accuracy level required for ER 2.1 is determined by the data audit procedures described in the *New Zealand Pipe Inspection Manual.*

Outcomes and evidence requirements

Outcome 1

Complete CCTV inspection header information non-pressure water services assets.

Evidence requirements

1.1 Details of the inspected asset are recorded in accordance with organisational procedures.

Range asset ID, pipe length, pipe material, joint spacing, pipe size, pipe shape, pipe use.

1.2 Pipe location details are recorded in accordance with organisational procedures.

Range upstream/downstream node ID and type, depth to invert.

1.3 Pipe inspection details are recorded in accordance with organisational procedures.

Range client, inspection date and time, setup, completion status, pipe condition status.

Outcome 2

Identify and code defects and features within non-pressure water services assets.

Evidence requirements

2.1 All defects and features are recoded on CCTV inspection logsheet report to an accuracy level of 95%.

Range defects including severity band, feature codes, distance to defects/features, clock references, mandatory remarks.

2.2 Still images are captured in the logsheet report in accordance with organisational procedures.

Replacement information	This unit standard replaced unit standard nnnnn. [Only appears if populated.]

Planned review date	31 December 2021

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1		

Consent and Moderation Requirements (CMR) reference	0101

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Requirements for consent to assess and an outline of the moderation system that applies to this standard are outlined in the Consent and Moderation Requirements (CMRs). The CMR also includes useful information about special requirements for organisations wishing to develop education and training programmes, such as minimum qualifications for tutors and assessors, and special resource requirements.

Comments on this unit standard

Please contact the Infrastructure Industry Training Organisation qualifications@connexis.org.nz if you wish to suggest changes to the content of this unit standard.

Appendix 6 - Comparison of Pipe Grading Descriptions

Grade	Current NZPIM definition	Infrastructure Asset Grading Guideline	IIMM	Meta-Data Standards	WSAA (WSA 05) Structural Condition	WSAA (WSA 05) Service Condition
1	**Excellent** (No Description)	**Very Good** Modern pipe material designed to current standards with no structural defects and no evidence of internal or external degradation.	**Very Good**	**Very Good** As new condition (No observable defects or deterioration)	Insignificant deterioration of the sewer has occurred. Appears to be in good condition	No or insignificant loss of hydraulic performance has occurred. Appears to be in good condition and there is little likelihood of sewer surcharge or overflow
2	**Good** (No Description)	**Good** As condition 1 but not designed to current standards in respect of manufacturer's specification, jointing or corrosion protection. Some deterioration, for example, circumferential cracking or minor joint defects causing minimum influence on performance	**Good** Minor Defects Only	**Good** Superficial deterioration only (No defects evident that if worsened would result in asset failure)	Minor deterioration of the sewer has occurred. Minor defects are present	Minor defects are present causing minor loss of hydraulic performance and/or minor likelihood of sewer discharge
3	**Moderate** (No Description)	**Moderate** Sewer pipes which are generally sound, although with some defects (for example deformation 0% to 5% and cracked or fractured or longitudinal/multiple cracking or occasional fractures or external pipe wall degradation) over not more than 25% of the length. Some deterioration beginning to be reflected in performance.	**Fair to Moderate** Maintenance required to Return to Accepted Level of Service	**Adequate** Defects and/or deterioration evident (Defects evident that if worsened could result in asset failure)	Moderate deterioration of the sewer has occurred. Developed defects are present but not affecting short term structural integrity	Developed defects are present causing moderate loss of hydraulic performance and/or moderate likelihood of sewer surcharge and possible overflow
4	**Poor** (No Description)	**Poor** Sewer pipes with a significant level of defects (for example, deformation 5% to 10% and cracked or fractured or broken or serious loss of level or external pipe wall degradation) over not more than 50% of the length causing, or likely to cause, a marked deterioration in performance in the medium term. Some asset replacement or rehabilitation needed within the medium term.	**Poor** Consider Renewal	**Poor** Significant defects and/or serious deterioration evident (Significant defects and/or serious deterioration affecting an asset's structural integrity evident)	Serious deterioration of the sewer has occurred. Significant defects are present affecting structural integrity	Significant defects are present causing serious loss of hydraulic performance and/or significant likelihood of sewer surcharge and overflow
5	**Fail** (No Description)	**Very Poor** Unsound Sewer pipes with a high level of defects (for example, deformation > 10% and cracked or fractured or broken, already collapsed or extensive areas of missing fabric), or grade for over > 50% of length, causing unacceptable performance. No life expectancy, requiring urgent replacement or rehabilitation.	**Very Poor** Approaching Unserviceable	**Very Poor** Asset has failed or failure is imminent (If the asset had not already failed it could fail at any time)	Failure of the sewer has occurred or is imminent	Failure of the sewer has occurred or is imminent

Appendix 7 - Comparison between the WSA 05-2008-2.2, Conduit Inspection Reporting Code of Australia and The New Zealand Pipe Inspection Manual, 3rd Edition 2006

