

Finding Every Drop

PUB's Evolving Approach to Leak Management

Muhammad Yunos bin Ab Rani| Senior Engineer

PUB, Singapore's National Water Agency

2 September 2026

MAKE
EVERY
DROP
COUNT

Presentation Outline

- Background
- PUB's Leak Management Framework
 - Pipeline Renewal Strategy
 - Surveillance and Enforcement
 - Proactive Leak Detection
 - Prompt Responses to Leaks and Repair
- Case Study
- Past, Present and Future

About Singapore



744.3 km²
Land Area



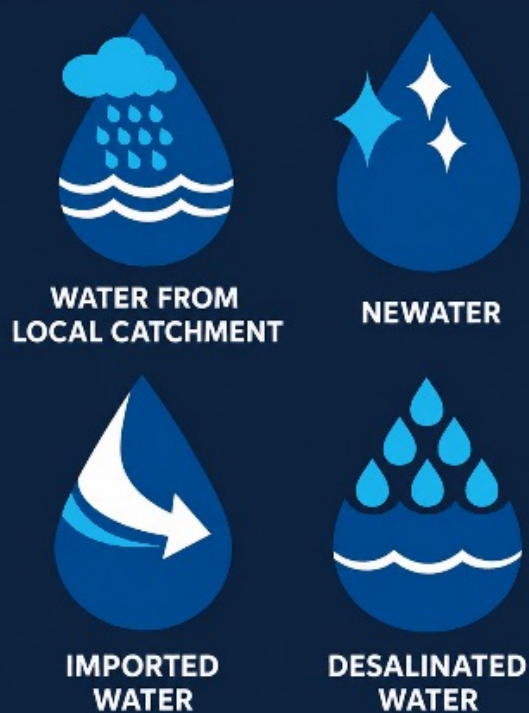
6.1 million
