



INFRASTRUCTURES  
SOUTERRAINES

# INFRASTRUCTURE ASSESSMENT COMMITTEE (IAC)

## PACP Version 8 Updates & QA/QC

CERIU Congrès INFRA  
4 décembre, 2023 2PM



**NASSCO**



- Tanya Stephens, A.Sc.T., GIS (pg)
  - President, Infrastructure Assessment Academy Inc.
  - Condition Assessment Program Manager, Town of Newmarket, Ontario
  - Co-Chair, NASSCO Infrastructure Assessment Committee
  - CANADIAN NASSCO-Certified Trainer



- Ronnie Flannery
  - Directeur général, Aqua Data inc.
  - Responsable comité Ceriu/NASSCO et représentant CERIU au NASSCO





- NASSCOS LARGEST COMMITTEE
- GROUP OF APPROX. 95 VOLUNTEERS MADE UP OF CITY EMPLOYEES, ENGINEERING FIRMS, CONTRACTORS, NASSCO TRAINERS, SUPPLIERS
- OUR MISSION IS TO IMPROVE ON CODING AND PROCEDURES AS IT RELATES TO INFRASTRUCTURE ASSESSMENT OF:
  - SEWERS
  - STORM WATER PIPES
  - MANHOLES
  - SERVICE LATERALS
  - PERFORATED PIPE/UNDERDRAINS
  - AND NOW POTABLE WATER MAINS/PRESSURE PIPES!





1. PACP/LACP/MACP Background
2. NASSCO Quality Control Guidelines
3. PACP/MACP/LACP Version 8
  - a) Coding Improvements – PACP/MACP/LACP
  - b) Stormwater Code updates
  - c) New Pressure Pipe Codes
  - d) Perforated Pipe Codes
4. Asset management courses
  - a) PACP for Asset Management – Evaluating Condition Grades
  - b) PACP for Asset Management – Assessing Risk



- National voluntary standard often referenced in regulatory orders as the condition assessment standard
- Recommended in Canada and required in Québec
- Adapted from WRc for North America in 2002
  - MACP in 2006
  - LACP in 2010
- Codes updated periodically with last update (Version 7) in May 2015
- WRc released ownership of PACP to NASSCO in 2023





Appendix B - Color Coded Chart

### NASSCO'S PIPELINE ASSESSMENT CERTIFICATION PROGRAM® (PACP®)

**Section 5 — Operation and Maintenance**

<b>D DEPOSITS 5-3</b> (Internal)	<b>D DEPOSITS 5-4</b> (External)	<b>D DEPOSITS 5-4</b> (Internal)	<b>R ROOT 5-11</b> (Pipe)	<b>R ROOTS 5-11</b> (Tree)	<b>R ROOTS 5-11</b> (Medium)	<b>R ROOTS 5-11</b> (Shrub)
DAB Encrustation 5-3 DAS Slimes 5-3 DAP Rapping 5-3 DAZ Other 5-3	DDE Fine 5-4 DDG Sludge 5-4 DDI Silt/Clay/Sand 5-4 DDZ Other 5-4	DDE Fine (Internal) 5-4 DDG Sludge 5-4 DDI Silt/Clay/Sand 5-4 DDZ Other 5-4	RFB Barrel 5-11 RFL Lateral 5-11 RFJ Connection 5-11 RFJ Joint 5-11	R7B Barrel 5-11 R7L Lateral 5-11 R7J Connection 5-11 R7J Joint 5-11	R8B Barrel 5-11 R8L Lateral 5-11 R8J Connection 5-11 R8J Joint 5-11	R9B Barrel 5-11 R9L Lateral 5-11 R9J Connection 5-11 R9J Joint 5-11
<b>I INFILTRATION 5-19</b>	<b>I INFILTRATION 5-19</b>	<b>I INFILTRATION 5-19</b>	<b>I INFILTRATION 5-19</b>	<b>I INFILTRATION 5-19</b>	<b>OB OBSTACLES 5-29</b> OBSTRUCTIONS	<b>OB OBSTACLES 5-29</b> OBSTRUCTIONS
IS Inlet 5-19 ISB Barrel 5-19 ISL Lateral 5-19 ISC Connection 5-19 ISJ Joint 5-19	ISB Barrel 5-19 ISL Lateral 5-19 ISC Connection 5-19 ISJ Joint 5-19	ISB Barrel 5-19 ISL Lateral 5-19 ISC Connection 5-19 ISJ Joint 5-19	ISB Barrel 5-19 ISL Lateral 5-19 ISC Connection 5-19 ISJ Joint 5-19	ISB Barrel 5-19 ISL Lateral 5-19 ISC Connection 5-19 ISJ Joint 5-19	OBK Break in Integrity 5-29 OBM Pipe Material 5-29 OBS Obstruction 5-29 OBT Obstruction 5-29 OBT Other 5-29	OBK Break in Integrity 5-29 OBM Pipe Material 5-29 OBS Obstruction 5-29 OBT Obstruction 5-29 OBT Other 5-29
<b>OB OBSTACLES 5-29</b> OBSTRUCTIONS	<b>V VERMIN 5-43</b>	<b>G GROUT TEST 5-48</b> & SEAL	<b>G GROUT TEST 5-48</b> & SEAL	<b>Section 7 — Miscellaneous Features</b>		
OBK Break in Integrity 5-29 OBM Obstruction 5-29 OBS Obstruction 5-29 OBT Other 5-29	VR Rat 5-43 VC Coon/Raccoon 5-43 VE Other 5-43	GTV Grout Test Passed 5-48 GTV Fail 5-48 GTV Leak 5-48 GTV Seal Test Failed 5-48 GTV Seal Test Passed 5-48 GTV Leak 5-48	GTV Grout Test Passed 5-48 GTV Fail 5-48 GTV Leak 5-48 GTV Seal Test Failed 5-48 GTV Seal Test Passed 5-48 GTV Leak 5-48	<b>M MISCELLANEOUS FEATURES 7-1</b>		
<b>Section 6 — Construction Features</b>				<b>M MISCELLANEOUS FEATURES 7-1</b>		
<b>T TAP 6-3</b>	<b>T TAP 6-3</b>	<b>T TAP 6-3</b>	<b>T TAP 6-3</b>	<b>IS INTRODUCING SEALING MATERIAL 6-43</b>	<b>M MISCELLANEOUS FEATURES 7-1</b>	<b>M MISCELLANEOUS FEATURES 7-1</b>
TF Factory Made 6-3 TFI Insulating 6-3 TFA Active 6-3 TFD Capped 6-3 TFB Abandoned 6-3 TFD Defective 6-3	TFB Break in Hammer 6-3 TFI Insulating 6-3 TFA Active 6-3 TFD Capped 6-3 TFB Abandoned 6-3 TFD Defective 6-3	TFB Break in Hammer 6-3 TFI Insulating 6-3 TFA Active 6-3 TFD Capped 6-3 TFB Abandoned 6-3 TFD Defective 6-3	TFB Break in Hammer 6-3 TFI Insulating 6-3 TFA Active 6-3 TFD Capped 6-3 TFB Abandoned 6-3 TFD Defective 6-3	ISB Sealing Ring 6-43 ISB Hanging 6-43 ISB Broken 6-43 ISB Loose 6-43 ISB Seal 6-43 ISB Other 6-43	MW Water Mark 7-1 MT Tape Test 7-1 T CV 7-1	MW Water Mark 7-1 MT Tape Test 7-1 T CV 7-1
<b>L LINE 6-17</b> (at event)	<b>L LINE 6-17</b> (at event)	<b>A ACCESS POINT 6-19</b>	<b>A ACCESS POINT 6-19</b>	<b>A ACCESS POINT 6-19</b>	<b>M MISCELLANEOUS FEATURES 7-1</b>	
LL Left 6-17 LU Left/Up 6-17 LU Down 6-17 LR Right 6-17	LRU Right/Up 6-17 LRD Right/Down 6-17 LU Up 6-17 LD Down 6-17	AAH Access 6-19 AAW Access/Access 6-19 AAB Access 6-19 ATC New Connection 6-19	AAC Other Structure 6-19 AAW Access 6-19 AAB Access 6-19 AAB Other 6-19 AAB Junction Box 6-19	APD Access 6-19 APD Other 6-19 APD Access 6-19 APD Other 6-19 APD Junction Box 6-19	<b>M MISCELLANEOUS FEATURES 7-1</b>	

