Bearspaw South Feeder Main Pipe Investigation Findings

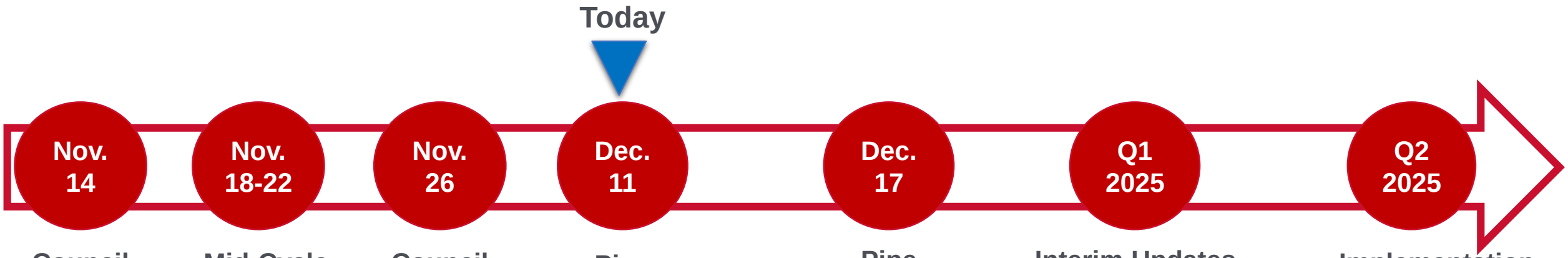
IP2024-1237
December 11, 2024

Purpose of today's discussion

To provide an update on:

1. The final detailed results of the pipe investigation from Associated Engineering.
2. The process for prioritizing asset condition assessments and managing risk.

Current timeline



Council Information Session

Mid-Cycle Adjustments

Council Update

Pipe Investigation Findings to Infrastructure & Planning Committee

Pipe Investigation Findings to Regular Meeting of Council

Interim Updates

Including updates on:

- Resilience for the Bearspaw South Feeder Main
- North and South Water Servicing
- Response report

Implementation Plan and Recommendations

Keep the public informed – at key milestones

Recommendations:

That Infrastructure and Planning Committee recommend that Council:

1. Receive this report for the Corporate Record.

That Infrastructure and Planning Committee:

1. Forward this report to the 2024 December 17 Regular Meeting of Council.

Results of the pipe investigation

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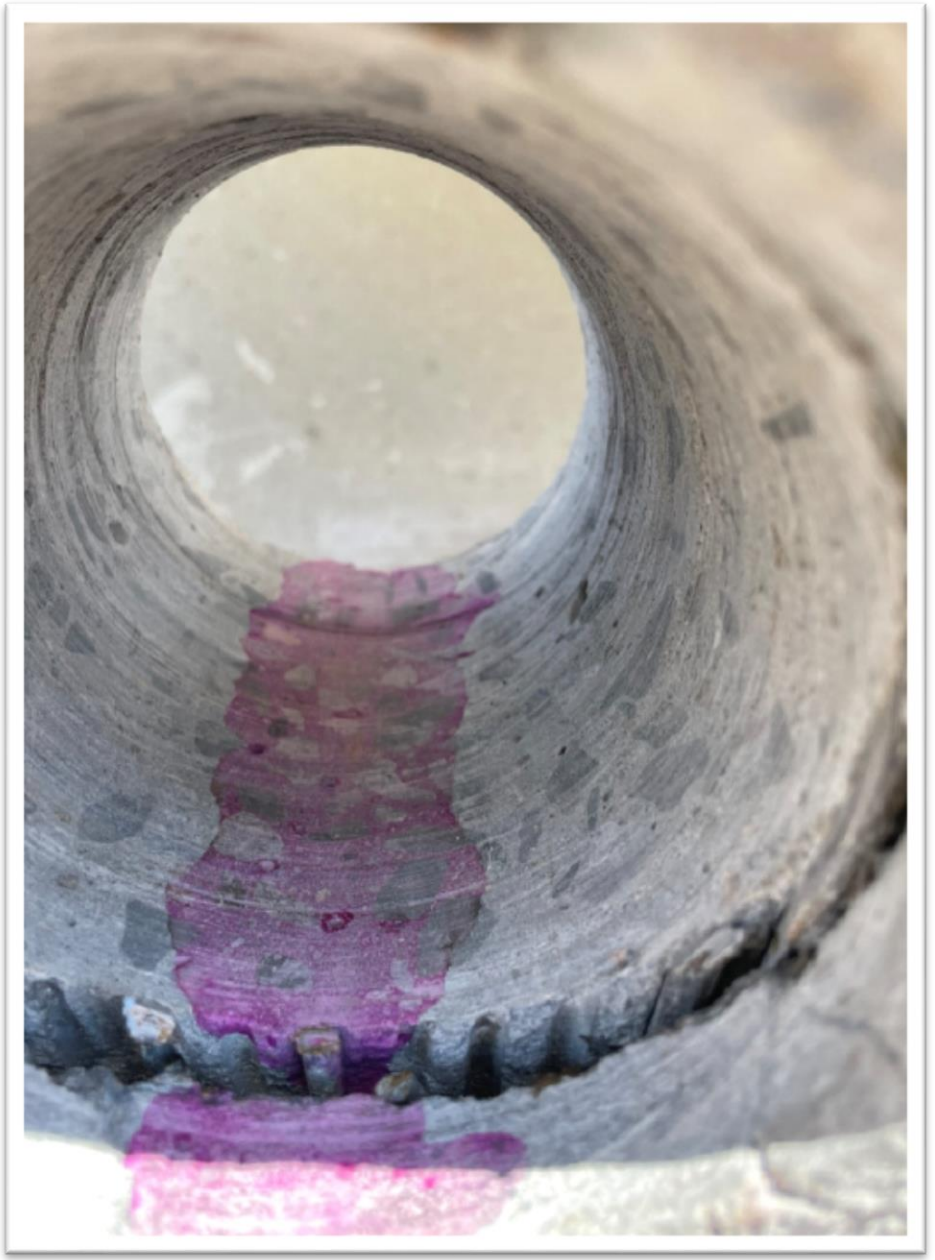
Pipe investigation - overview