Population



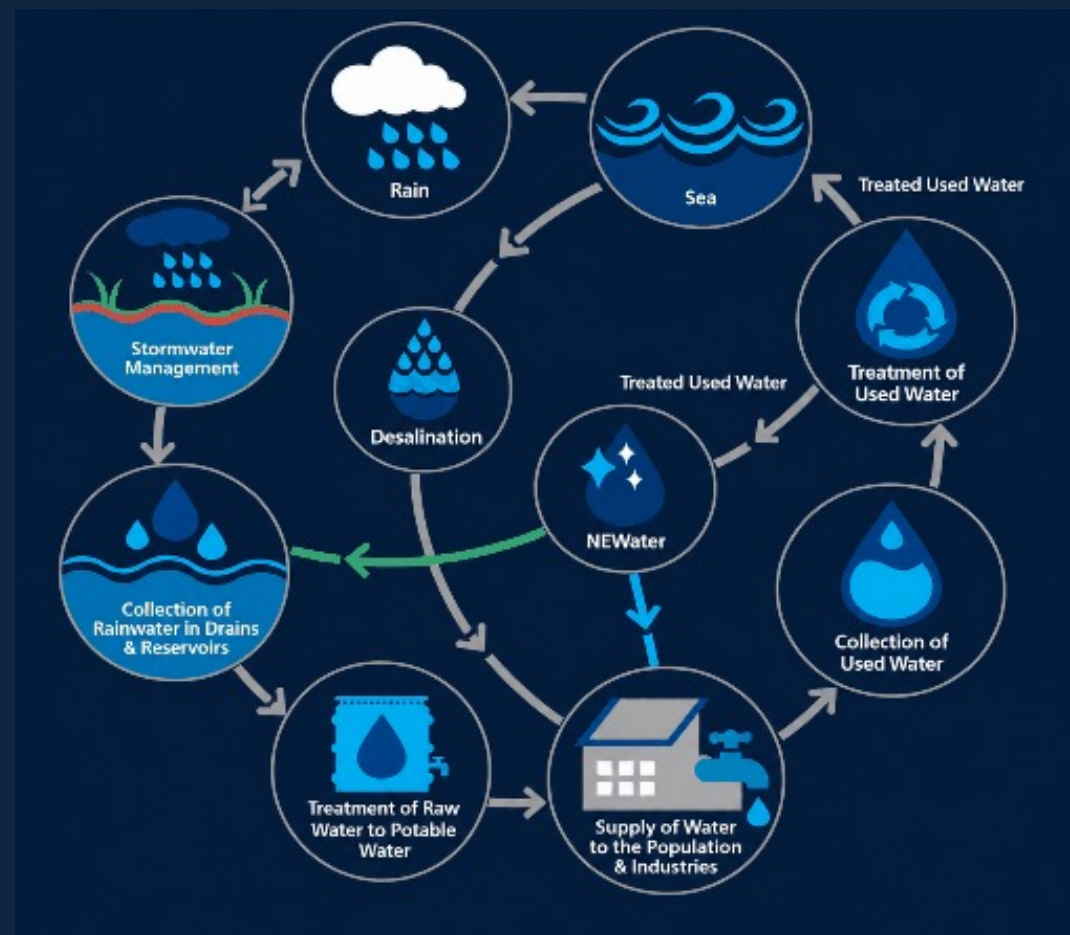
~2,984.9 mm
Annual Rainfall

Singapore's Water Sources

4 National Taps

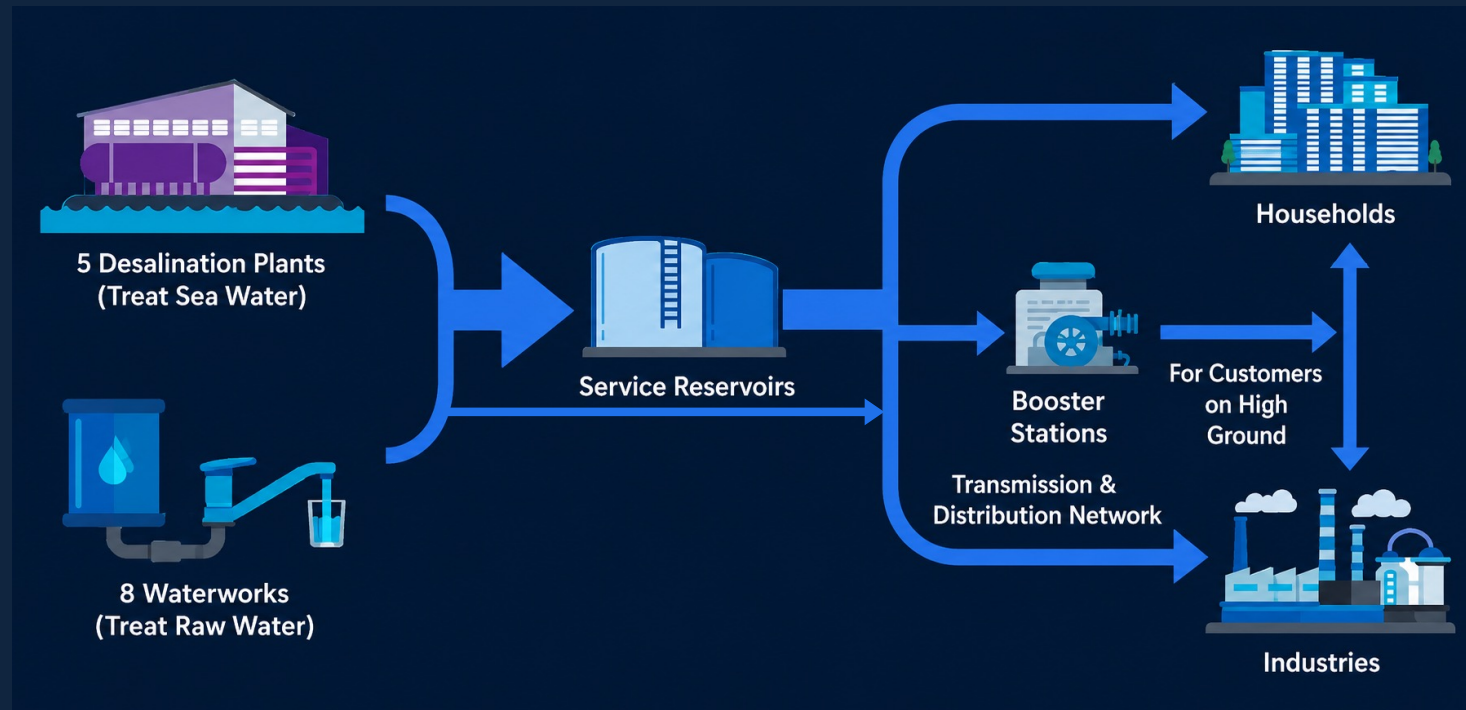


Water Loop



Mode of Supply

Potable water supply is largely distributed **indirectly** to customers under pressure via Service Reservoirs



- **Highly integrated network** dispatching treated water from various sources
- **Ring main system** to provide alternate feed
(Challenging to implement DMAs)



6,000 km

Length of Potable Watermains (PW)