Pipeline Assessment Certification Program  
Version 7.0.0 May 2015

Appendix B - Color Coded Chart

### NASSCO'S PIPELINE ASSESSMENT CERTIFICATION PROGRAM® (PACP®)

**Section 4 — Structural Defect Coding**


<b>C CRACK 4-9</b>	<b>F FRACTURE 4-9</b>	<b>B BROKEN 4-17</b>	<b>H HOLE 4-11</b>	<b>D DEFORMED 4-25</b> (Right)	<b>D DEFORMED 4-25</b> (Flexure)	<b>D DEFORMED 4-25</b> (Bulge)
CL Longitudinal 4-9 CLC Circumferential 4-9 CM Multiple 4-9 CS Seal 4-9 CR Hinge (L, S, R) 4-9	FL Longitudinal 4-9 FLC Circumferential 4-9 FM Multiple 4-9 FS Seal 4-9 FR Hinge (L, S, R) 4-9	BBV Bad Valve 4-17 BBV Bad Valve 4-17 BBV Bad Valve 4-17	HVV Bad Valve 4-11 HVV Bad Valve 4-11 HVV Bad Valve 4-11	DR Deformed Right 4-25 No notches used	DFR Deformed Flexure 4-25 DFB Deformed In-Cum 4-25 DFC Deformed 4-25 DFE Deformed 4-25	DBR Deformed Bulge 4-25 DBB Deformed In-Cum 4-25 DBE Deformed 4-25
<b>K COLLAPSE 4-37</b>	<b>J JOINT 4-43</b>	<b>J JOINT 4-43</b>	<b>J JOINT 4-43</b>	<b>J JOINT 4-43</b>	<b>S SURFACE DAMAGE 4-51</b>	<b>S SURFACE DAMAGE 4-51</b>
KC Collapse 4-37 No notches and no- notches used	JJC Other Joint 4-43 JJC Other Medium 4-43 JJC Other Large 4-43	JJC Other Joint 4-43 JJC Other Medium 4-43 JJC Other Large 4-43	JJC Separation Small 4-43 JJC Separation Med 4-43 JJC Separation Large 4-43	JJC Angular Small 4-43 JJC Angular Medium 4-43 JJC Angular Large 4-43	SSB Roughness Increased 4-51 SSB Aggregate Missing 4-51 SSB Aggregate Missing 4-51 SSB Aggregate Missing 4-51	SSB Roughness Increased 4-51 SSB Roughness Increased 4-51 SSB Roughness Increased 4-51 SSB Roughness Increased 4-51
<b>S SURFACE DAMAGE 4-51</b>	<b>LF LINING FEATURES 4-57</b>	<b>LF LINING FEATURES 4-57</b>	<b>LF LINING FEATURES 4-57</b>	<b>WF WELD FAILURE 4-59</b>	<b>RP POINT REPAIR 4-59</b>	<b>RP POINT REPAIR 4-59</b>
SSB Surface Cracking 4-51 SSB Surface Cracking 4-51 SSB Surface Cracking 4-51 SSB Surface Cracking 4-51	LFL Lining Features 4-57 LFL Lining Features 4-57 LFL Lining Features 4-57 LFL Lining Features 4-57	LFL Lining Features 4-57 LFL Lining Features 4-57 LFL Lining Features 4-57 LFL Lining Features 4-57	LFL Lining Features 4-57 LFL Lining Features 4-57 LFL Lining Features 4-57 LFL Lining Features 4-57	WFL Weld Failure 4-59 WFL Weld Failure 4-59 WFL Weld Failure 4-59 WFL Weld Failure 4-59	RPL Point Repair 4-59 RPL Point Repair 4-59 RPL Point Repair 4-59 RPL Point Repair 4-59	RPL Point Repair 4-59 RPL Point Repair 4-59 RPL Point Repair 4-59 RPL Point Repair 4-59
<b>BC BACKWORK 4-57</b>	<b>BC BACKWORK 4-57</b>					
BCB Backwork 4-57 BCB Backwork 4-57 BCB Backwork 4-57	BCB Backwork 4-57 BCB Backwork 4-57 BCB Backwork 4-57					