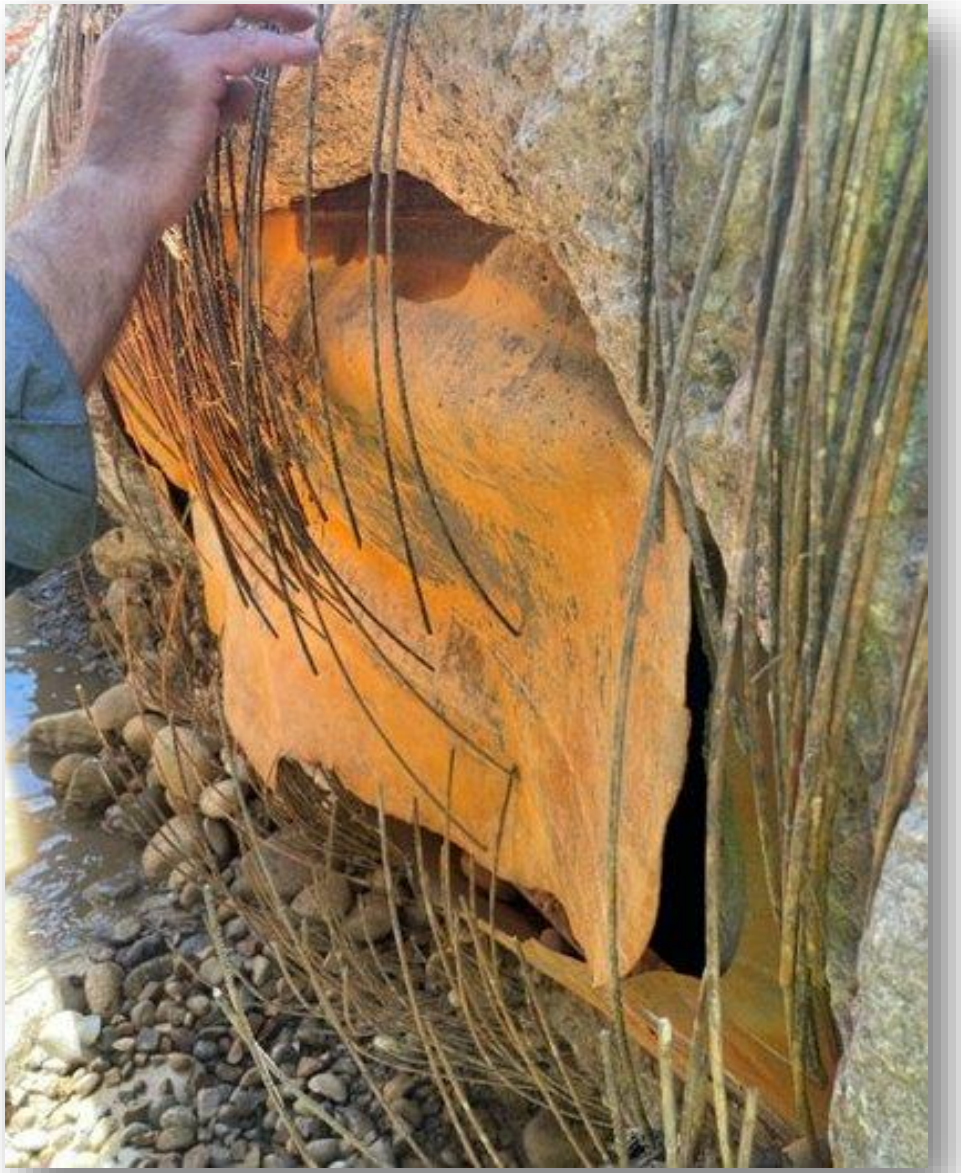
Understand the factors that led to the deterioration of the Bearspaw South Feeder Main and its failure on June 5, 2024.

The findings will inform asset management decisions and future infrastructure investments.

Associated Engineering



Cause of the 2024 June 5th failure



"The cause of the June 5 failure was the **breakage of a sufficient number of prestress wires** in a pipe segment causing loss of pressure resisting capability in the pipe."

"...the **ruptured pipe experienced microcracking or previous mortar damage** allowing soil interaction with the prestress wires. The compromised mortar allowed **Stress Corrosion Cracking and/or Hydrogen Embrittlement** of the prestress wires resulting in brittle wire failures/fractures."

