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Towards an exit assessment program for PVC drinking water pipes

Added value of a failure registration database

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How do we work at KWR?

KWR is an independent and non-profit knowledge enterprise



KWR has:

- 200+ employees with a strong international presence (~20%)
- Close ties with drinking water utilities (shareholders/clients)
- Employees with diverse expertise's related to drinking water



Regular interaction with practitioners during definition, execution, and completion of project



Research themes surrounding the Dutch drinking water supply



Water quality:

1. Chemical
2. Biological
3. Sediment

Future-proof supply:

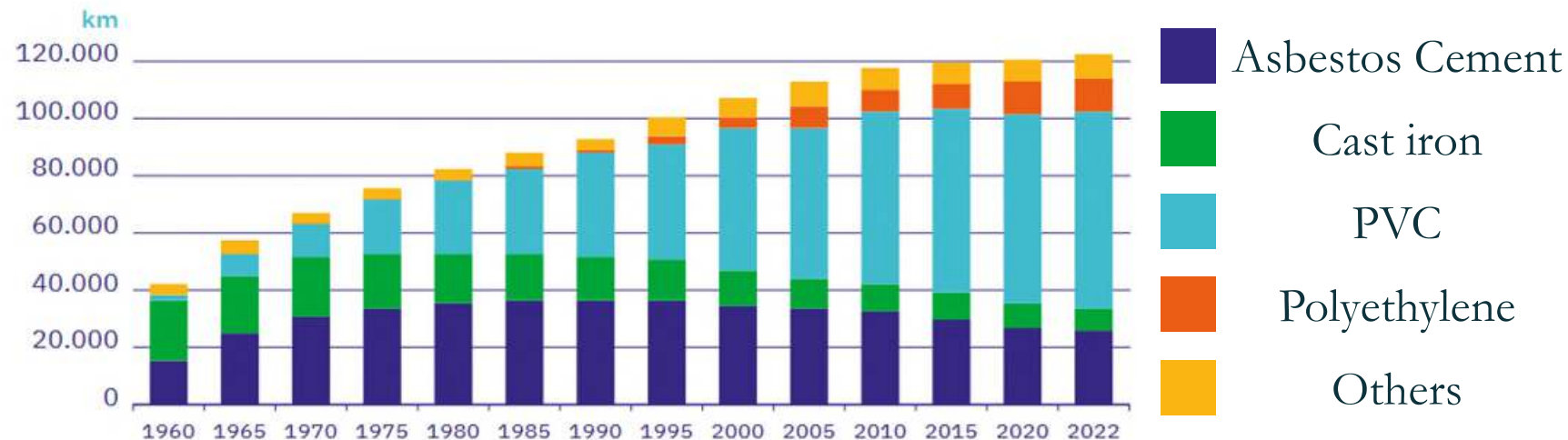
1. Water demand
2. Optimal network design
3. Digital technology

Asset management:

1. Condition assessment
2. Decision making
3. Collaboration underground

Conundrum: Which PVC pipes should be prioritized for replacement?

Replacing 600 km PVC (1%) in a year costs €150M!



Source: Kerngegevens drinkwater 2023, VEWIN

USTORE – failure registration database for Dutch drinking water utilities



Pipe information

Material, Installation year,
Diameter, Total length



Failure information

Date, Material, Installation
Year, Diameter, Type of
Object, Failure mode,
Cause...



KWR PCD 9 | december 2022

Uniforme storingsregistratie (USTORE)