Pipeline Assessment Certification Program  
Version 7.0.0 May 2015



## Sample Output Report

O&M Index:	<u>4.00</u>	O&M Quick:	<u>41.00</u>	O&M Rating:	<u>4.00</u>
Structural Index:	<u>2.50</u>	Structural Quick:	<u>3323</u>	Structural Rating:	<u>15.00</u>
Overall Index:	<u>2.71</u>	Overall Quick:	<u>4333</u>	Overall Rating:	<u>19.00</u>



0	AMH	Manhole	0	NA
0	MWL	Miscellaneous Water Level	26	NA
0	SAV(S01)	Surface Damage Aggregate Visible	31	S 2
13.4	LFD(S02)	Lining Feature Detached	81	S 3
14.5	SAV(F01)	Surface Damage Aggregate Visible	98	S 2
30.0	LFD(F02)	Lining Feature Detached	129	S 3
175.7	MGO	Miscellaneous General Observation	341	NA
369.1	LL	Line Left	663	M 4
404.2	MSA	Miscellaneous Survey Abandoned	1033	NA

## Grading System Details for Gravity and Pressure Assets

- 5 – Most significant defect grade
- 4 – Significant defect grade
- 3 – Moderate defect grade
- 2 – Minor to moderate defect grade
- 1 – Minor defect grade



### Purpose:

- Evaluation of a PACP-certified individual
- Evaluation of a product submission

### GUIDELINES FOR QUALITY CONTROL (QC) OF NASSCO's PACP™, LACP™ and MACP™ Surveys



**NASSCO**

April 2022

Thanks to the following NASSCO Infrastructure Condition Assessment Committee members for the development of these Guidelines:

Michelle Beason, P.E.  
James Burn  
Edward Carpenetti  
Christopher Garrett, P.E.  
Michael Kerr  
Christopher Mitchell  
Tanya Stephens  
Eric Sullivan  
Jerry Welmer



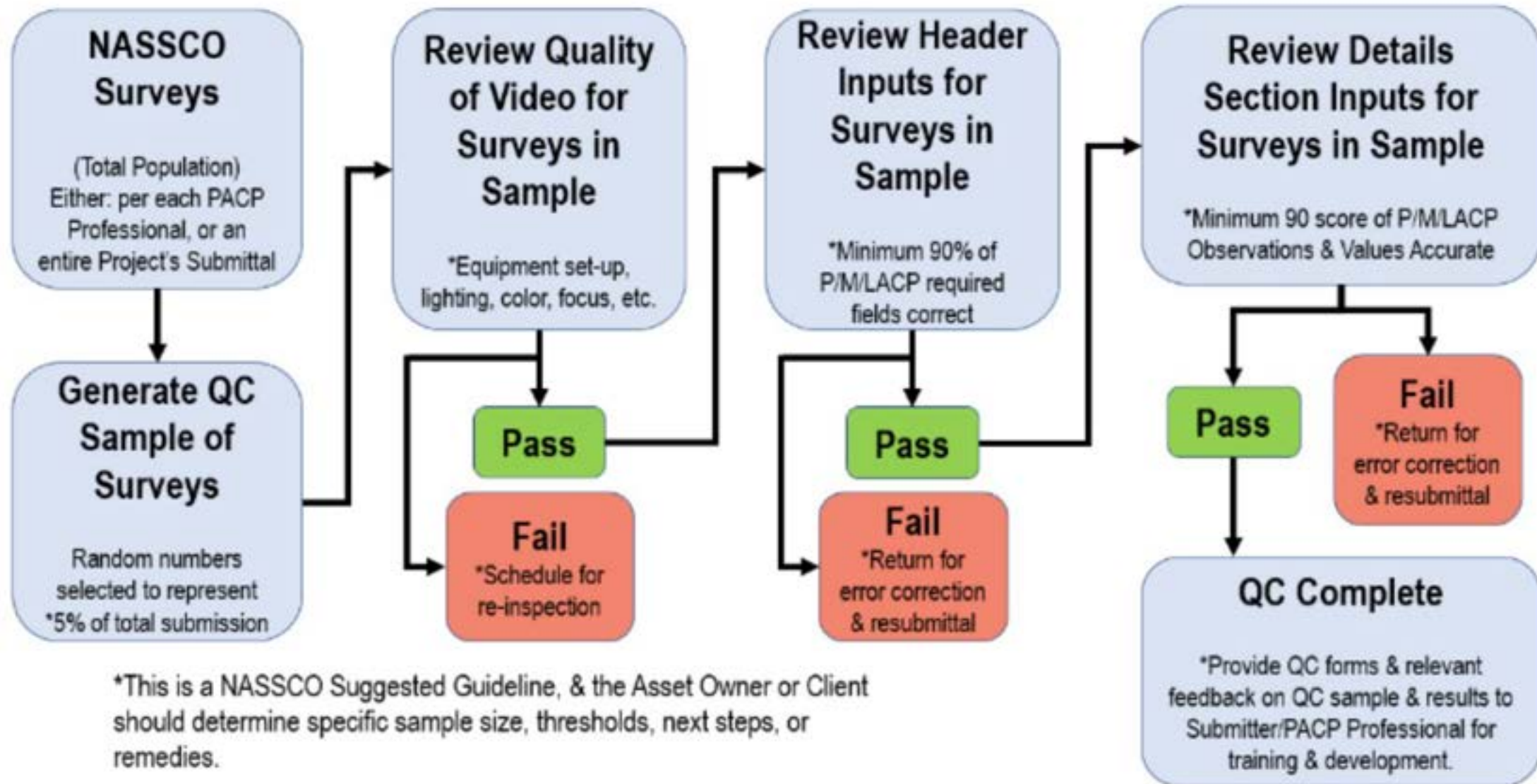


1. Visibility during inspection
  - a. Provide an unobstructed (perspective) view of the entire pipe, including removal of obstructions, clean camera lens, minimal fogging, and sufficient lighting.
2. Equipment set-up and appropriate cable calibration, such as beginning inspections at the interface of the pipe and access point wall (0.0 ft/m).
3. NASSCO PACP camera speed limitation.