WSA05 Codes									NZPIM Codes				
Main Code	**Description**	**Ch1**	**Description**	**Ch2**	**Description**	**Quantification 1**			**Main Code**	**Description**	**Band**	**Description**	**Definition**
C	Cracking	L	Longitudinal	S	Surface Crack	Estimate or measure the width of the crack in mm		Difference between Cracking & Fracturing is the opening/separation of the crack. Cracking/Fracturing Multiple overlaps with the NZPIM Pipe Broken (PB).	CL	Cracking Longitudinal	S	Small	**Small** = Crack is present but does not extend all of the way through the pipe wall **Medium** = Crack is open and possibly the crack extends all the way through the pipe wall **Large** = The is clear visual evidence that the crack extends all the way through the pipe wall (this may include displacement of the pipe wall at the crack)
C	Cracking	C	Circumferential	W	Wall Crack				CL	Cracking Longitudinal	M	Medium	
C	Cracking	M	Multiple						CL	Cracking Longitudinal	L	Large	
									CC	Cracking Circumferential	S	Small	
									CC	Cracking Circumferential	M	Medium	
									CC	Cracking Circumferential	L	Large	
									CM	Cracking Multiple	S	Small	
									CM	Cracking Multiple	M	Medium	
									CM	Cracking Multiple	L	Large	
C	Cracking	S	Simple										No Cracking Simple in NZPIM, this would be recorded as Pipe Broken (break defined by the crack forming a 'block' with the joint).
F	Fracturing	L	Longitudinal			Estimate or measure the width of the crack in mm							
F	Fracturing	C	Circumferential										
F	Fracturing	S	Simple										
F	Fracturing	M	Multiple										
B	Breaking	D	Displaced			Record the length of break to the nearest 100mm			PB	Pipe Broken	S	Small	**Small** = broken pieces are up to 10% of the pipe circumference and either not displaced or displaced by less than the pipe wall thickness **Medium** = broken pieces are up to 20% of the pipe circumference and either not displaced or displaced by less than the pipe wall thickness **Large** = broken pieces are more than 20% of the pipe circumference or displaced by more than the pipe wall thickness or maybe missing Differs from WSA05 in that movement of the pieces or distortion of the pipe does not have to occurred. For the smaller bands (Small & Medium) this defect is defined by the pipe wall broken by the cracks forming pieces (extension of Cracking Multiple) WSA05 Breaking is also used to cover the NZPIM "PH" Pipe Holed - WSA05 does not have a specific PH equivalent code.
B	Breaking	M	Missing						PB	Pipe Broken	M	Medium	
B	Breaking	E	Exception						PB	Pipe Broken	L	Large	
D	Deformation	V	Vertical			Record the % change in diameter for deformation in 5% increments	Measure and record the total length of the deformation (if less than 1m)	Longitudinal Cracking present is coded separately	DF	Deformed Pipe	M	Medium	**Medium** = Deformation/Ovality up to 10% (identified by the 3(+) longitudinal cracks **Large** = Deformation/Ovality >10% The Longitudinal Cracks are not coded separately - they are deemed included in the DF code.
D	Deformation	H	Horizontal						DF	Deformed Pipe	L	Large	
D	Deformation	M	Mixed						PF	Deformed Plastic Pipe	S	Small	**Small** = Deformation/Ovality up to 10% **Medium** = Deformation/Ovality >10% up to 25% **Large** = Deformation/Ovality >25%
									PF	Deformed Plastic Pipe	M	Medium	
									PF	Deformed Plastic Pipe	L	Large	
X	Collapsed Conduit					Record the length of affected conduit		Includes Deformation > 25%	PX	Pipe Collapsed	L	Large	No remaining conduit. If there is some remaining conduit, this is coded as DF
S	Surface Damage	W	Wall Roughened			Estimate the % reduction in cross sectional area			SD	Surface Damage	S	Small	**Small** = Damage effect has minor defect on the integrity of pipe wall **Medium** = Damage effect has moderate defect on the integrity of pipe wall **Large** = Damage effect has significate defect on the integrity of pipe wall The nature and type of Surface damage is recorded in the Remarks
S	Surface Damage	S	Spalling						SD	Surface Damage	M	Medium	
S	Surface Damage	AV	Aggregate Visible						SD	Surface Damage	L	Large	
S	Surface Damage	AP	Aggregate Protruding										
S	Surface Damage	AM	Aggregate Removed										
S	Surface Damage	RC	Reinforcement Corroded										
S	Surface Damage	RV	Reinforcement Visible										
S	Surface Damage	RVP	Reinforcement Visible Projecting										
S	Surface Damage	CP	Corrosion Products Visible										
S	Surface Damage	T	Tuberculation										
S	Surface Damage	H	Holed										
S	Surface Damage	WS	Wall Staining										
S	Surface Damage	Z	Other										
SV	Soil Visible Through Defect												Most likely that this would be recorded using the "GC" General Comment code with remarks describing the occurrence.
VV	Void Visible Through Defect								TM	Tomo	L	Large	Large Severity is the default band to be recorded, no specific meaning other than coding requirement.
PP	Porous Conduits (Pipes)												Most likely that this would be recorded using the "GC" General Comment code with remarks describing the occurrence.
DB	Displaced Bricks	I	Moving Inwards			Record the total length of conduit over which the displacement occurs	Record the maximum displacement of the most affected brick(s) or masonry unit(s) in mm						NZPIM does not cover specific defects occurring in Brick or Masonry Pipes
DB	Displaced Bricks	O	Moving Outwards										
MB	Missing Bricks	V	More Bricks Visible										
MB	Missing Bricks	NV	No More Bricks Visible										
DI	Dropped Invert					Record the depth of drop in mm							
BS	Brick Separation					Record the total length of conduit over which the separation occurs	Estimate or measure & record the typical separation of brick courses in mm						

WSA05 Codes									NZPIM Codes				
Main Code	**Description**	**Ch1**	**Description**	**Ch2**	**Description**	**Quantification 1**			**Main Code**	**Description**	**Band**	**Description**	**Definition**
XB	Brick Conduit Collapsed						Record the length of affected conduit		PX	Pipe Collapsed	L	Large	
MM	Missing Mortar	S	Shallow										
MM	Missing Mortar	M	Moderate										
MM	Missing Mortar	T	Thick										
DE	Deposits on the Wall and in the Invert	F	Fouling			Estimate & record the % reduction in Cross-sectional area		This relates to an organism or growth attached to the walls					
DE	Deposits on the Wall and in the Invert	G	Grease on Wall						DG	Debris Greasy	S	Small	**Small** = Deposits up to 10% of the Pipe Diameter **Medium** = Deposits >10% up to 25% of the Pipe Diameter **Large** = Deposits >25% of the Pipe Diameter For Debris Silty, the Nature/Type of deposit is recorded in the Remarks
									DG	Debris Greasy	M	Medium	
									DG	Debris Greasy	L	Large	
DE	Deposits on the Wall and in the Invert	E	Encrustation on Wall						ED	Encrustation Deposit	S	Small	
									ED	Encrustation Deposit	M	Medium	
									ED	Encrustation Deposit	L	Large	
DE	Deposits on the Wall and in the Invert	S	Invert Sediments - fine						DE	Debris Silty	S	Small	
DE	Deposits on the Wall and in the Invert	R	Invert Sediments - Coarse						DE	Debris Silty	M	Medium	
DE	Deposits on the Wall and in the Invert	C	Invert Sediments - Compacted						DE	Debris Silty	L	Large	
DE	Deposits on the Wall and in the Invert	Z	Invert Sediments - Other										
EX	Exfiltration												NZPIM does not cover Exfiltration
I	Infiltration	S	Sweating/seepage						IP	Infiltration Present	S	Small	**Small** = Seeping or Dripping **Medium** = Running **Large** = Gushing or Jetting
I	Infiltration	D	Dripping						IP	Infiltration Present	M	Medium	
I	Infiltration	R	Running						IP	Infiltration Present	L	Large	
I	Infiltration	G	Gushing										
OB	Obstruction	B	Brick			Estimate & record the % reduction in Conduit Cross Section	Record "H" for Hazard to draw attention to potentially major problem requiring urgent attention, otherwise leave blank		OT	Obstruction Temporary	S	Small	**Small** = Obstruction up to 10% of the Pipe Diameter **Medium** = Obstructions >10% up to 25% of the Pipe Diameter **Large** = Obstructions >25% of the Pipe Diameter The Nature/Type of the obstruction is recorded in the Remarks
OB	Obstruction	M	Conduit Material						OT	Obstruction Temporary	M	Medium	
OB	Obstruction	Z	Other						OT	Obstruction Temporary	L	Large	
OB	Obstruction	I	Wall Intrusion						OP	Obstruction Permanent	S	Small	
OB	Obstruction	J	Wedged Joint						OP	Obstruction Permanent	M	Medium	
OB	Obstruction	C	Object in Connection						OP	Obstruction Permanent	L	Large	
OB	Obstruction	P	External Cable or Pipe										
OB	Obstruction	S	Object built into Structure										
ING	Ingress of soil	S	Sand					ING is not used if soil is inside the pipe - in which case DE is used. When would this be used?	DE	Debris Silty	S	Small	The ingress of soil would be covered by NZPIM by Debris Silty (DE) If it is soil ingress from the outside of the pipe, this would be recorded in the remarks. The structural defect causing the ingress of soil would be coded separately.
ING	Ingress of soil	F	Fine Material						DE	Debris Silty	M	Medium	
ING	Ingress of soil	G	Granular						DE	Debris Silty	L	Large	
ING	Ingress of soil	Z	Other										
R	Roots	T	Tap			Estimate & record the % reduction in Conduit Cross Section			RI	Root Intrusion	S	Small	**Small** = Root Intrusion up to 10% of the Pipe Diameter **Medium** = Root Intrusion >10% up to 25% of the Pipe Diameter **Large** = Root Intrusion >25% of the Pipe Diameter The Nature/Type of the root intrusion is recorded in the Remarks
R	Roots	F	Fine						RI	Root Intrusion	M	Medium	
R	Roots	M	Mass Roots						RI	Root Intrusion	L	Large	
R	Roots	RT	Recently Cut Tap Roots										
R	Roots	RF	Recently Cut Tap Roots										
R	Roots	RB	Recently Cut Root Beard										
JD	Joint Displaced	R	Radial			Record Radial Displacement in Bands: S = 5 - 10mm M = 11 - 20mm [illegible]		Band Measurements of WSA05 is similar to the NZPIM severity bands	JD	Joint Displaced	S	Small	Small = Reduction in Diameter up to 10% of the Pipe Diameter Medium = Reduction in Diameter >10% up to 25% of the Pipe Diameter Large = Reduction in Diameter >25% of the Pipe Diameter
									JD	Joint Displaced	M	Medium	
									JD	Joint Displaced	L	Large	
JD	Joint Displaced	L	Longitudinal			Record longitudinal Displacement in Bands: S = 10 - 20mm M = 21 - 30mm L = >30mm For Angular displacement, the Angle of the displacement is recorded. If not able to be measured the field is left blank.			JO	Joint Open	S	Small	Small = Longitudinal Displacement up to 20mm Medium = Longitudinal Displacement >20mm up to 40mm Large = Longitudinal Displacement >40mm Angular Open joints are nor code differently than longitudinal displacement. If it is angular, this would be recorded in the Remarks.
JD	Joint Displaced	A	Angular						JO	Joint Open	M	Medium	
									JO	Joint Open	L	Large	
JI	Jointing Material (seal) Intrusion	R	Sealing Ring	N	Seal Not Intruding	Record the reduction in cross sectional area of the original seal gap at the area of the intrusion			JF	Joint Faulty	L	Large	NZPIM does not have a specific joint material intrusion code. This would be recorded using more than one code: the JF code would be used as the joint seal is faulty due the displacement of the sealing material. The OP code would be used due to the obstruction/reduction in the cross sectional area. The Bands are defined as follows: (JF) **Large** = Joint seal is faulty, there is a pathway from the outside to the inside of the pipe (OP) **Small** = Obstruction up to 10% of the Pipe Diameter (OP) **Medium** = Obstructions >10% up to 25% of the Pipe Diameter (OP) **Large** = Obstructions >25% of the Pipe Diameter
JI	Jointing Material (seal) Intrusion	Z	Other Sealant	HH	Seal Hanging High				OP	Obstruction Permanent	S	Small	
JI	Jointing Material (seal) Intrusion			HL	Sealing Hanging Low				OP	Obstruction Permanent	M	Medium	
JI	Jointing Material (seal) Intrusion			B	Seal Broken				OP	Obstruction Permanent	L	Large	