Results of the pipe investigation

Factors believed **not** to have contributed to the failure:

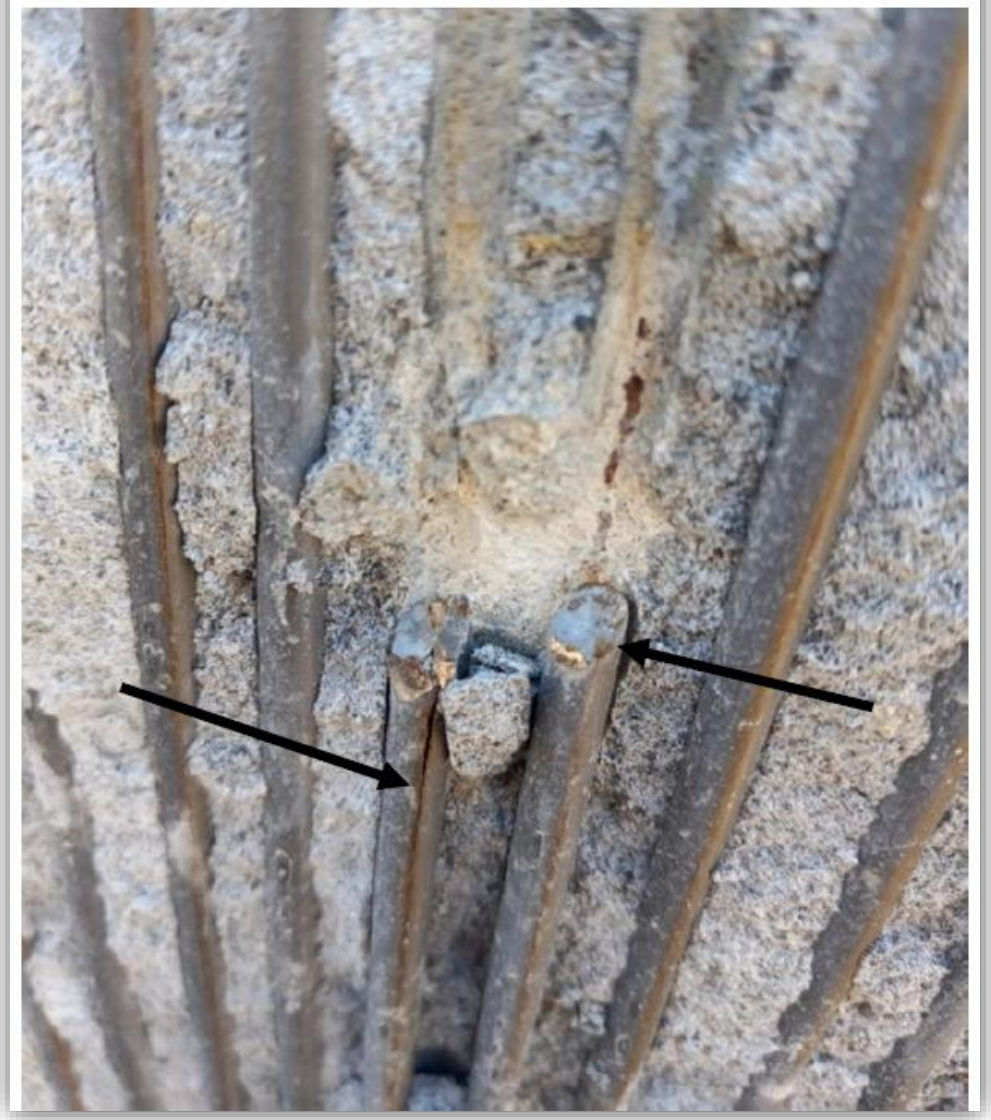
- No information indicates that the **manufacturing standards** in 1975 were not followed.
- **Live loading** subsequent to the construction in 1975 is not believed to be a contributing factor.
- **Stray current induced corrosion** does not appear to be present.
- Operations did not create an over or under **pressure situation** that contributed to the failure.
- A **transient pressure** event did not occur immediately before the rupture.

Results of the pipe investigation (continued)

The investigation report yielded the following observations relative to the ruptured and distressed portions of pipe:

- Some pipes showed visible **mortar cracking**, while other pipe had intact mortar.
- Some distressed pipes did have **chlorides penetrate** the mortar, while others showed none.
- Soil testing showed **high chloride soils** in certain areas.
- Severe **pitting and corrosion of the prestress wires** was present, as well as significant quantities of **brittle wire failure**.
- Evidence of **Hydrogen Embrittlement and Stress Corrosion Cracking** due to chloride penetration of the mortar and/or microcracking.