***Inspection videos that do not meet the standards outlines above are to be rejected and the QC process need not continue. The QC processes described herein assume image and inspection quality meet these minimum requirements.***



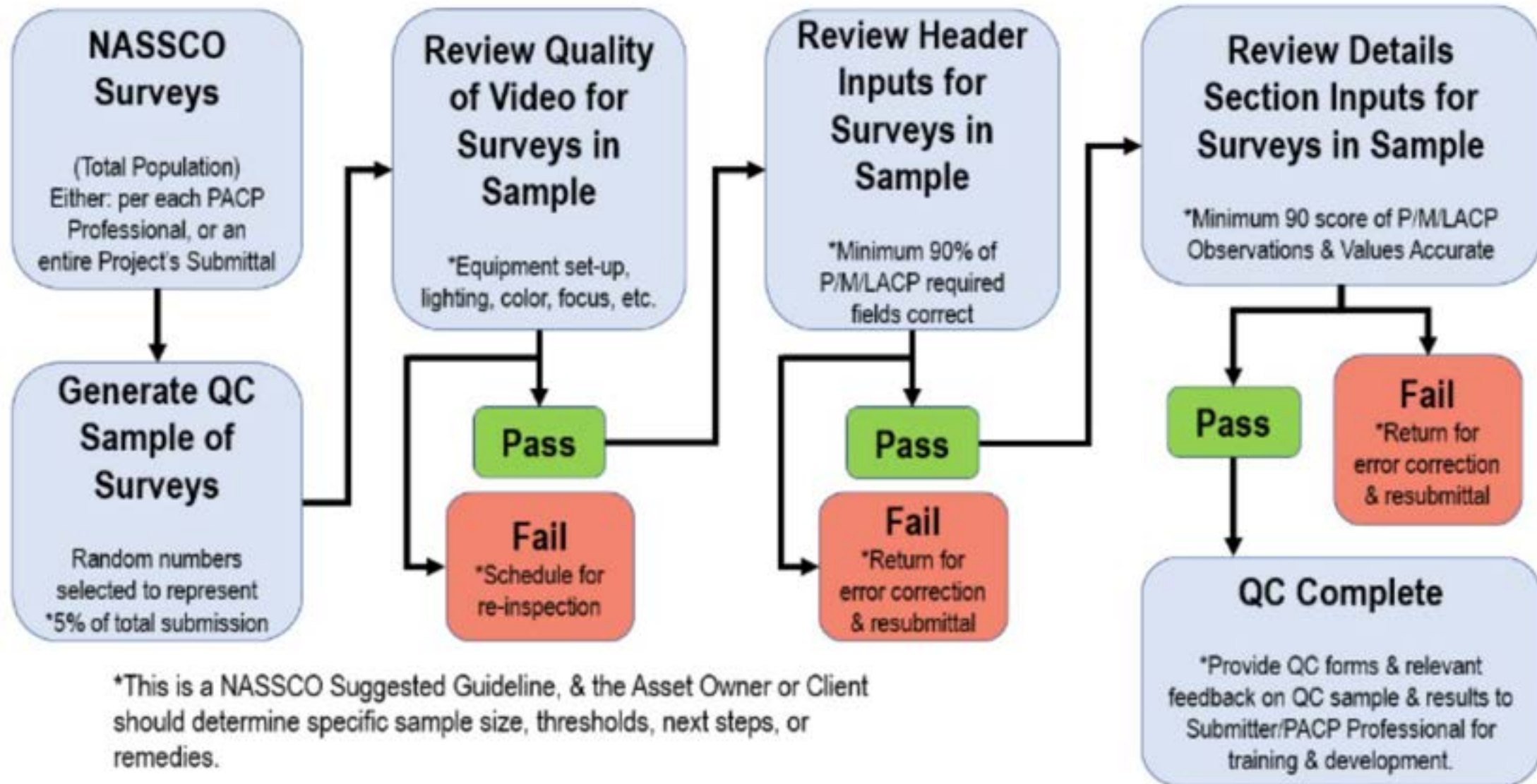
## NASSCO Quality Control (QC) Suggested Process



\*This is a NASSCO Suggested Guideline, & the Asset Owner or Client should determine specific sample size, thresholds, next steps, or remedies.



## NASSCO Quality Control (QC) Suggested Process



\*This is a NASSCO Suggested Guideline, & the Asset Owner or Client should determine specific sample size, thresholds, next steps, or remedies.



- It is NASSCO's suggestion that the accuracy of the Header records meet or exceed 90%, as most of the field contents are based upon quantitative observations, known asset identifiers, and other field-verified facts.

$(\text{Error count} / \text{number of fields checked}) * 100 = \text{percentage error}$

$100 - \text{error percentage} = \text{accuracy percentage}$

***Example (2 errors/32 fields checked) \* 100 = 6.25%***

***100 - 6.25 = 93.75% accuracy level***





- NASSCO suggests a minimum passing threshold of 90 points which would allow for 2 large errors.
- Survey details start with 100 points. Scores are deducted based on the following:

Large Error	-5 points
Medium Error	-3 points
Small Error	-1 points



- Similar to PACP Recommendations
  - NASSCO recommends a minimum 5% sample size
  - Review quality of video/photos/3D model
  - Review quality of MACP inspection forms
    - Header
    - Component Observation Form
    - Details Form

**Download complete guideline at**

**<https://nassco.org/resources/nassco-specification-guidelines/>**



- Version 7 was released in May 2015
- Code comments and suggested changes have been compiled since the release of Version 7.
- From November 2020 through May 2021, the IAC Version 8 workgroup reviewed all comments and code updates.
- Release of Version 8 is planned for January 2024.





1. Reorganizing the manual and training materials so that LACP follows after PACP, with MACP last.
2. Updated examples and photos in the manual.
3. Coding of defects in new pipe vs. existing pipe.
4. Additional surface damage codes added for those other than concrete.
5. Condition Grade Scores were reviewed and updated.