WSA05 Codes									NZPIM Codes				
Main Code	Description	Ch1	Description	Ch2	Description	Quantification 1			Main Code	Description	Band	Description	Definition
W	Weld Defect	L	Longitudinal					Mostly associated with Steel pipe welds. Scope includes for PE welds, but PE weld					NZPIM does not have a code for (steel) weld defects
W	Weld Defect	C	Circumferential										
W	Weld Defect	H	Helical										
CN	Connection	G	Good Workmanship	O	Open	Record the vertical height of the connecting conduit in mm	Record the horizontal size of the connecting conduit	WSA05 has specific codes for each type of connection onto the pipe, i.e. Stub 'connection' factory 'junction'.	LO	Lateral Open (OK)			NZPIM does not differentiate between the different types of connection. The type of connection i.e. Stub connection or factory junction is recorded in the Remarks. "LB is used where the connecting conduit is closed/capped. Where a connection or junction is faulty this is recorded using the LF code. The LF code covers the point of connection of the two conduits. **Small** = Poor seal but does not extend all of the way through the pipe wall
CN	Connection	P	Poor Workmanship	C	Connection Closed, Capped				LB	Lateral Blank			
									LF	Lateral Faulty	S	Small	
CI	Intruding Connection					Estimate and record the % reduction in the conduit cross sectional area.			LP	Lateral Protruding	S	Small	**Small** = Reduction in Diameter up to 10% of the Pipe Diameter **Medium** = Reduction in Diameter >10% up to 25% of the Pipe Diameter **Large** = Reduction in Diameter >25% of the Pipe Diameter
									LP	Lateral Protruding	M	Medium	
									LP	Lateral Protruding	L	Large	
CX	Defective Connection	P	Position Incorrect					WSA05 does not delineate any difference between the connection/junction on the main and the connecting conduit pipe extending away from it other than the Characterisation codes.	LF	Lateral Faulty	S	Small	Defects relating to the point where the connecting conduit joins the main pipe is covered by the "LF" code. **Small** = Poor seal or crack is present but does not extend all of the way through the pipe wall **Medium** = Poor seal or crack is open and possibly the crack extends all the way through the pipe wall **Large** = The is clear visual evidence that the poor seal or crack extends all the way through the pipe wall
CX	Defective Connection	G	Gap						LF	Lateral Faulty	M	Medium	
CX	Defective Connection	H	Half Gap						LF	Lateral Faulty	L	Large	
CX	Defective Connection	D	Damaged						LX	Lateral Problem	S	Small	Defects inside the lateral are recorded using the LX code. The Band is defined by the type of defect observed inside the connecting conduit; the Band description of the defect is the band description of the LX
CX	Defective Connection	B	Blocked						LX	Lateral Problem	M	Medium	
CX	Defective Connection	SR	Some Roots						LX	Lateral Problem	L	Large	
CX	Defective Connection	SE	Soil Entering										
CX	Defective Connection	Z	Other										
JN	Junction	G	Good Workmanship	O	Open	Record the vertical height of the connecting conduit in mm	Record the horizontal size of the connecting conduit	WSA05 has specific codes for each type of connection onto the pipe, i.e. Stub 'connection' factory 'junction'.	LO	Lateral Open (OK)			NZPIM does not differentiate between the different types of connection. The type of connection i.e. Stub connection or factory junction is recorded in the Remarks. "LB is used where the connecting conduit is closed/capped. Where a connection or junction is faulty this is recorded using the LF code. The LF code covers the point of connection of the two conduits. Small = Poor seal but does not extend all of the way through the pipe wall
JN	Junction	P	Poor Workmanship	C	Connection Closed, Capped				LB	Lateral Blank			
									LF	Lateral Faulty	S	Small	
JX	Junction Defective	P	Position Incorrect					WSA05 does not delineate any difference between the connection/junction on the main and the connecting conduit pipe extending away from it other than the Characterisation codes.	LX	Lateral Problem	S	Small	Defects inside the lateral are recorded using the LX code. The Band is defined by the type of defect observed inside the connecting conduit; the Band description of the defect is the band description of the LX
JX	Junction Defective	D	Damaged						LX	Lateral Problem	M	Medium	
JX	Junction Defective	B	Blocked						LX	Lateral Problem	L	Large	
JX	Junction Defective	BC	Branch Cracked										
JX	Junction Defective	SR	Some Roots										
JX	Junction Defective	SE	Soil Entering										
JX	Junction Defective	Z	Other										
PL	Lining Defective	D	Detached			Estimate and record the % reduction in conduit cross sectional area (where applicable).			PL	Lining Defective	S	Small	Small = Reduction in Diameter up to 10% of the Pipe Diameter Medium = Reduction in Diameter >10% up to 25% of the Pipe Diameter Large = Reduction in Diameter >25% of the Pipe Diameter The nature & type of liner defect is recorded in the Remarks
PL	Lining Defective	C	Discoloration						PL	Lining Defective	M	Medium	
PL	Lining Defective	E	End is Defective						PL	Lining Defective	L	Large	
PL	Lining Defective	W	Wrinkled	L	Wrinkling - Longitudinal								
PL	Lining Defective	W	Wrinkled	C	Wrinkling - Circumferential								
PL	Lining Defective	W	Wrinkled	M	Wrinkling - Multiple Patterns								
PL	Lining Defective	B	Blistered										
PL	Lining Defective	BU	Bulged										
PL	Lining Defective	WD	Weld Defective										
PL	Lining Defective	RC	Re-establishment of Connection Done Improperly										
PL	Lining Defective	L	Leak										
PL	Lining Defective	R	Roots										
PL	Lining Defective	RM	Rendered Mortar Missing										
PL	Lining Defective	SJ	Spiral Joints Separated										
PL	Lining Defective	PW	Poor Workmanship										
PL	Lining Defective	Z	Other										
RP	Point Repair	R	Pipe Replaced			Record the total length of the repaired section in mm where <1m			MC	Material Change			NZPIM does not have a specific repair point code. Effectively this is coved by the "MC" code identifying the change in material within the pipe due to a repair or partial replacement. Where a localised liner or patch has been installed the "LC" code would identify the start and end of the repair.
RP	Point Repair	L	Localised Lining						LC	Lining Change			
RP	Point Repair	I	Injected Mortar						GC	General Comment			
RP	Point Repair	S	Injected Sealant										
RP	Point Repair	H	Hole repaired						PH	Pipe Holed	S	Small	NZPIM uses PH S for pipe holes that have been 'repaired'. Small = Pipe Hole that has been covered/filled (with no evidence of pathway to the outside of the pipe)
RP	Point Repair	IC	Internal Clip										
RP	Point Repair	Z	Other										