1.7 million

No. of Customer Accounts



7.2 %

Distribution Loss



4.4

Leak on Mains / 100km



29

Average Age of PW Network

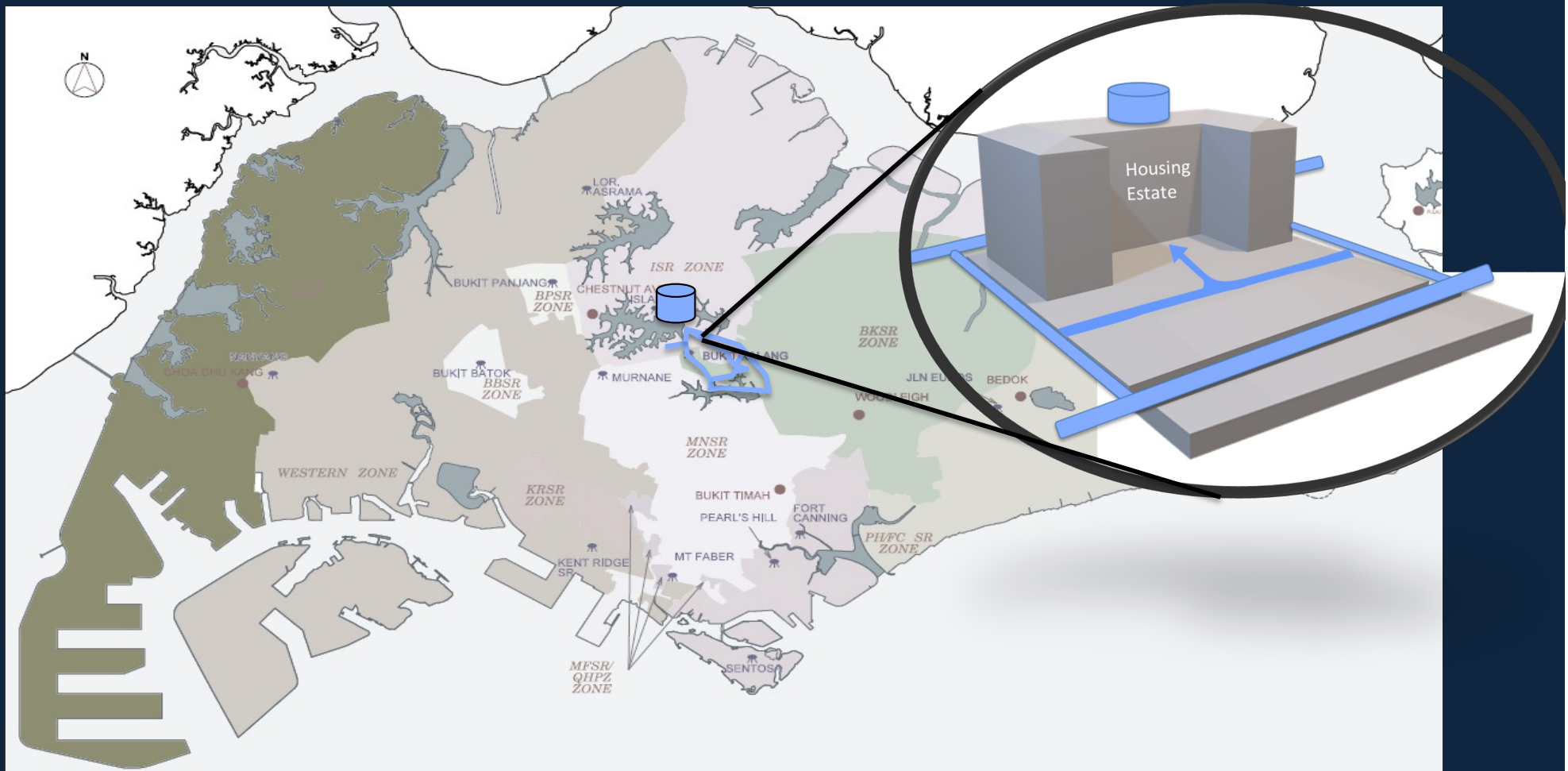


70 years

Economical Lifespan

Network Configuration to Ensure Supply Resilience

- **Flexible network configuration** to direct waterworks output into different raw water reservoirs
- **Looped network design** to ensure multiple feeds to each area
- **Water tank storage** for one day daily water requirements at buildings & critical installations



PUB's Leak Management Framework

(1) Pipeline Renewal



Targeted renewal plan based on risk-based analytics and supported by condition assessment tools