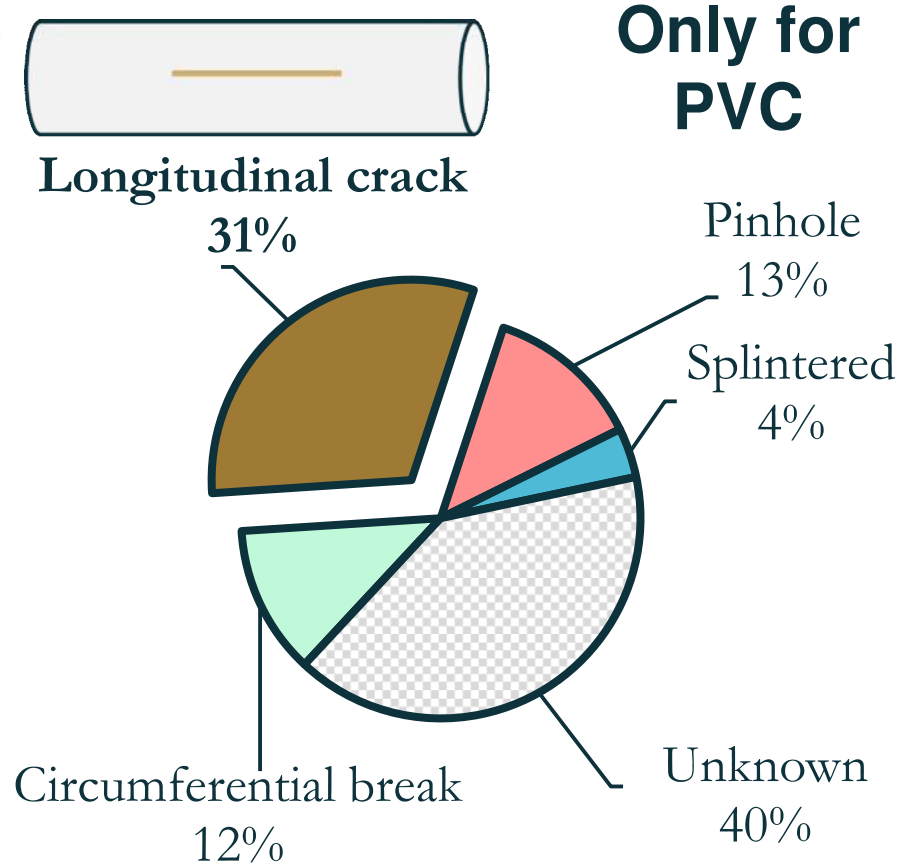
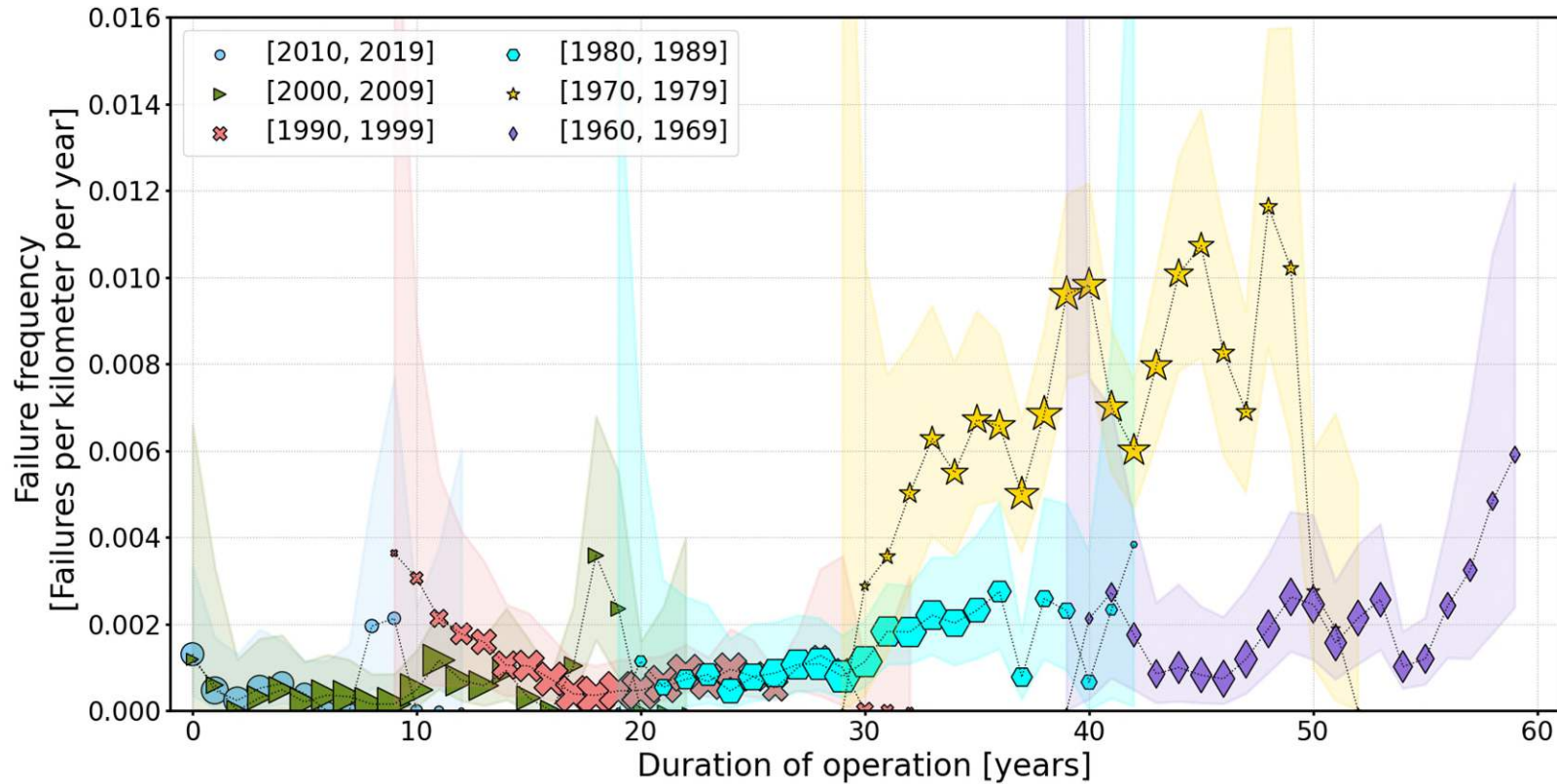
Praktijkcode voor het beheer van storingsregistratie van leidingnetten