Description	Code	Structural Grade	O&M Grade	
			Sewer/Combined/ Stormwater	Levee
			>20% to ≤ 30% → 4 >30% → 5	>20% to ≤ 30% → 4 >30% → 5
			2	2
			1	2
			1	2
			1	2
			3	3
			2	3
			2	3
			2	3
Roots Medium Barrel	RMB		4	4
Roots Medium Lateral	RML		3	4
Roots Medium Connection	RMC		3	4
Roots Medium Joint	RMJ		3	4
Roots Ball Barrel	RBB		5	4

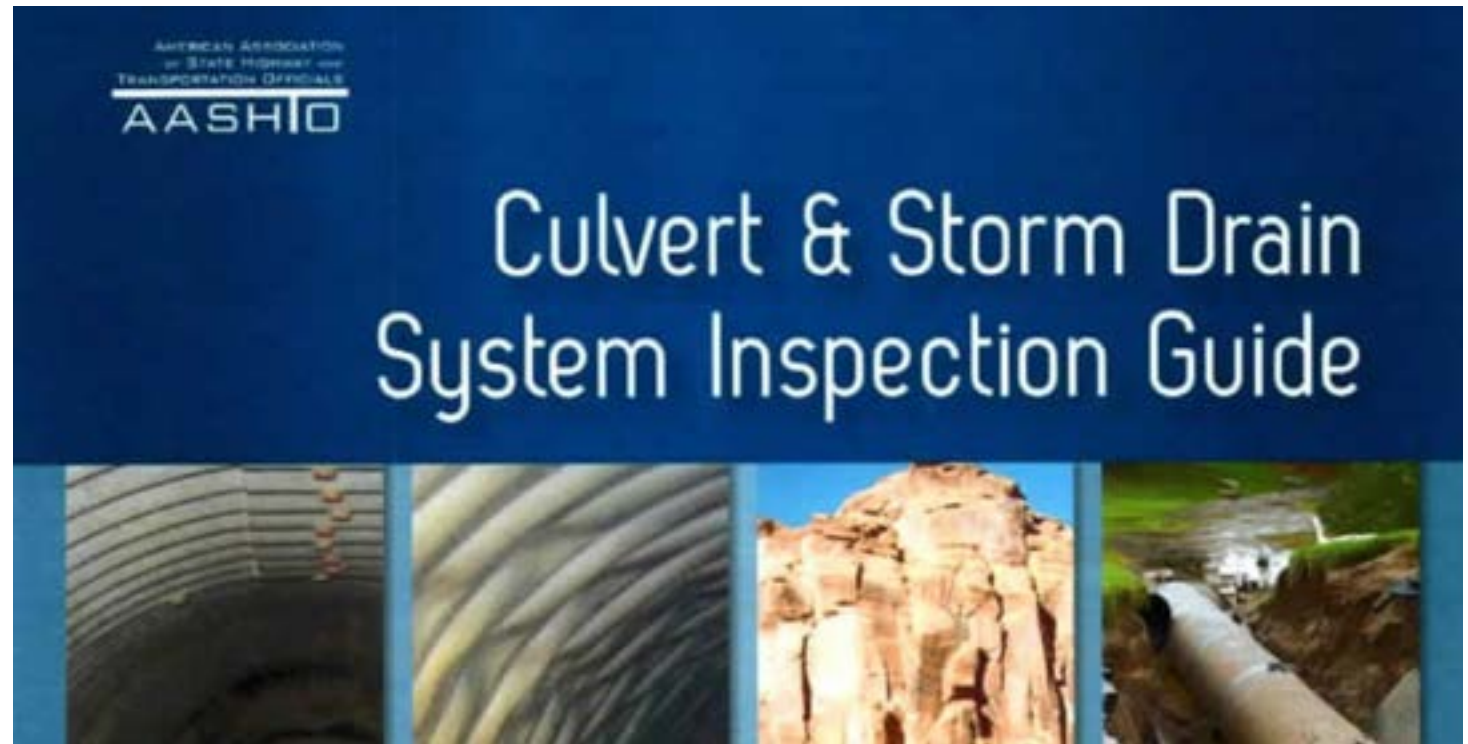
**Laptop 10:57 AM**

RBB for barrel should be a 5 for sewer...and also a 5 for Levees





6. Reviewed the 2020 AASHTO Stormwater guideline to ensure our codes meet their recommendations



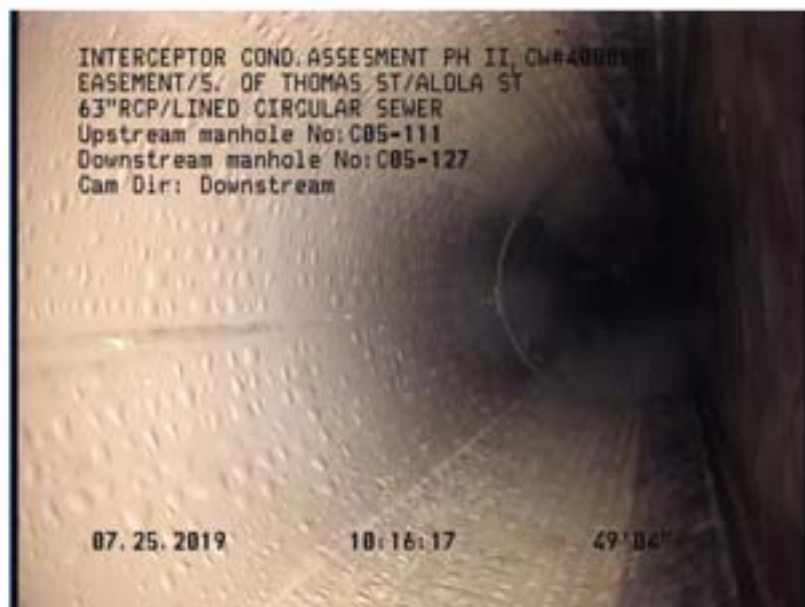


We had a lot of lively discussions!