WSA05 Codes									NZPIM Codes				
Main Code	**Description**	**Ch1**	**Description**	**Ch2**	**Description**	**Quantification 1**			**Main Code**	**Description**	**Band**	**Description**	**Definition**
RX	Defective Repair	M	Major Wall Gaps						GC	General Comment			NZPIM does not have a specific code for poor repair. This would be recorded using "GC" with a description of the poor workmanship in the Remarks. Where a PH repair is not effective (there is a pathway to the outside of the pipeline, this would be coded using
RX	Defective Repair	P	Patch										
RX	Defective Repair	B	Bellies in line										
RX	Defective Repair	Z	Other										
IF	Flow In Coming Conduit	C	Clear	O	Sewerage Out	Record the water level in the connecting Conduit as a % of the vertical dimension							NZPIM does not have a specific code for flow coming in from a connecting conduit. If observed would be recorded using "GC" with flow depth noted in the Remarks.
IF	Flow In Coming Conduit	T	Turbid	I	Stormwater In								
IF	Flow In Coming Conduit	YY	Cannot Tell										
L	Line of Conduit Deviates	L	Left	U	Up	Record total length of the curved section in mm where <1m			LL	Line Deviates Left			
L	Line of Conduit Deviates	R	Right	D	Down				LR	Line Deviates Right			
									LU	Line Deviates Up			
									LD	Line Deviates Down			
V	Vermin	R	Rodent	S	In the Conduit	Record the number of living creatures observed using Band codes as follows: S = Single living creature F = A few living Creatures i.e. 2 - 5 M = Many living Creatures i.e. >5							NZPIM does not have a specific code for vermin in the pipe or connecting conduits. If observed would be recorded using "GC" with the observations noted in the Remarks.
V	Vermin	Z	Other	C	In a Connection								
V	Vermin			J	In an Open Joint								
V	Vermin			Z	Other								
ST	Start Node	MH	Maintenance Hole			Node Reference	Grid Reference		IS	Inspection Starts			NZPIM does not differentiate all of the different Start node types, principally as the node types are identified in the inspection header. The type of node and the reference number is recorded in the Remarks.
ST	Start Node	MS	Maintenance Shat										
ST	Start Node	TMS	Terminal Maintenance Shaft										
ST	Start Node	RE	Rodding Eye										
ST	Start Node	IO	Inspection Opening										
ST	Start Node	LH	Lamphole										
ST	Start Node	IS	Inspection Shaft										
ST	Start Node	O	Outfall										
ST	Start Node	C	Major Connection										
ST	Start Node	VD	Vertical Drop										
ST	Start Node	DE	Dead End										
ST	Start Node	J	Junction										
ST	Start Node	SP	Side Entry Pit										
ST	Start Node	GP	Grated Inlet Pit										
ST	Start Node	Z	Other										
FH	Finish Node	MH	Maintenance Hole			Node Reference	Grid Reference		IE	Inspection Ends			NZPIM does not differentiate all of the different End node types, principally as the node types are identified in the inspection header. The type of node and the reference number is recorded in the Remarks.
FH	Finish Node	MS	Maintenance Shat										
FH	Finish Node	TMS	Terminal Maintenance Shaft										
FH	Finish Node	RE	Rodding Eye										
FH	Finish Node	IO	Inspection Opening										
FH	Finish Node	LH	Lamphole										
FH	Finish Node	IS	Inspection Shaft										
FH	Finish Node	O	Outfall										
FH	Finish Node	C	Major Connection										
FH	Finish Node	VD	Vertical Drop										
FH	Finish Node	DE	Dead End										
FH	Finish Node	J	Junction										
FH	Finish Node	SP	Side Entry Pit										
FH	Finish Node	GP	Grated Inlet Pit										
FH	Finish Node	Z	Other										
GC	General Comment								GC	General Comment			Same code
GP	General Photograph	L	Pointing Left						GC	General Comment			NZPIM does not have a specific code for General Photographs. Where a general photo is required "GC" is used.
GP	General Photograph	R	Pointing Right										
GP	General Photograph	F	Pointing Forward										
GP	General Photograph	B	Pointing Backward										
GV	General Video Clip	L	Pointing Left										General video clip is not a feature used here in NZ. This possibly tends to be software capable specific. Similar to photograph GC may be appropriate?
GV	General Video Clip	R	Pointing Right										
GV	General Video Clip	F	Pointing Forward										
GV	General Video Clip	B	Pointing Backward										
WL	Flow (water) Level	C	Clear			Record the depth of flow as a % of the diameter or vertical height to nearest 5%							NZPIM does not have a specific code for water level. GC would be used with depth of flow noted in the Remarks.
WL	Flow (water) Level	T	Turbid or Discolored										
GAS	Atmosphere in the Conduit	OD	Oxygen Deficiency			Record the % of gas where this is known	Record the concentration of as in ppm where this in known						NZPIM does not have a specific code for hazardous atmosphere, as has not be a process to record.
GAS	Atmosphere in the Conduit	HS	Hydrogen Sulphide										
GAS	Atmosphere in the Conduit	ME	Methane										
GAS	Atmosphere in the Conduit	F	Other Flammable Gas										
GAS	Atmosphere in the Conduit	Z	Other										
LOV	Loss of Vision	UW	Under Water										NZPIM does not have a specific code for loss of vision. This would be recorded using the GC code with the specifics noted in the Remarks
LOV	Loss of Vision	D	Debris										
LOV	Loss of Vision	S	Steam										
LOV	Loss of Vision	Z	Other/Unknown										
SA	Inspection (Survey) Abandoned	OB	Obstruction						IA	Inspection Abandoned			NZPIM does not differentiate all of the different reasons for abandonment, the code IA is used to identify that the inspection was not completed/abandoned. The reason for abandonment is recorded in the Remarks.
SA	Inspection (Survey) Abandoned	R	Roots										
SA	Inspection (Survey) Abandoned	HW	High Water										
SA	Inspection (Survey) Abandoned	EF	Equipment Failure										
SA	Inspection (Survey) Abandoned	D	Other										
LC	Change of Lining	MFL	Manufacturer's Lining		Report the material now used in the conduit lining using a standard set of material codes				LC	Lining Change			NZPIM does not differentiate all of the different lining types, the code LC is used to identify that there is a change in the lining used in the conduit (typically for repair). The type of material/process for the lining of the conduit is recorded in the Remarks.
LC	Change of Lining	SPL	Sprayed Lining										
LC	Change of Lining	CIP	Cured in place Lining										
LC	Change of Lining	SEG	Segmental Linings										
LC	Change of Lining	LDP	Lining with Discrete Pipes										
LC	Change of Lining	LCP	Lining with Continuous Pipes										
LC	Change of Lining	CFL	Close Fit Lining										
LC	Change of Lining	SWL	Spirally Wound Lining										
LC	Change of Lining	Z	Other										
MC	Change of Conduit Material				Report the new material using a standard set of material codes				MC	Material Change			Same Code. The new material is noted in the Remarks