National code of practice

35000+ failures registered since 2009 (8300+ for PVC and PVC-O)

Reading the graph: For PVC pipes installed between years Z_1 and Z_2 , after X years of operation, there are Y failures per kilometer per year with a longitudinal crack

USTORE helps assess performance of various pipe groups

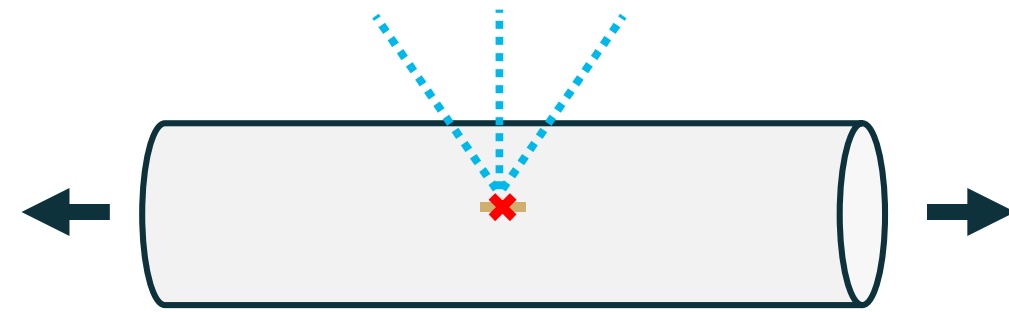


Possible explanation: PVC pipe production still maturing in 1970's (good and bad pipes produced)
Data reveals performance but not the causality

Understanding longitudinal cracks

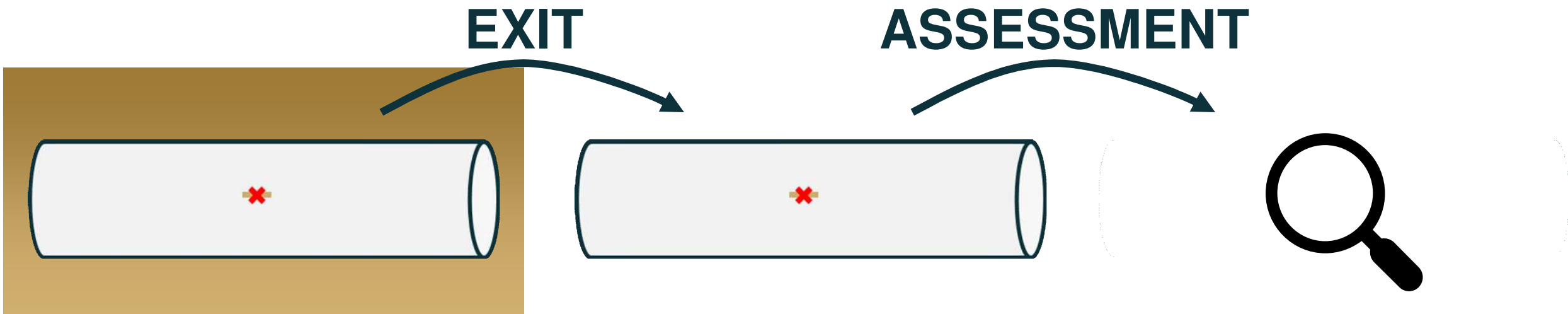
“The long-term performance of PVC pressure pipes is an interplay between the matrix strength, the defect spectrum and the loading conditions.”