Figure 3-22 Pipe 20202 – Evidence of Brittle Failures

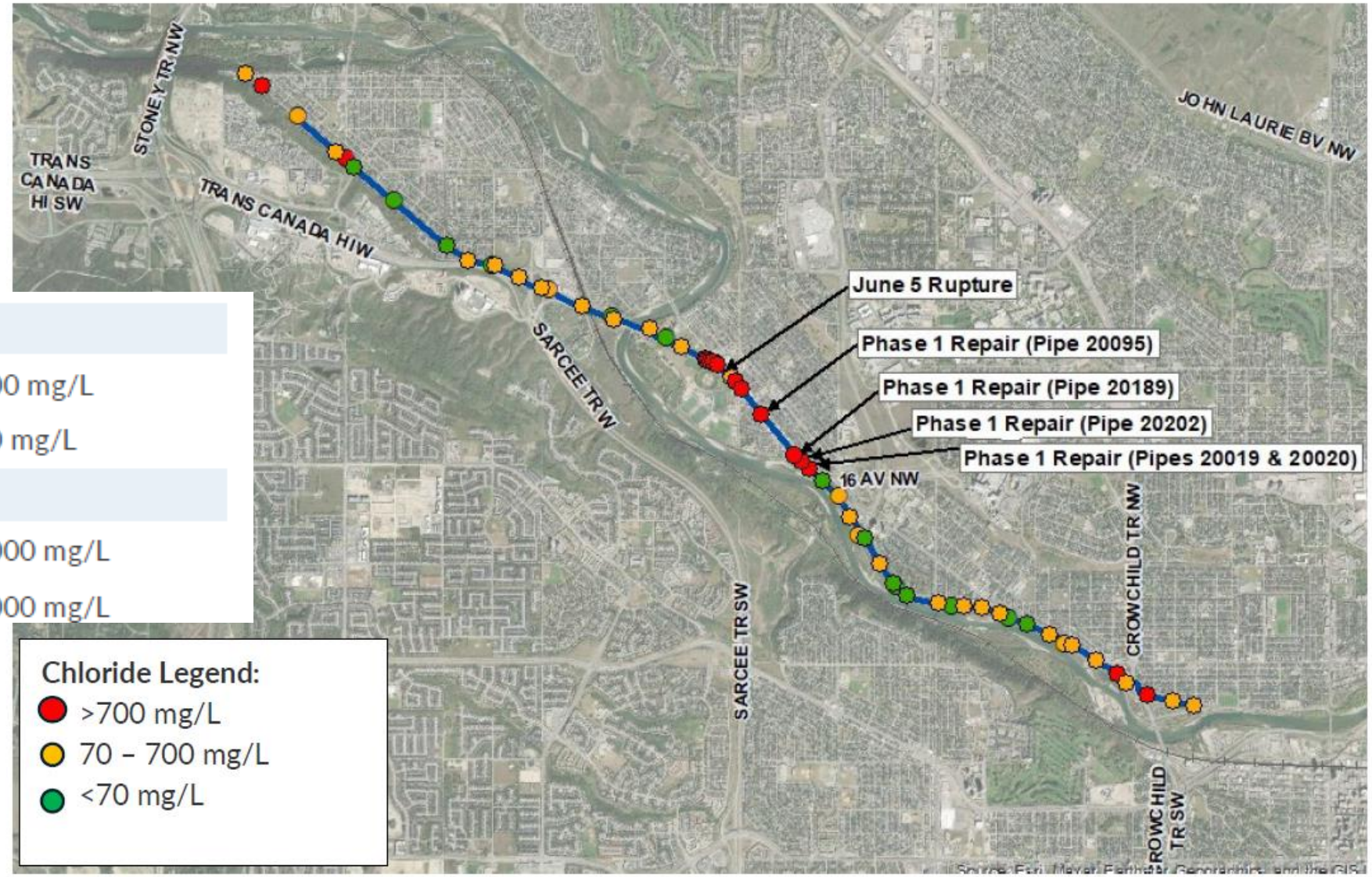


Results of environmental investigation: chlorides

Strong correlation between distress and chlorides.

Chlorides	
Corrosive	> 700 mg/L
Moderately Corrosive	> 70 mg/L
Sulphate	
Aggressive	> 2000 mg/L
Moderately Aggressive	> 1000 mg/L

Figure 8-1 Chloride Levels– mg/L



Results of metallurgical analysis

Strong correlation between distress and chlorides, and likelihood of de-icers contributing to elevated chlorides.

- The **steel cylinder and wires met standards** at the time of manufacturing.
- The **prestress wires had poor torsional ductility** - not a requirement at the time.
- Some had **longitudinal splits**.
- The wire used in **the pipe that failed had hydrogen embrittlement sensitivity**.
- The wire used in the **5 hot spot pipe had some sensitivity to hydrogen embrittlement**.