WSA05 Codes									NZPIM Codes				
Main Code	**Description**	**Ch1**	**Description**	**Ch2**	**Description**	**Quantification 1**			**Main Code**	**Description**	**Band**	**Description**	**Definition**
PC	Change in Conduit Length				Report the new length in m of the individual conduit (pipe) units that now make up the conduit			This relates to the change in Joint Spacing, not the change in the pipe length.					NZPIM does not have a specific code for the change in the pipe joint spacing. This would be recorded using "GC" with the change noted in the Remarks.
RC	Change in Precipitation	N	Precipitation has stopped (None)										NZPIM does not have a specific code for the change in the precipitation. The type of precipitation (Weather) at the commencement of the inspection is recorded in the inspection header fields
RC	Change in Precipitation	R	Precipitation (Rain) has commenced										
RC	Change in Precipitation	S	Melting Snow or ice is entering (Snow)										
SC	Change in Cross Section	C	Circular			Record the height if the new cross section in mm	Record the width of the new cross section in mm (not required when height and width are the same)		DC	Dimension Change			NZPIM does not differentiate all of the different shapes, the code DC is used to identify that there is a change in either the shape or size of the conduit. The new shape or size (if it can be estimated) of the conduit is recorded in the Remarks.
SC	Change in Cross Section	R	Rectangular										
SC	Change in Cross Section	E	Oviform (Egg Shape)										
SC	Change in Cross Section	U	U-Shape										
SC	Change in Cross Section	A	Arch										
SC	Change in Cross Section	O	Oval										
SC	Change in Cross Section	X	Locally Defined Section										
SC	Change in Cross Section	Z	Other										
AC	Change Photographic Volume Reference					Record the reference number of the new film or CD Album							The NZPIM does not have a specific code for the change in the photographic volume reference - in fact it does not record the initial photographic volume reference either in the condition codes or the header fields.
TC	Change Video Volume Reference					Record the reference number of the new CD or DVD volume							The NZPIM does not have a specific code for the change in the Video reference. The video reference at the commencement of the inspection is recorded in the Inspection Header field. If there is a change this would be noted in the inspection header comments.
								WSA05 does not have a code for dips in pipes	DP	Dipped Pipe	S	Small	
									DP	Dipped Pipe	M	Medium	
									DP	Dipped Pipe	L	Large	
								WSA05 does not have a code for features built into pipes (such as inspection points, lifting eyes, etc.)	CF	Construction Feature			
								WSA05 does not have a specific code to defects that occur only at the joint. Defects associated with the joint are identified with the Joint association, which is a type of additional Characterisation.	JF	Joint Faulty	S	Small	Joint Faulty (JF) is used to identify any sealing or structural defect occurring within 100mm either side of the joint face (a total 200mm zone referred to as the 'joint zone'). This joint zone allows for the jointing mechanism and defects attributed to the JF indicate that the defects likely relate only to the joint itself and not to defects in the pipe beyond the joint. **Small** = There is a defect present, but there is no pathway to the outside of the pipe **Medium** = the defective seal or cracking may extend through to the outside of the pipe (Possible pathway) **Large** = There is clear visual evidence of a pathway to the outside of the pipe through the defects.
									JF	Joint Faulty	M	Medium	
									JF	Joint Faulty	L	Large	
								WSA05 does not have a specific code for Pipe Holes. WSA05 uses the Breaking codes for pipe holes - there is no differentiation between breaking form cracking or external impacts on the pipe.	PH	Pipe Holed	S	Small	**Small** = Pipe Hole that has been covered/filled, regardless of the size of the hole (with no evidence of pathway to the outside of the pipe) **Medium** = Pipe Hole, the size of the hole is up to 20% of the circumference **Large** = Pipe Hole, the size of the hole is > 20% of the circumference
									PH	Pipe Holed	M	Medium	
									PH	Pipe Holed	L	Large	