(2) Surveillance and Enforcement



Surveillance and enforcement regime to minimise damage to water pipelines

(3) Proactive Leak Detection



Use of smart solutions and technologies to improve leak detection efficiency and accuracy

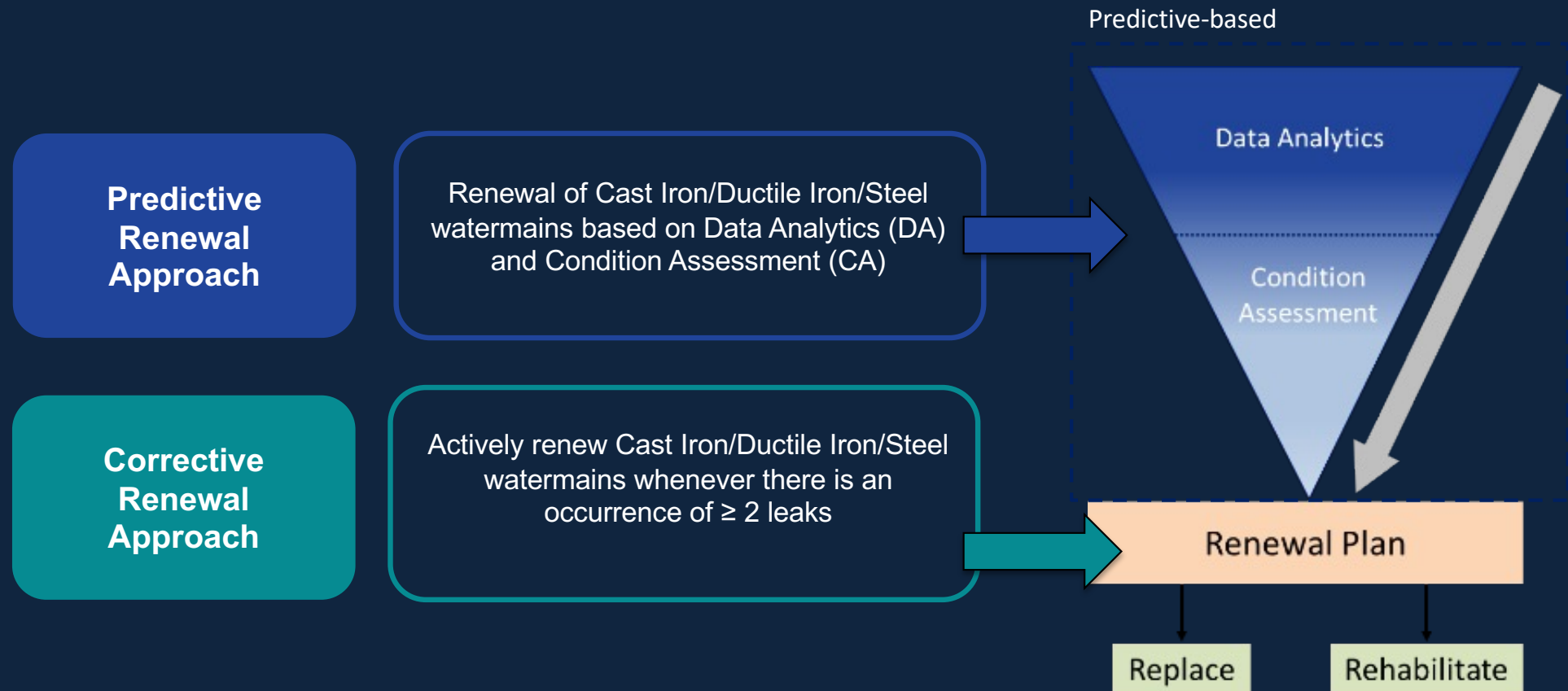
(4) Prompt Responses to Leaks and Repair



Leak response and repair workflow to minimise inconvenience to customers and minimise water loss