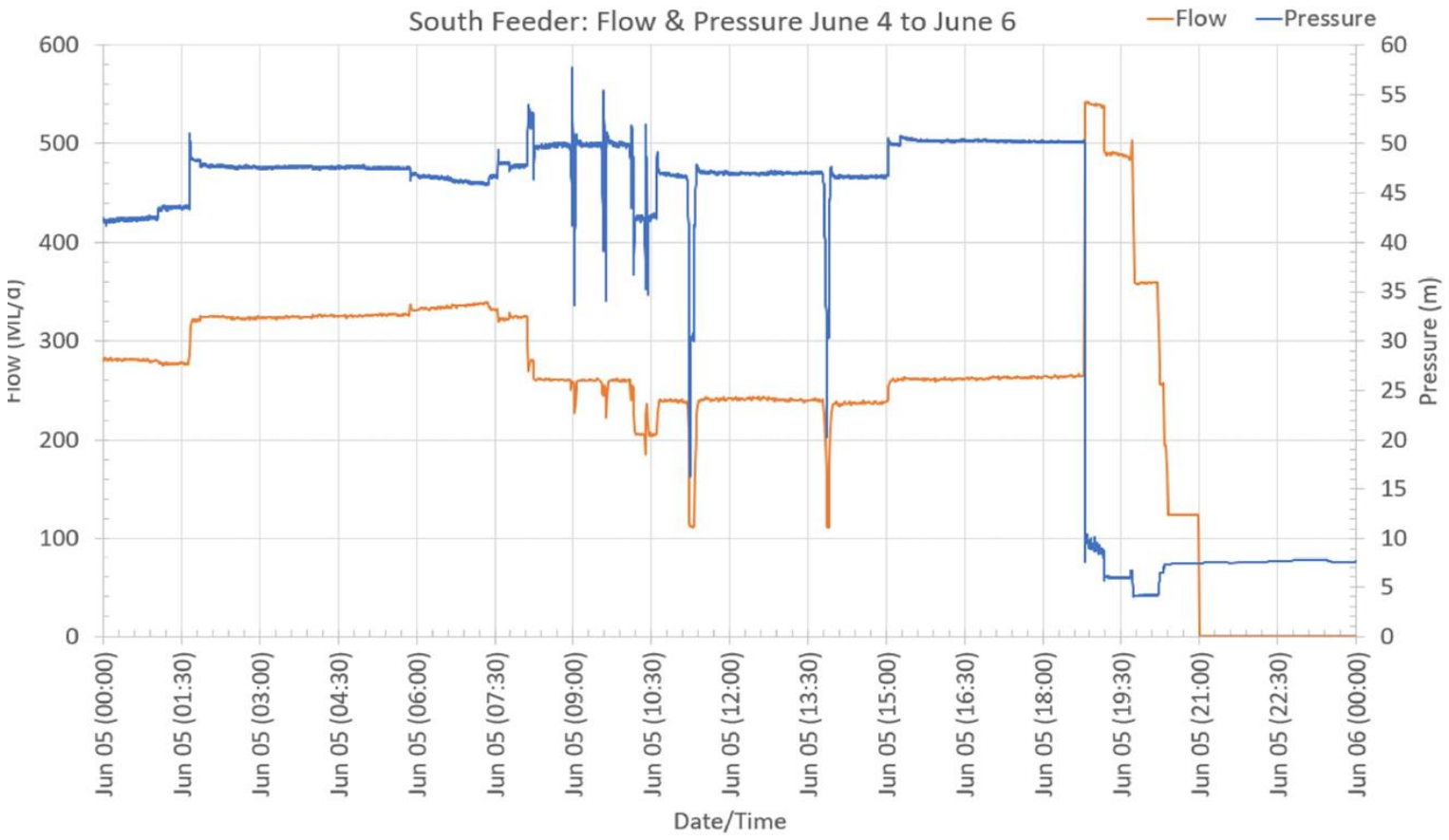
Additional findings

Stray Current Analysis:
- No significant levels of stray current found.

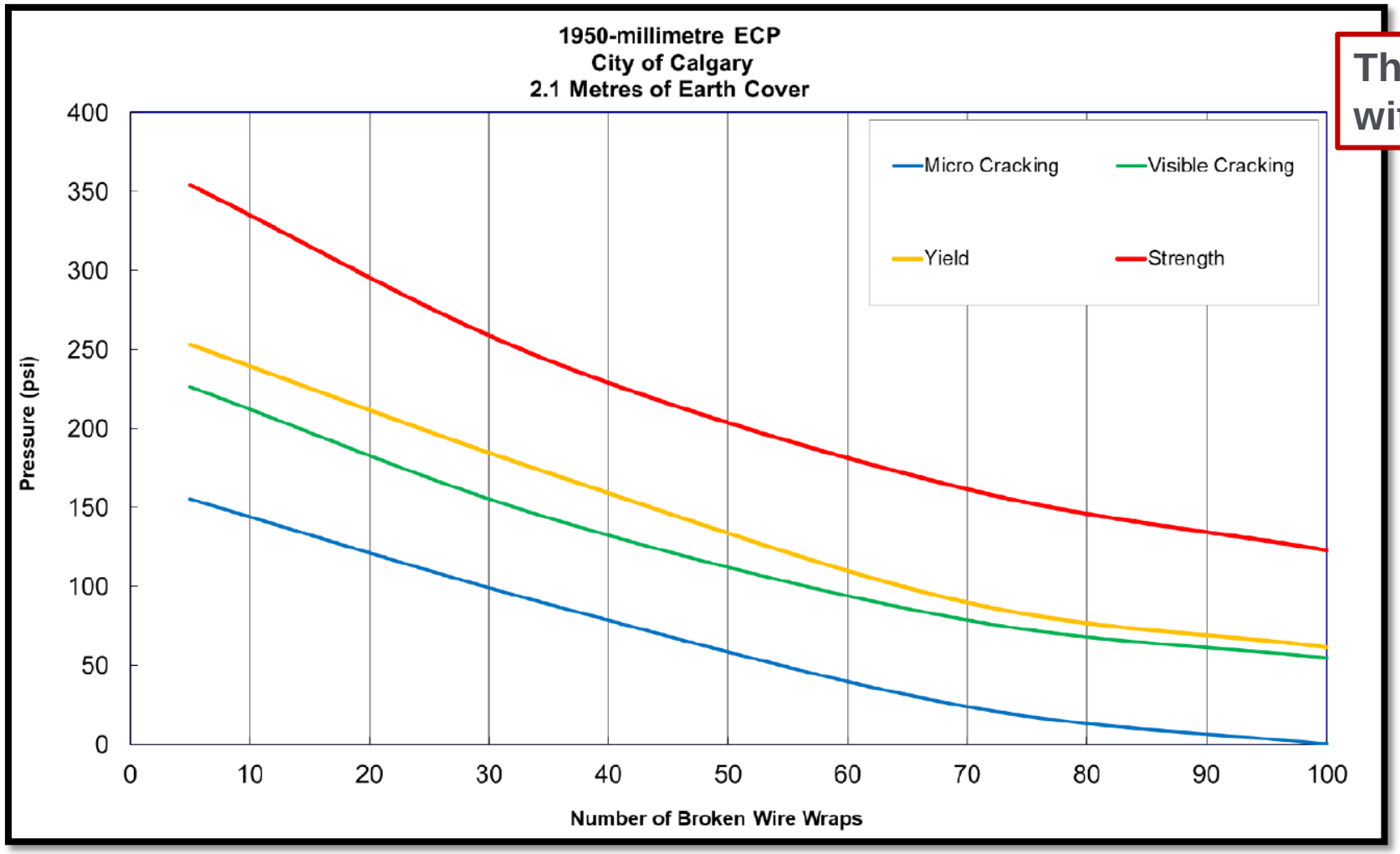
Pump Operations:
- No evidence of over or under pressure situation.
- A transient pressure event did not occur before the break.