1. T-lock question: should it be coded as precast? Or RCP Lined? Or ZZZ lined, type plastic? Put T-lock in the remarks? **MAYBE CALL IT PRE-LINED, OR PRECAST LINED, OR FACTORY LINED, RCP FACTORY LINED??**

- CSP / CMP Jointing systems
  - Bolts, yielding, loose or missing
  - Bolt holes, deformation of hole through bolt shear (cracking / splitting noted)

**ADD A BOLTS MISSING CODE. BTL, AND BTM. ANY CODE ENTERED IS A 1, OPTIONAL PERCENTAGE AND MANDATORY CLOCK 'FROM' POSITION, 'TO' POSITION IS OPTIONAL. IF CONTINUOUS, IT GETS A 3.**





## 7. New Pressure Pipe Codes

- Used same PACP codes
- Added new defect codes
- Added new access point and material types



# NEW PRESSURE PIPE DEFECT CODES ADDED



Code Expanded	DESCRIPTION	SUGGESTED NEW CODE	SUGGESTED SCORE
Leak	A point of the pipeline where product is leaving the pipeline in a manner not intended or designed. Detected acoustically or by other sensors.	LK	5
Leak in Pipe Barrel	A leak with a location that is in the pipe barrel, as opposed to at a joint or feature.	LKB	5
Leak at a Pipeline Feature	A leak co-located with a pipeline feature (Offtake??, valve, ARV, etc.)	LKZ	5
Leak on a joint	A leak with a location that corresponds to a joint	LKJ	5
Transient Air	A volume of air (such as bubbles) which is moving through the pipeline	MTA	2
Turbidity	Cloudiness or haziness of a fluid caused by large numbers of tiny particles that are generally invisible during an internal inspection (similar to smoke in air). The measurement of turbidity is a common test and one parameter used to classify general water quality.	MT	3

\*Partial List



# NEW PRESSURE PIPE ACCESS POINTS & MATERIALS



## ADDED

Access Points	PACP CODE
Gate Valve	AVG
Ball Valve	AVB
Blind Flange	AEP
Hydrant	AVH
Plug	AVP
Butterfly Valve	AVBF
NPT Fitting	ANPT
Corporation Stop	ACS
Open Channel	AOPN
Valve Intake	VI

Pressure Pipe Material List	PACP
Asbestos Cement Pipe (ACP)	ACP
Bar-Wrapped Concrete Cylinder Pipe (BWP or BWCCP)	
Cast Iron Pipe (CIP)/Pit Cast	CAS
Cast Iron Pipe (CIP)/Spun Cast	CAS
Cast Iron Pipe (CIP) – Lined/Cement	CAS
Cast Iron Pipe (CIP) – Lined/Bituminous	CAS
Cast Iron Pipe (CIP) – Unlined/Pit Cast	CAS
Cast Iron Pipe (CIP) – Unlined/Spun Cast	CAS
Copper Pipe (CP)	
Cross-Linked Polyethylene Pipe (PEX)	PE
Ductile Iron Pipe (DIP) – Unlined	DIP
Ductile Iron Pipe (DIP) – Lined /Cement	DIP
Ductile Iron Pipe (DIP) – Lined/Epoxy	DIP
Ductile Iron Pipe (DIP) – Lined/Bituminous	DIP
Galvanized Steel Pipe (GSP)	SP
Gray Iron Pipe (GIP)	CAS
High Density Polyethylene Pipe (HDPE)	PE
Polyethylene Pipe (PE)	PE
Polyvinyl Chloride Pipe (PVC)	PVC
Prestressed Concrete Cylinder Pipe (PCCP)	PCCP
[Riveted Pipe]	RP



# NEW PERFORATED PIPE SCORES



## Appendix C - PACP Condition Grading System



Description	Code	Structural Grade			O&M Grade
		Sewer/Combined/ Stormwater	Levee/Dam	Perforated Storm	
<b>COLLAPSE</b>					
Collapse	X	5	5	5	
<b>JOINT</b>					
Joint Offset Small (Displaced)	JOS	1	4	1	
Joint Offset Small Defective	JOSD	2	5	5	
Joint Offset Medium	JOM	4	5	3	
Joint Offset Medium Defective	JOMD	4	5	5	4
Joint Offset Large	JOL	5	5	5	
Joint Offset Large Defective	JOLD	5	5	5	5
Joint Separated Small (Open)	JSS	1	5	1	
Joint Separated Medium	JSM	4	5	3	
Joint Separated Large	JSL	5	5	5	
Joint Angular Small	JAS	1	4	1	
Joint Angular Medium	JAM	3	5	3	
Joint Angular Large	JAL	5	5	5	