(1) Pipeline Renewal Strategy

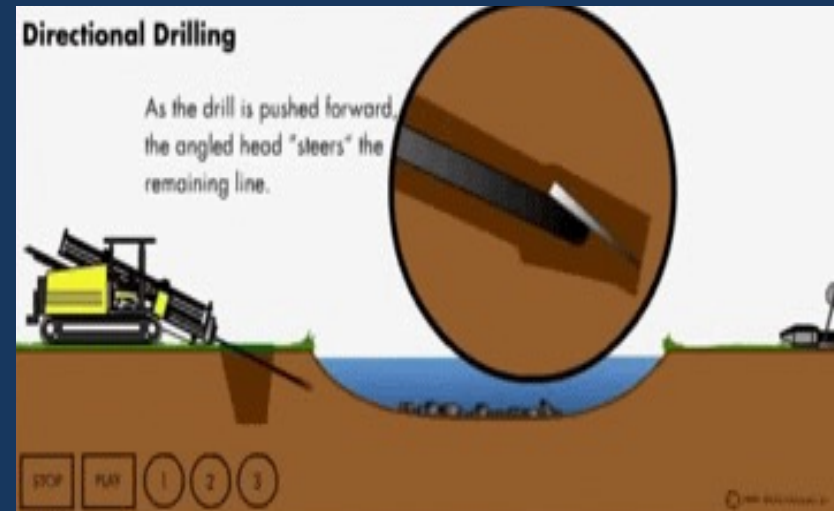
- We adopt a predictive renewal approach using data analytics and pipeline condition assessment to identify and prioritise at-risk pipelines for targeted renewal
- In addition, we also have a corrective renewal approach to renew leak-prone pipelines where there are known leaks



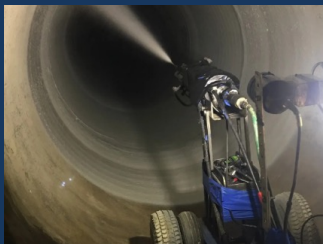
(1) Pipeline Renewal Strategy

Pipeline Renewal Methods

- Replacement via open-cut along same alignment
- Replacement via open-cut along alternate alignment
- Trenchless
 - Horizontal Directional Drilling
 - Pipe Jacking / Pipe Sleeving
 - Pipe Rehabilitation



Spray-in-Place Pipe



Flexible Composite Liner



Cured-in-Place Pipe



Fibre-Reinforced Polymer



(2) Surveillance and Enforcement Programme: Safeguarding Our Water Infrastructure



Protection of Water Pipes Infrastructure Regulations

- All works within water pipe corridor require submission for PUB's review and approval
- To minimize damage to the watermain and safeguard maintenance access



Site Surveillance at Work Sites

- Conduct regular site inspections
- Monitor worksite near transmission watermain using surveillance cameras
- GPS tagging on machinery for high-risk work (e.g. piling)

Verify compliance with approved plans and PUB requirements through inspection.