Live Load:
- Live loading subsequent to construction not believed to be a contributing factor.

Stray current, operation and live loads not a factor.



Finite element analysis

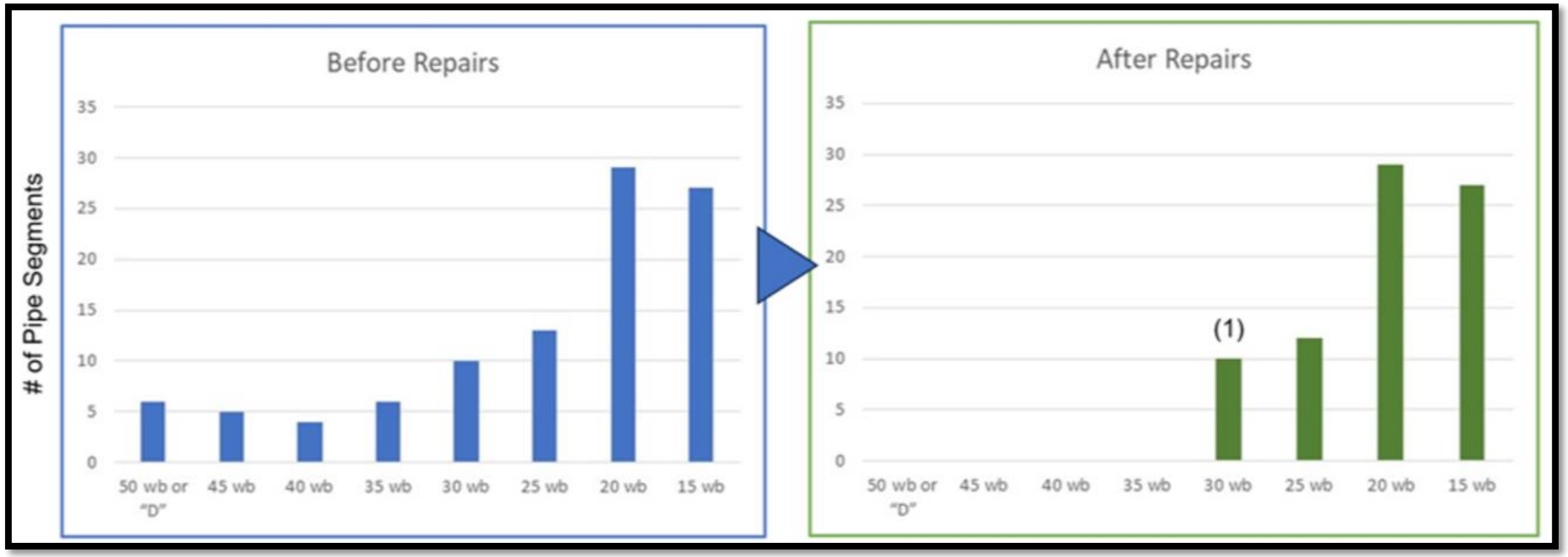


The pipe was being operated within structural limits.

Normal working pressure are well within the yield strength and ultimate strength of the pipe.

Pipes could possibly experience microcracking due to mild transient events.

Results of electromagnetic inspection: overall pipe condition



Number of Reinforcing Wire Breaks per Pipe	Recommended Action
0-5	Reinspect at a later date
6-25	Monitor with acoustic monitoring
26-50	Monitor and repair as soon as practical
50+	Emergency Shutdown and Replacement

The feeder main is in good to fair condition, it has stabilized and is being monitored continuously.