Appendix 8 - Proposed Modified Defect and Feature Codes

=New or Changed Codes

Defect Codes

Code Type	Main Code	Sub-Code Type	Characterisation	Full Code	Notes on proposed Changes
Brick Separation	BS			BS	added new codes (from WSA05) as NZPIM does not cover Brick Pipes
Brick Conduit Collapsed	BX			BX	
Cracks Longitudinal	CL			CL	Unchanged
Cracks Circumferential	CC			CC	Unchanged
Cracks Multiple	CM			CM	Unchanged
Displaced Bricks	DB	Moving Inwards	I	DBI	added new codes (from WSA05) as NZPIM does not cover Brick Pipes
	DB	Moving Outwards	O	DBO	
Debris Silty	DE			DE	Unchanged
Deformed Pipe	DF			DF	Unchanged
Debris Greasy	DG			DG	Unchanged
Dropped Invert (Brick Conduit)	DI			DI	added new codes (from WSA05) as NZPIM does not cover Brick Pipes
Dipped Pipe	DP			DP	Unchanged
Encrustation Deposit	ED			ED	Unchanged
Exfiltration	EX			EX	Added new code (from WSA05) as NZPIM does not cover Exfiltration (where observed)
Infiltration Present	IP			IP	Unchanged
Joint Displaced	JD			JD	Unchanged
Joint Faulty	JF	Cracked	C	JFC	Modified existing (added Characterisation) JF code to enable better differentiation and attribute appropriate weighted score based on type of fault at joint. Severity Assessment remains unchanged.
	JF	Broken	B	JFB	
	JF	damaged	D	JFD	
	JF	Seal	SX	JFSX	
	JF			JF	Existing code (without characterisation) remains for existing records and can be used where no characterisation code is appropriate
Joint Open	JO			JO	Unchanged
Joint Open (Angular)	JO	Angular Deflection	A	JOA	Added characterisation code (A) to identify difference between longitudinal opening against Angular (rotation opening)
Lateral Sealing Faulty	LF	Cracked	C	LFC	Modified existing LF code (added Characterisation) to enable better differentiation and attribute appropriate weighted score based on type of fault at joint. Severity assessment remains unchanged.
	LF	Broken	B	LFB	
	LF	Seal	S	LFS	
	LF			LF	Existing code (without characterisation) remains for existing records and can be used where no characterisation code is appropriate
Lateral Protruding	LP			LP	Unchanged
Lateral Problem (Defective)	LX	Blocked	B	LXB	Modified existing LX code (added Characterisation based on WSA05) to enable better differentiation and attribute appropriate weighted score based on type of fault at joint
	LX	Branch Cracked	C	LXC	
	LX	Some Roots	R	LXR	
	LX	Soil Entering	SE	LXSE	
	LX	*(Other)*		LX	Existing code (without characterisation) remains for existing records and can be used where no characterisation code is appropriate
Missing Bricks	MB	More Bricks Visible	V	MBV	added new codes (from WSA05) as NZPIM does not cover Brick Pipes
	MB	No More Bricks Visible	NV	MBNV	
Missing Mortar	MM	Shallow	S	MMS	
	MM	Moderate	M	MMM	
	MM	Thick	T	MMT	

Code Type	Main Code	Sub-Code Type	Characterisation	Full Code	Notes on proposed Changes
Obstruction Permanent	OP			OP	Unchanged
Obstruction Temporary	OT			OT	Unchanged
Pipe Broken	PB			PB	Unchanged
Deformed Plastic Pipe	PF			PF	Unchanged
Pipe Holed	PH			PH	Unchanged
Protective Lining Defective	PL	Detached	D	PLD	Modified existing PL coded (added Characterisation codes based on WSA05) to enable better differentiation and attribute appropriate weighted scores based on type of fault at with the liner
	PL	Discoloration	C	PLC	
	PL	End is Defective	E	PLE	
	PL	Weld Defective	WD	PLWD	
	PL	Re-establishment of Connection Done Improperly	RC	PLRC	
	PL	Leak	L	PLL	
	PL	Holed	H	PLH	
	PL	Rendered Mortar Missing	RM	PLRM	
	PL	Spiral Joints Separated	SJ	PLSJ	
	PL	Poor Workmanship	PW	PLPW	
	PL	Wrinkling - Longitudinal	WL	PLWL	
	PL	Wrinkling - Circumferential	WC	PLWC	
	PL	Wrinkling - Multiple Patterns	W	PLW	
	PL	Blistered	B	PLB	
	PL	Bulged	BU	PLBU	
	PL	*(Other)*		PL	Existing code (without characterisation) remains for existing records and can be used where no characterisation code is appropriate
Pipe Collapsed	PX			PX	Unchanged
Root Intrusion	RI			RI	Unchanged
Defective Repair	RX	Major Wall Gaps	M	RXM	Added new RX code (from WSA05) as NZPIM does not cover defective repairs. This is separate to PL issues
	RX	Seal	S	RXS	
	RX	Other	Z	RXZ	
Surface Damage	S	Wall Roughened	W	SW	Modified existing SD coded (added Characterisation codes based on WSA05) to enable better more accurate reporting, differentiation and attribute appropriate weighted scores based on type of surface damage evident
	S	Spalling	S	SS	
	S	Aggregate Visible	AV	SAV	
	S	Aggregate Protruding	AP	SAP	
	S	Aggregate Removed	AM	SAM	
	S	Reinforcement Corroded	RC	SRC	
	S	Reinforcement Visible	RV	SRV	
	S	Reinforcement Visible Projecting	RVP	SRVP	
	S	Corrosion Products Visible	CP	SCP	
	S	Tuberculation	T	ST	
	S	Holed	H	SH	
	S	Wall Staining	WS	SWS	
	SD			SD	Existing code (without characterisation) remains for existing records and can be used where no characterisation code is appropriate
Soil Visible Through Defect	SV			SV	Added new SV code (from WSA05) as NZPIM does not cover cases where soil is visible without a cavity (Tomo)

Code Type	Main Code	Sub-Code Type	Characterisation	Full Code	Notes on proposed Changes
Tomo	TM			TM	Unchanged
Weld Defect	W	Longitudinal	L	WL	Added new W code (from WSA05) as NZPIM does not cover defects associated with Steel pipe weld or PE Welds
	W	Circumferential	C	WC	
	W	Helical	H	WH	

FEATURE CODES

Code Type	Main Code		Characterisation	Full Code	Notes on proposed Changes
Construction Feature	CF			CF	Unchanged
Dimension Change	DC			DC	Unchanged
General Comment	GC			GC	Unchanged
General Photograph	GP	Pointing Left	L	GPL	Added new GP code (from WSA05) to add clarification to the CCTV report - currently GC would be used but more appropriate to use an alternative to make it clearer.
	GP	Pointing Right	R	GPR	
	GP	Pointing Forward	F	GPF	
	GP	Pointing Backward	B	GPB	
Inspection Abandoned	IA			IA	Unchanged
Inspection Ends	IE			IE	Unchanged
Inspection Starts	IS			IS	Unchanged
Lateral Blank	LB			LB	Unchanged
Lining Change	LC			LC	Unchanged
Lateral Open (OK)	LO			LO	Unchanged
Loss of Vision	LOV	Under Water	UW	LOVUW	Added new LOV code (from WSA05) to add clarification to the CCTV report - currently GC would be used but more appropriate to use an alternative to make it clearer.
	LOV	Debris	D	LOVD	
	LOV	Steam	S	LOVS	
	LOV	Other/Unknown	Z	LOVZ	
Line Deviates Down	LD			LD	Unchanged
Line Deviates Left	LL			LL	Unchanged
Line Deviates Right	LR			LR	Unchanged
Line Deviates Up	LU			LU	Unchanged
Material Change	MC			MC	Unchanged
Change in Segment Length (joint spacing)	PC			PC	Added new RX code (from WSA05) as NZPIM does not cover where there is a change in joint spacing. This would could be covered under GC. Addition of this code would better clarify this circumstance.
Point Repair	RP	Pipe Replaced	R	RPR	Added new RP code (From WSA05) as NZPIM does not caver adequately - previously covered by PH small severity, but this is not always appropriate.
	RP	Localised Lining (Patch Repair)	L	RPL	
	RP	Injected Mortar	I	RPI	
	RP	Injected Sealant	S	RPS	
	RP	Hole repaired	H	RPH	
	RP	Internal 'Clip' seal	IC	RPIC	
	RP	Other	Z	RPZ	
Flow (water) Level	WL	Clear	C	WLC	Added new WLC code (from WSA05) to add clarification to the CCTV report - currently GC would be used but more appropriate to use an alternative to make it clearer. Similar code existed in the first edition of the manual
	WL	Turbid or Discolored	T	WLT	