Water pipe alignment tagged and demarcated on site



Water valve tagged and demarcated on site

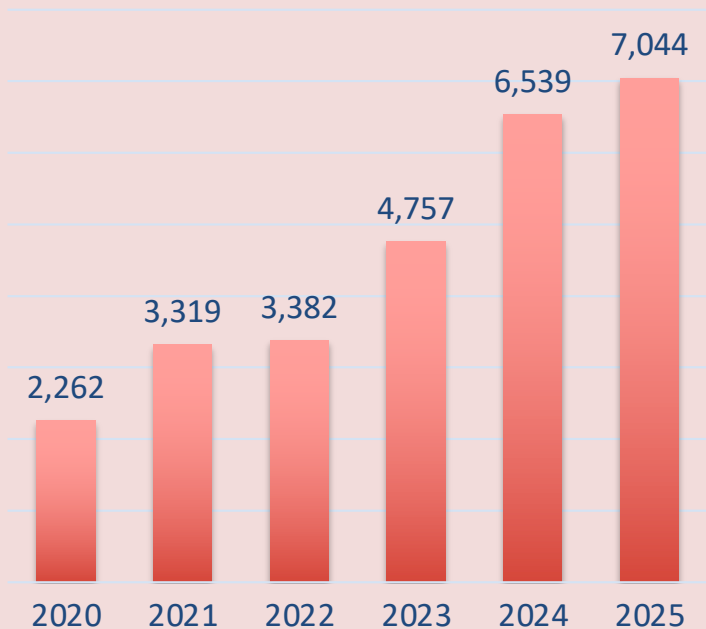


Geofencing and GPS tagging of piling rigs

(2) Outcome of Surveillance and Enforcement Efforts

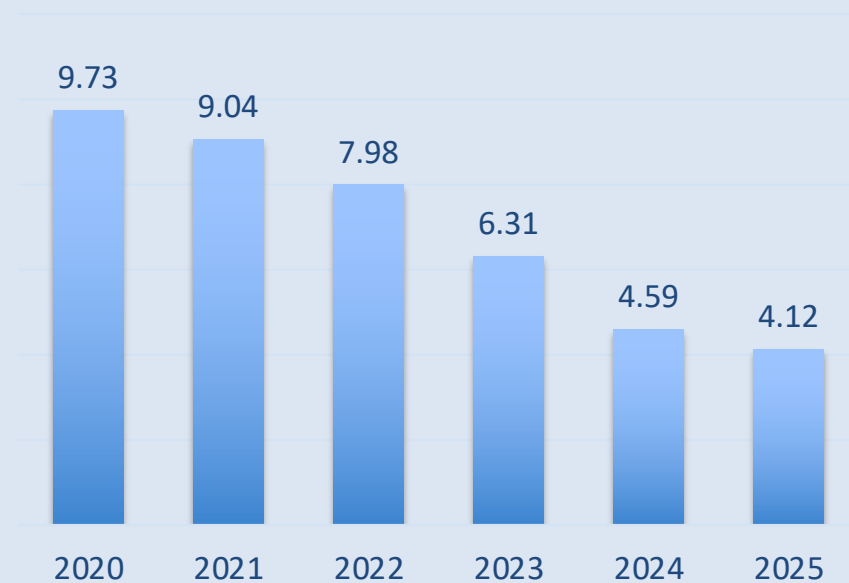
- The number of damage per 1,000 submissions has reduced over the years.
- This can be attributed to increased awareness of PUB's requirements and surveillance efforts.

**Construction Activities
near Watermain**



Increase in submissions due to more developments → Increase volume of construction activities near water mains

**Damage on Watermains per 1,000
submission**



No. of damage cases relatively constant despite increasing volume of construction activities

(3) Proactive Leak Detection Framework

- We conduct annual island-wide leak detection surveys.
- Additionally, we deploy permanent loggers and sensors to monitor key segments of our transmission network and high-risk Cast Iron watermains.

Distribution Mains ($\leq 500\text{mm}$ dia)



Mobile Noise Loggers



Permanent Noise Loggers



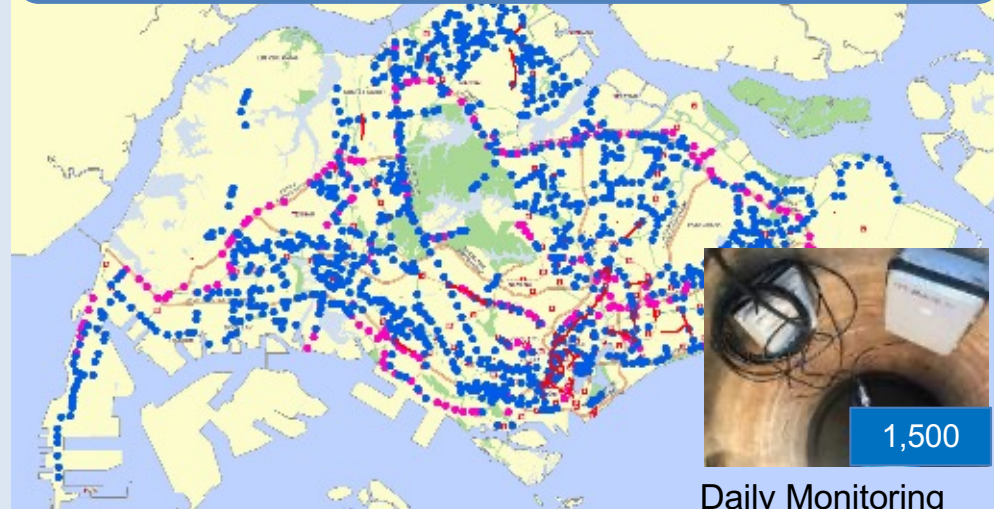
Correlators



Transmission Mains ($\geq 700\text{mm}$ dia)



Permanent Leak Detection Sensors



Daily Monitoring

Key Benefits of Early Leak Detection:



Reduce water loss



Less unplanned disruption to stakeholders



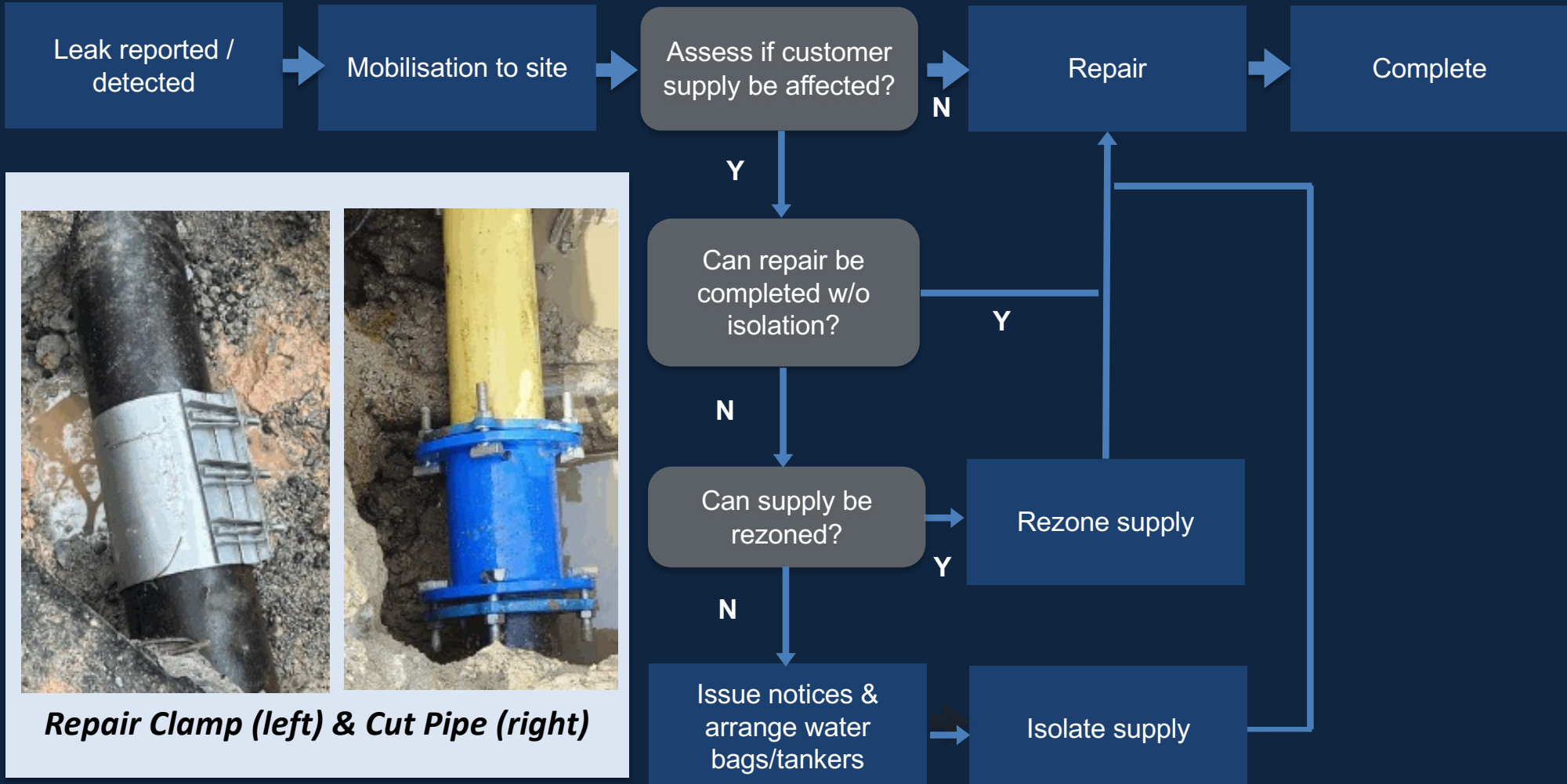
Small leaks, less costly repair

(4) Prompt Response to Leak and Repair