- Evaluating Condition Grades
- Assessing Risk

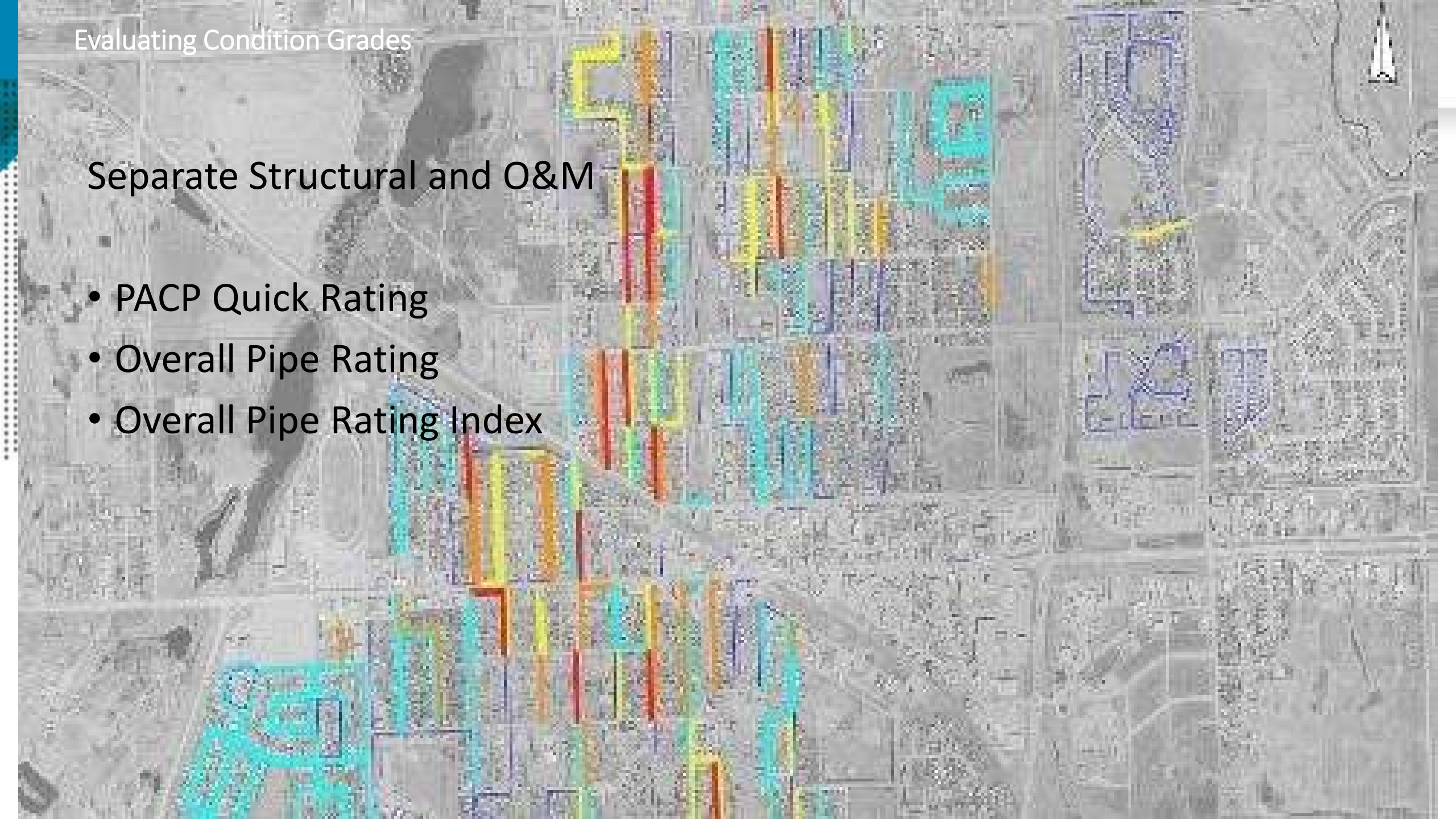
**Likelihood of Failure**

Very High	Immediate Rehab Replace	Immediate Rehab Replace	Immediate Rehab Replace	Immediate Rehab / Replace	Immediate Rehab / Replace
High	Immediate Rehab Replace	Immediate Rehab Replace	Immediate Rehab Replace	Immediate Rehab / Replace	Immediate Rehab / Replace
Medium	Medium Term Rehab Replace	Medium Term Rehab Replace	Medium Term Rehab Replace	Monitor Assess Frequently	Monitor Assess Frequently
Low	Long Term Rehab / Replace	Long Term Rehab / Replace	Medium Term Rehab / Replace	Monitor Assess Frequently	Monitor Assess Frequently
Very Low	Long Term Rehab / Replace	Long Term Rehab / Replace	Medium Term Rehab / Replace	Monitor Assess Frequently	Monitor Assess Frequently
	Very Low	Low	Medium	High	Very High