DEFECT QUANTIFICATION

Code Type	Main Code	Characterisation	Description	Severity Band	Severity Description	Severity Definition	Full Code (Proposed)	Full Code (Existing)
Brick Separation	BS			S	Small	**Small** = Separation width < 10mm **Medium** = Separation width >10mm upto 20mm **Large** = Separation width >20mm	BSS	
Brick Separation	BS			M	Medium		BSM	
Brick Separation	BS			L	Large		BSL	
Brick Conduit Collapsed	BX						BX	
Cracks Longitudinal	CL			S	Small	**Small** = Crack is present but does not extend all of the way through the pipe wall **Medium** = Crack is open and posibly the crack extends all the way through the pipe wall **Large** = The is clear visual evidence that the crack extends all the way through the pipe wall (this may include displacement of the pipe wall at the crack)	CLS	CLS
	CL			M	Medium		CLM	CLM
	CL			L	Large		CLL	CLL
Cracks Circumferential	CC			S	Small		CCS	CCS
	CC			M	Medium		CCM	CCM
	CC			L	Large		CCL	CCL
Cracks Multiple	CM			S	Small		CMS	CMS
	CM			M	Medium		CMM	CMM
	CM			L	Large		CML	CML
Displaced Bricks	DB	I	Moving Inwards				DBI	
	DB	O	Moving Outwards				DBO	
Debris Silty	DE			S	Small	**Small** = Deposits upto 10% of the Pipe Diameter **Medium** = Deposits >10% upto 25% of the Pipe Diameter **Large** = Deposits >25% of the Pipe Diameter For Debris Silty, the Nature/Type of deposit is recorded in the Remarks	DES	DES
	DE			M	Medium		DEM	DEM
	DE			L	Large		DEL	DEL
Deformed Pipe	DF			M	Medium	Medium = Deformation/Ovality upto 10% (identified by the 3(+) longitudinal cracks Large = Deformation/Ovaity >10%	DFM	DFM
	DF			L	Large		DFL	DFL
Debris Greasy	DG			S	Small	**Small** = Deposits upto 10% of the Pipe Diameter **Medium** = Deposits >10% upto 25% of the Pipe Diameter **Large** = Deposits >25% of the Pipe Diameter	DGS	DGS
	DG			M	Medium		DGM	DGM
	DG			L	Large		DGL	DGL
Dropped Invert	DI						DI	
Dipped Pipe	DP			S	Small	**Small** = Depth of dip upto 25% of the Pipe Diameter **Medium** = Depth of Dip >25% upto 50% of the Pipe Diameter **Large** = Depth of DIp >50% of the Pipe Diameter	DPS	DPS
	DP			M	Medium		DPM	DPM
	DP			L	Large		DPL	DPL
Encrustation Deposit	ED			S	Small	**Small** = Deposits upto 10% of the Pipe Diameter **Medium** = Deposits >10% upto 25% of the Pipe Diameter **Large** = Deposits >25% of the Pipe Diameter	EDS	EDS
	ED			M	Medium		EDM	EDM
	ED			L	Large		EDL	EDL
Exfiltration	EX						EX	
Infiltration Present	IP			S	Small	**Small** = Seeping or Dripping **Medium** = Running **Large** = Gushing or Jetting	IPS	IPS
	IP			M	Medium		IPM	IPM
	IP			L	Large		IPL	IPL
Joint Displaced	JD			S	Small	**Small** = Reduction in Diameter upto 10% of the Pipe Diameter **Medium** = Reduction in Diameter >10% upto 25% of the Pipe Diameter **Large** = Reduction in Diameter >25% of the Pipe Diameter	JDS	JDS
	JD			M	Medium		JDM	JDM
	JD			L	Large		JDL	JDL
Joint Faulty	JF	C	Cracked	S	Small	Joint Faulty (JF) is used to identify any sealing or structural defect occuring within 100mm either side of the joint face (a total 200mm zone refered to as the 'joint zone'). This joint zone allows for the jointing mechanism and defects attributed to the JF indicate that the defects likely relate only to the joint itself and not to defects in the pipe beyond the joint. **Small** = There is a defect present, but there is no pathway to the outside of the pipe **Medium** = the defective seal or cracking may extend through to the outside of the pipe (Possible pathway) **Large** = There is clear visual evidence of a pathway to the outside of the pipe through the defects.	JFCS	
	JF	C	Cracked	M	Medium		JFCM	
	JF	C	Cracked	L	Large		JFCL	
	JF	B	Broken	S	Small		JFBS	
	JF	B	Broken	M	Medium		JFBM	
	JF	B	Broken	L	Large		JFBL	
	JF	D	Damaged	S	Small		JFDS	
	JF	D	Damaged	M	Medium		JFDM	
	JF	D	Damaged	L	Large		JFDL	
	JF	SX	Seal	S	Small		JFSXS	
	JF	SX	Seal	M	Medium		JFSXM	
	JF	SX	Seal	L	Large		JFSXL	
	JF			*S*	*Small*		*JFS*	*JFS*
	JF			*M*	*Medium*		*JFM*	*JFM*
	JF			*L*	*Large*		*JFL*	*JFL*
Joint Open	JO			S	Small	**Small** = Longtitudinal Displacement upto 20mm **Medium** = Longitudinal Displacment >20mm upto 40mm **Large** = Longitudinal Displacment >40mm	JOS	JOS
	JO			M	Medium		JOM	JOM
	JO			L	Large		JOL	JOL
Joint Open (Angular)	JO	A	Angular Deflection	S	Small		JOAS	
	JO	A	Angular Deflection	M	Medium		JOAM	
	JO	A	Angular Deflection	L	Large		JOAL	
Lateral Sealing Faulty	LF	C	Cracked	S	Small	Defects relating to the the point where the connecting conduit joins the main pipe is covered by the "LF" code. **Small** = Poor seal or crack is present but does not extend all of the way through the pipe wall **Medium** = Poor seal or crack is open and posibly the crack extends all the way through the pipe wall **Large** = The is clear visual evidence that the poor seal or crack extends all the way through the pipe wall	LFCS	
	LF	C	Cracked	M	Medium		LFCM	
	LF	C	Cracked	L	Large		LFCL	
	LF	B	Broken	S	Small		LFBS	
	LF	B	Broken	M	Medium		LFBM	
	LF	B	Broken	L	Large		LFBL	
	LF	S	Seal	S	Small		LFSS	
	LF	S	Seal	M	Medium		LFSM	
	LF	S	Seal	L	Large		LFSL	LFL
	LF			*S*	*Small*		LFS	LFS
	LF			*M*	*Medium*		LFM	LFM
	LF			*L*	*Large*		LFL	LFL
Lateral Protruding	LP			S	Small	**Small** = Reduction in Diameter upto 10% of the Pipe Diameter **Medium** = Reduction in Diameter >10% upto 25% of the Pipe Diameter **Large** = Reduction in Diameter >25% of the Pipe Diameter	LPS	LPS
	LP			M	Medium		LPM	LPM
	LP			L	Large		LPL	LPL
Lateral Problem (Defective)	LX	B	Blocked				LXB	
	LX	C	Branch Cracked				LXC	
	LX	R	Some Roots				LXR	
	LX	SE	Soil Entering				LXSE	
	LX		Other	S	Small		LXS	LXS
	LX		Other	M	Medium		LXM	LXM
	LX		Other	L	Large		LXL	LXL
Missing Bricks	MB	V	More Bricks Visible				MBV	
	MB	NV	No More Bricks Visible				MBNV	
Missing Mortar	MM	S	Shallow				MMS	
	MM	M	Moderate				MMM	
	MM	T	Thick				MMT	
Obstruction Permenant	OP			S	Small	**Small** = Obstruction upto 10% of the Pipe Diameter **Medium** = Obstructions >10% upto 25% of the Pipe Diameter **Large** = Obstructions >25% of the Pipe Diameter The Nature/Type of the obstruction is recorded in the Remarks	OPS	OPS
	OP			M	Medium		OPM	OPM
	OP			L	Large		OPL	OPL
Obstruction Temporary	OT			S	Small		OTS	OTS
	OT			M	Medium		OTM	OTM
	OT			L	Large		OTL	OTL
Pipe Broken	PB			S	Small	**Small** = broken pieces are upto 10% of the pipe circumference and either not displaced or displaced by less than the pipe wall thickness **Medium** = broken pieces are upto 20% of the pipe circumference and either not displaced or	PBS	PBS
	PB			M	Medium		PBM	PBM
	PB			L	Large		PBL	PBL
Deformed Plastic Pipe	PF			S	Small	**Small** = Deformation/Ovality upto 10% **Medium** = Deformation/Ovality >10% upto 25% **Large** = Deformation/Ovality >25%	PFS	PFS
	PF			M	Medium		PFM	PFM
	PF			L	Large		PFL	PFL
Pipe Holed	PH			S	Small	**Small** = Pipe Hole that has been covered/filled, regardless of the size of the hole (with no evidence of apthway to the outside of the pipe) **Medium** = Pipe Hole, the size of the hole is upto 20% of the circumference	PHS	PHS
	PH			M	Medium		PHM	PHM
	PH			L	Large		PHL	PHL
Protective Lining Defective	PL	D	Detached				PLD	
	PL	C	Discolouration				PLC	
	PL	E	End is Defective				PLE	
	PL	WD	Weld Defective				PLWD	
	PL	RC	Re-establishment of Connection Done Improperly				PLRC	
	PL	L	Leak				PLL	
	PL	H	Holed				PLH	
	PL	RM	Rendered Mortar Missing				PLRM	
	PL	SJ	Spiral Joints Separated				PLSJ	
	PL	PW	Poor Workmanship				PLPW	
	PL	WL	Wrinkling - Longitudinal	S	Small	**Small** = Reduction in Diameter upto 10% of the Pipe Diameter **Medium** = Reduction in Diameter >10% upto 25% of the Pipe Diameter **Large** = Reduction in Diameter >25% of the Pipe Diameter	PLWLS	
	PL	WL	Wrinkling - Longitudinal	M	Medium		PLWLM	
	PL	WL	Wrinkling - Longitudinal	L	Large		PLWLL	
	PL	WC	Wrinkling - Circumferential	S	Small		PLWCS	
	PL	WC	Wrinkling - Circumferential	M	Medium		PLWCM	
	PL	WC	Wrinkling - Circumferential	L	Large		PLWCL	
	PL	W	Wrinkling - Multiple Patterns	S	Small		PLWS	
	PL	W	Wrinkling - Multiple Patterns	M	Medium		PLWM	
	PL	W	Wrinkling - Multiple Patterns	L	Large		PLWL	
	PL	B	Blistered	S	Small		PLBS	
	PL	B	Blistered	M	Medium		PLBM	
	PL	B	Blistered	L	Large		PLBL	
	PL	BU	Bulged	S	Small		PLBUS	
	PL	BU	Bulged	M	Medium		PLBUM	
	PL	BU	Bulged	L	Large		PLBUL	
	PL			*S*	*Small*		*PLS*	*PLS*
	PL			*M*	*Medium*		*PLM*	*PLM*
	PL			*L*	*Large*		*PLL*	*PLL*
Pipe Collapsed	PX						PX	PXL
Root Intrusion	RI			S	Small	**Small** = Root Intrusion upto 10% of the Pipe Diameter **Medium** = Root Intrusion >10% upto 25% of the Pipe Diameter **Large** = Root Intrusion >25% of the Pipe Diameter	RIS	RIS
	RI			M	Medium		RIM	RIM
	RI			L	Large		RIL	RIL