Prioritizing asset condition assessments and managing risk

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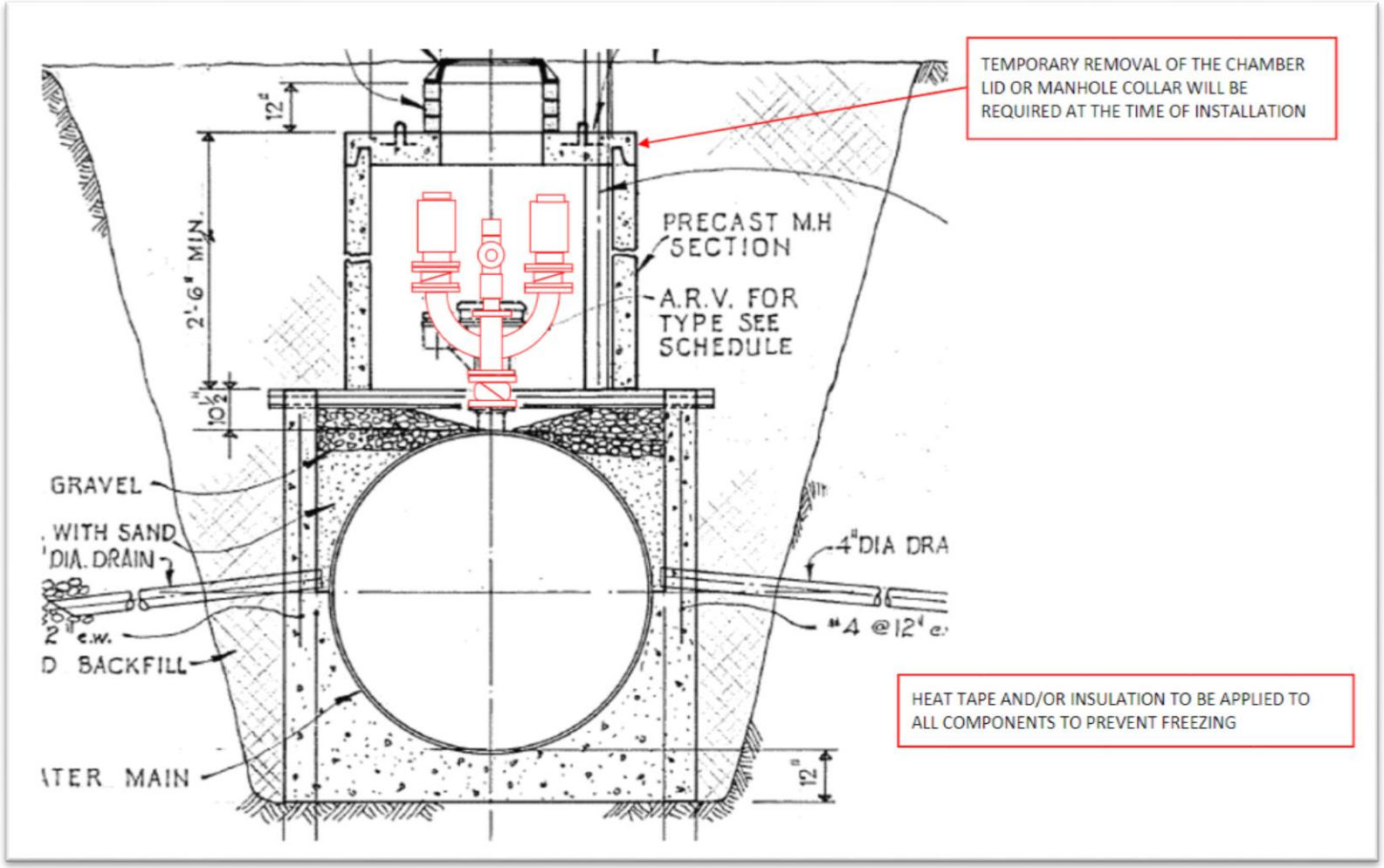
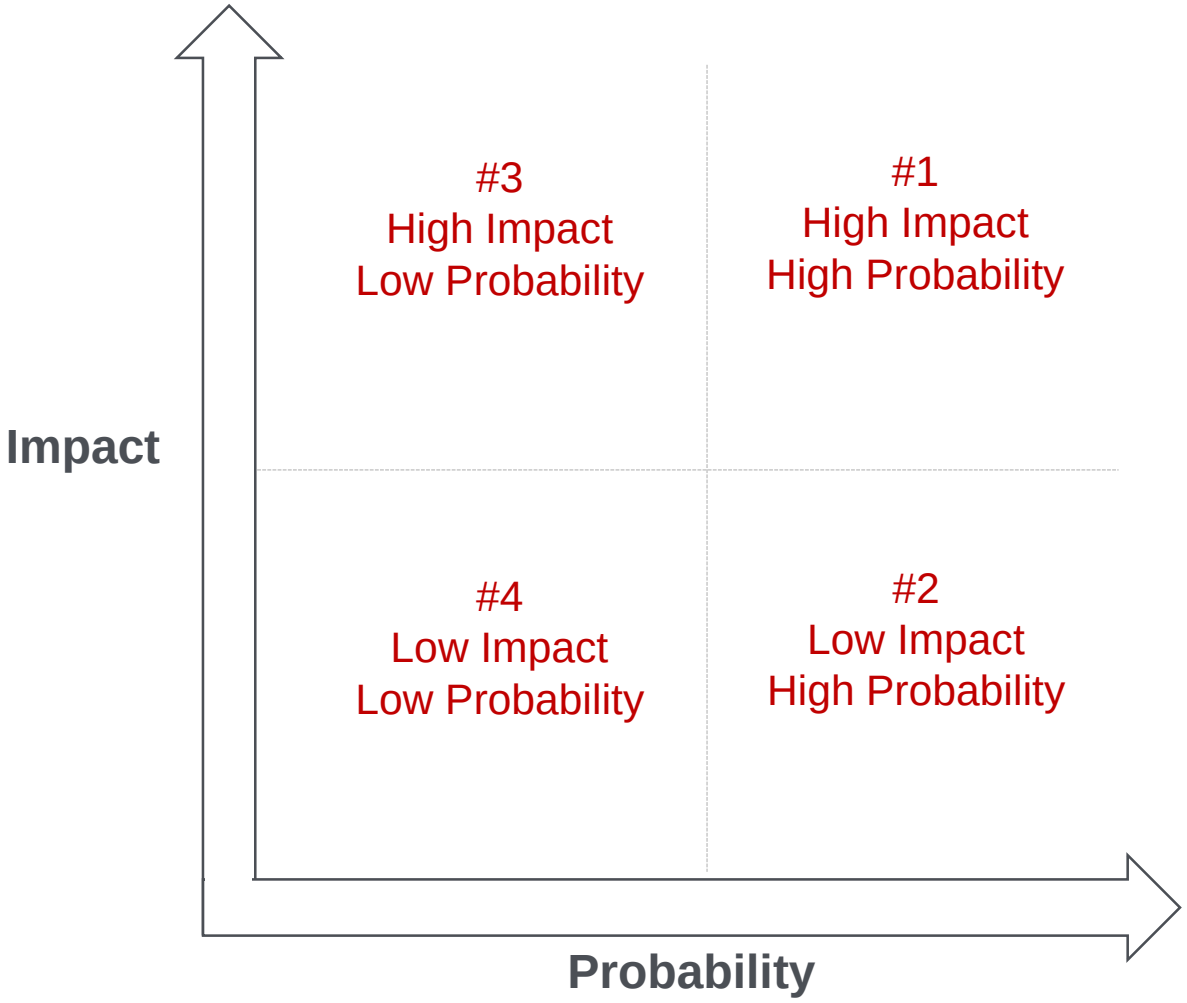
Process to inspect the bearspaw south feeder main