P.J.F. van den Heuvel, “Limitation of long-term brittle failures through quality control of commercial PVC pressure pipes” (1982)



How pipes fail through crack growth:

1. Crack initiates near existing defect
2. Crack grows slowly in time
3. Crack grows unstably and rapidly



15+ years experience with exit assessments:

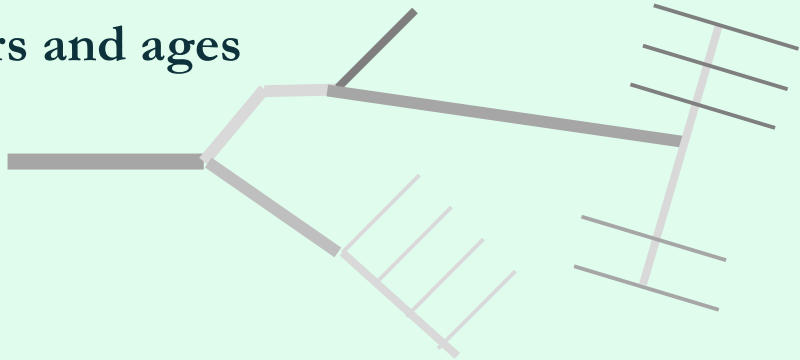
- Only 50 specimens assessed
- Too many damaged specimens, too few intact specimens

kiwa

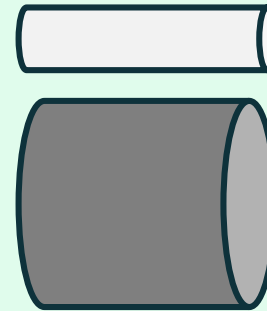
TNO

Multi-year exit assessment program to aid strategic pipe replacement

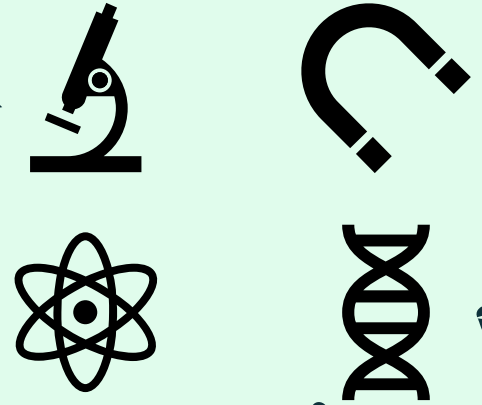
Network with PVC pipes of various diameters and ages



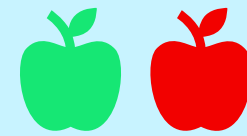
Pipe selection through USTORE and exhumation



Array of laboratory tests on exhumed pipe segments

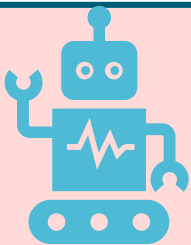


Which pipes are vulnerable and should be prioritized for replacement?

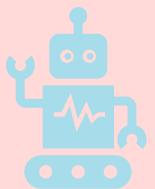


Identification of good and bad apples

Matured in-line inspection techniques

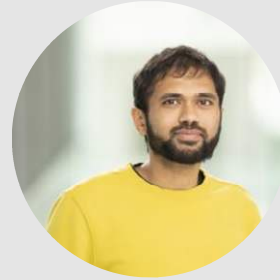


Validation of maturing in-line inspection techniques



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Collaborations are welcome ...

Take-home message: There will be a coordinated exit assessment program for PVC pipes to assist decision-making for asset managers at drinking water utilities.



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