Code Type	Main Code	Characterisation	Description	Severity Band	Severity Description	Severity Definition	Full Code (Proposed)	Full Code (Existing)
Defective Repair	RX	M	Major Wall Gaps				RXM	
	RX	S	Seal				RXS	
	RX	Z	Other				RXZ	
Surface Damage	S	W	Wall Roughened				SW	
	S	S	Spalling				SS	
	S	AV	Aggregate Visible				SAV	
	S	AP	Aggregate Protruding				SAP	
	S	AM	Aggregate Removed				SAM	
	S	RC	Reinforcement Corroded				SRC	
	S	RV	Reinforcement Visible				SRV	
	S	RVP	Reinforcement Visible Projecting				SRVP	
	S	CP	Corrosion Products Visible				SCP	
	S	T	Tubercolation				ST	
	S	H	Holed				SH	
	S	WS	Wall Staining				SWS	
	SD		Other (including existing surface damage defects)	S	Small	**Small** = Damage effect has minor defect on the integrity of pipe wall	SDS	SDS
	SD			M	Medium	**Medium** = Damage effect has moderate defect on the integrity of pipe wall	SDM	SDM
	SD			L	Large	**Large** = Damage effect has significate defect on the integrity of pipe wall	SDL	SDL
Soil Visible Through Defect	SV						SV	
Tomo	TM						TM	TML
Weld Defect	W	L	Longitudinal				WL	
	W	C	Circumferential				WC	
	W	H	Helical				WH	

FEATURE QUANTIFICATION

Code Type	Main Code	Characterisation	Description	Severity Band	Severity Description	Severity Definition	Full Code (Proposed)	Full Code (Existing)
Construction Feature	CF						CF	CF
Dimension Change	DC						DC	DC
General Comment	GC						GC	GC
General Photograph	GP	L	Pointing Left				GPL	
	GP	R	Pointing Right				GPR	
	GP	F	Pointing Forward				GPF	
	GP	B	Pointing Backward				GPB	
Inspection Abandoned	IA						IA	IA
Inspection Ends	IE						IE	IE
Inspection Starts	IS						IS	IS
Lateral Blank	LB						LB	LB
Lining Change	LC						LC	LC
Lateral Open (OK)	LO						LO	LO
Loss of Vision	LOV	UW	Under Water				LOVUW	
	LOV	D	Debris				LOVD	
	LOV	S	Steam				LOVS	
	LOV	Z	Other/Unknown				LOVZ	
Line Deviates Down	LD						LD	
Line Deviates Left	LL						LL	LL
Line Deviates Right	LR						LR	LR
Line Deivates Up	LU						LU	LU
Material Change	MC						MC	MC
Point Repair	RP	R	Pipe Replaced				RPR	
	RP	L	Localised Lining (Patch Repair)				RPL	
	RP	I	Injected Mortar				RPI	
	RP	S	Injected Sealant				RPS	
	RP	H	Hole repaired				RPH	
	RP	IC	Internal 'Clip' seal				RPIC	
	RP	Z	Other				RPZ	
Change in Conduit Length	PC						PC	
Flow (water) Level	WL	C	Clear				WLC	
	WL	T	Turbid or Discoloured				WLT	