Preparatory work was underway and required 3 years to execute.

- Modeling system impacts to service disruption.
- Develop emergency response and service continuity plans.
- Modify plant and pipe.
- Detailed shutdown and recommissioning.
- Testing to confirm procedures.
- Install pressure and structural monitors.

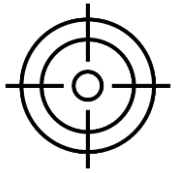
Prioritizing asset inspections based on risk



- Establish asset quadrant.
- Identify which are scheduled for upgrade, recently upgraded or to be assessed.
- Update as understanding of risk of failure and asset life cycle evolves.

How we will use this information to improve our asset management approaches

1. Increase our **soil sampling** along critical feeder mains with a specific focus on Chlorides.



2. Include the identified mechanisms as a factors to **focus ongoing feeder main risk assessment and redundancy,** monitoring activities and inspection priorities.

3. Continue to investigate the factors that lead to the intermittent presence of **chlorides in soil**.

4. Review **design guideline** for new feeder mains (including monitoring technology).

Bearspaw South Feeder Main – Next Steps

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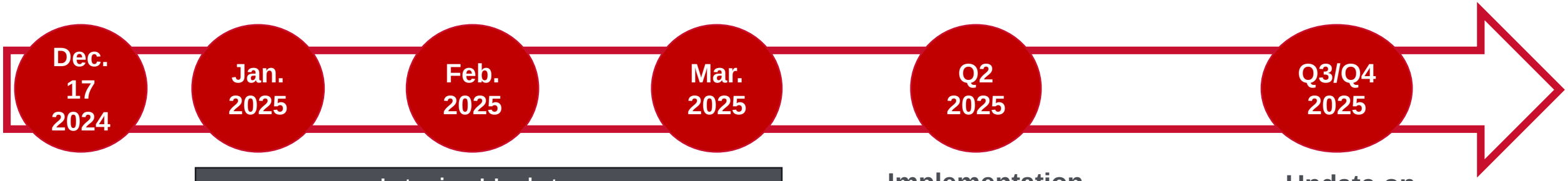
Next steps 2024/2025



Regular Meeting of Council

Interim Updates:

- **Redundancy for the Bearspaw South Feeder Main - North and South Water Servicing** (to Infrastructure & Planning Committee)
- **Bearspaw Emergency Response Review** (to Council)
- **Infrastructure Status Report** (to Infrastructure & Planning Committee)

Implementation Plan
to Infrastructure & Planning Committee

Update on Implementation
to Infrastructure & Planning Committee

Recommendations:

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