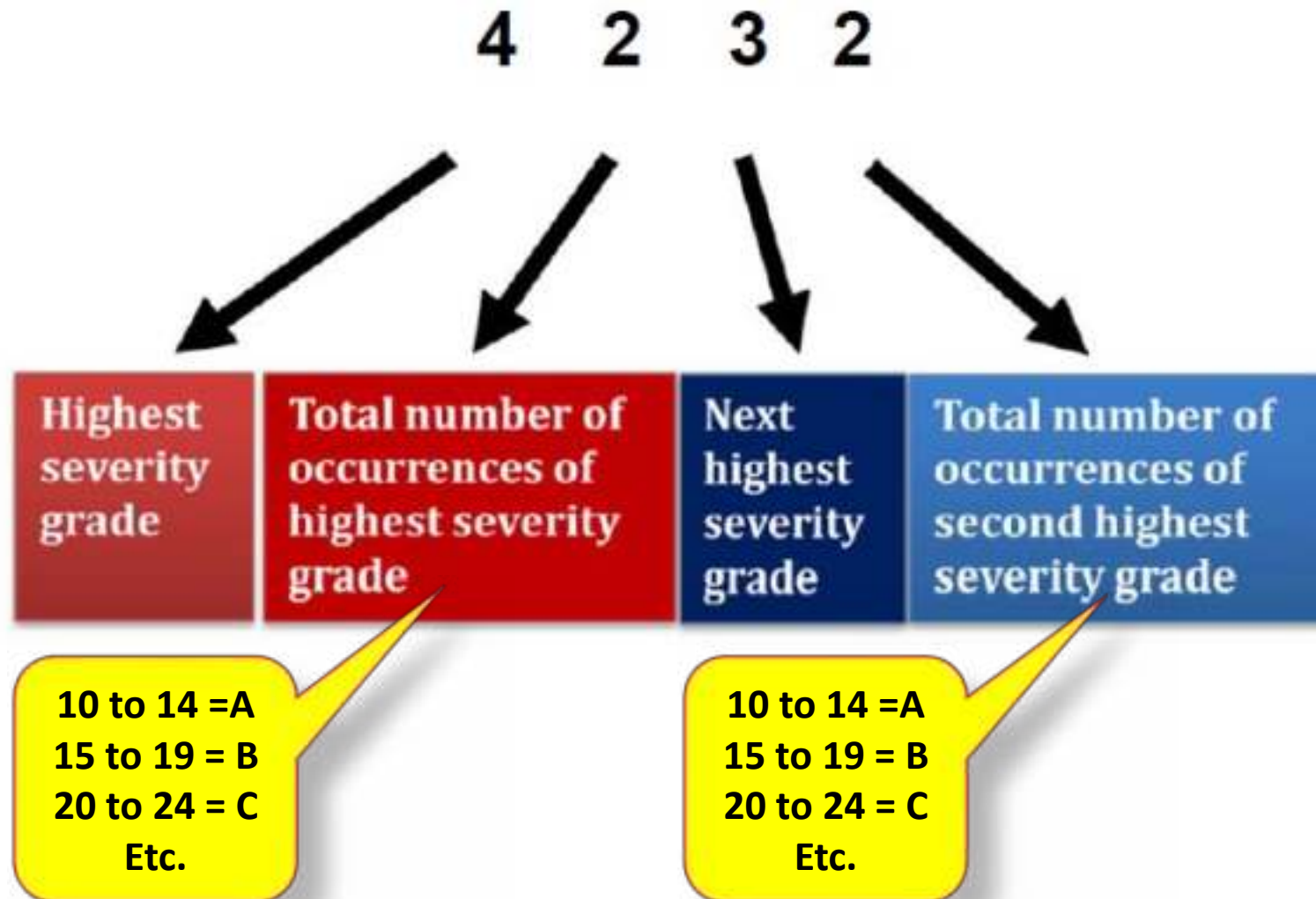
**Consequence of Failure**

## Separate Structural and O&M

- PACP Quick Rating
- Overall Pipe Rating
- Overall Pipe Rating Index



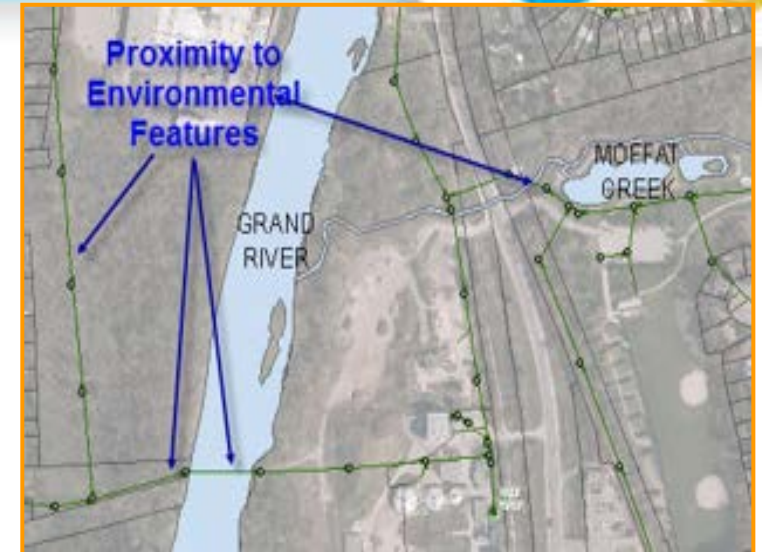




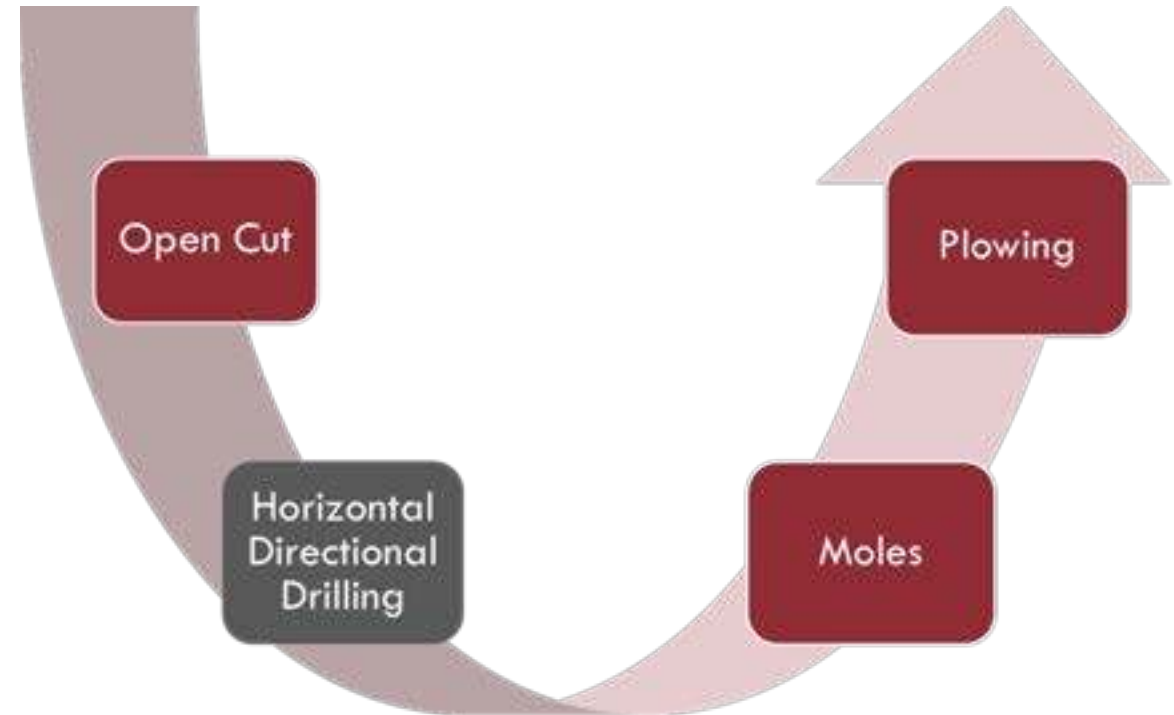


GRADE	STRUCTURAL	INFILTRATION	O & M	
1				
2				
3				
4				
5				

- Appendix D provides a basic introduction of how to use PACP in conjunction with other factors to assess risk.
- Target Audience: Utility Managers and Engineers or anyone interested in learning more
- Content:
  - Using assessment results combined with other tools to better manage assets
  - Guiding predictive maintenance, rehabilitation and/or replacement







## Methods for Utility Installation

# How Cross Bores Happen

- More utilities are being installed or updated underground
- Limited width to work, due to utility easement size
- Common options to install new utilities are:
  - dig deeper, or
  - Use HDD





- **SPECIFICATION GUIDELINE**

for

Cross Bore Prevention and  
Detection

Available at [NASSCO.ORG](http://NASSCO.ORG)



**NASSCO**



# NASSCO CLEANING SPECIFICATION GUIDELINE

Phase 1 Pre-cleaning Inspection. a. The preferred method for Pre-Cleaning Inspection is color CCTV conforming to NASSCO Pipeline Assessment Certification Program (PACP), and for the data to be exported electronically in a PACP certified format. Since this inspection is performed prior to cleaning, it is understood that the video may not provide an “unobstructed view of the entire pipe”.

1. SAFETY
2. DAMAGE
3. EFFICIENCY





# QUESTIONS?



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