Typical Repair Workflow

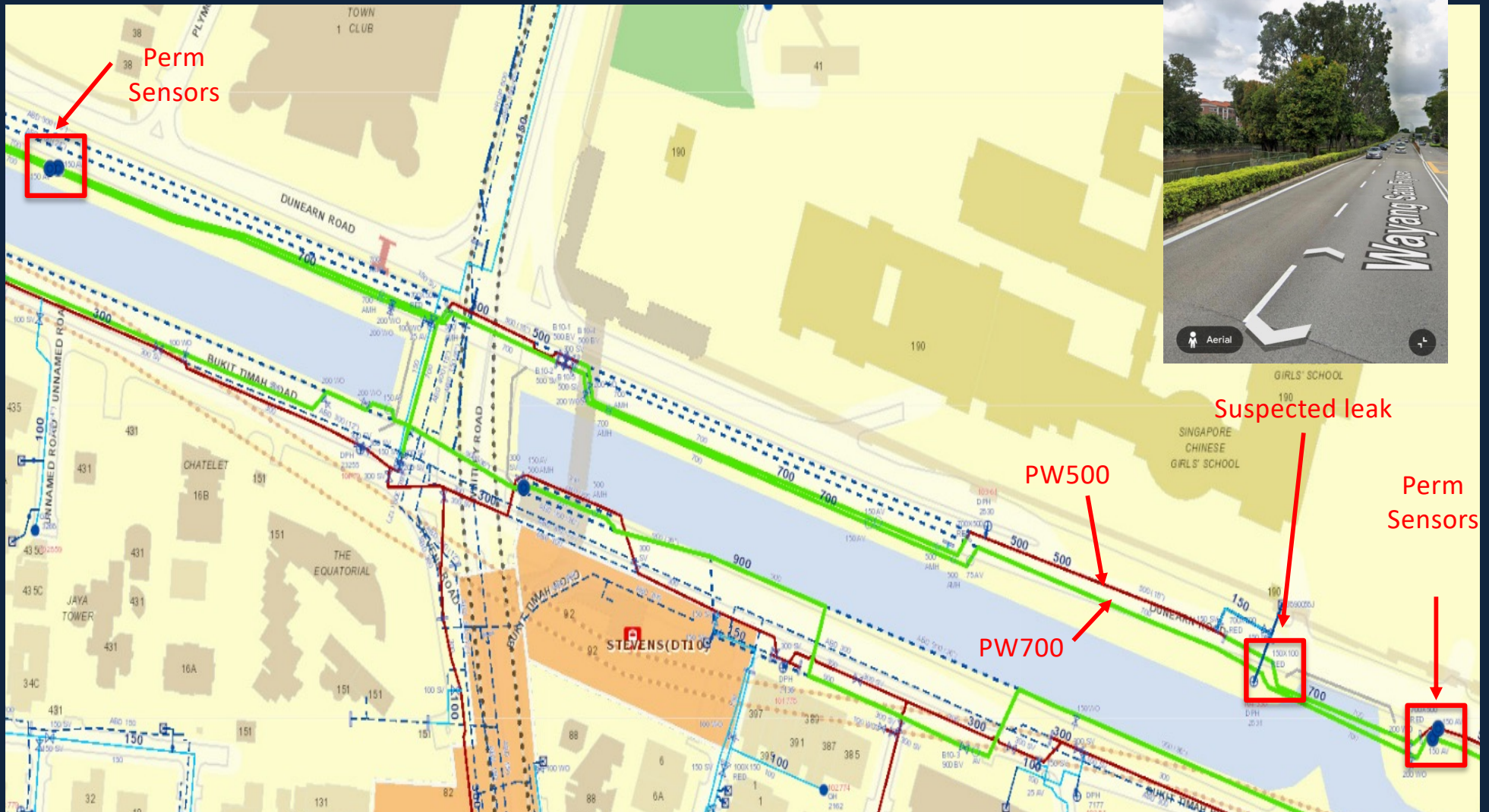
Key Considerations:

- Safety
- Minimise inconvenience to customers
- Minimise water loss



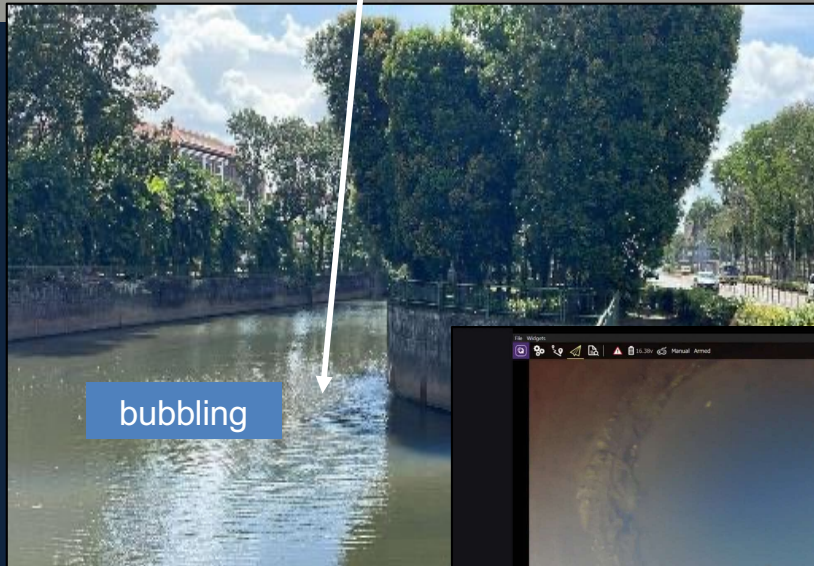
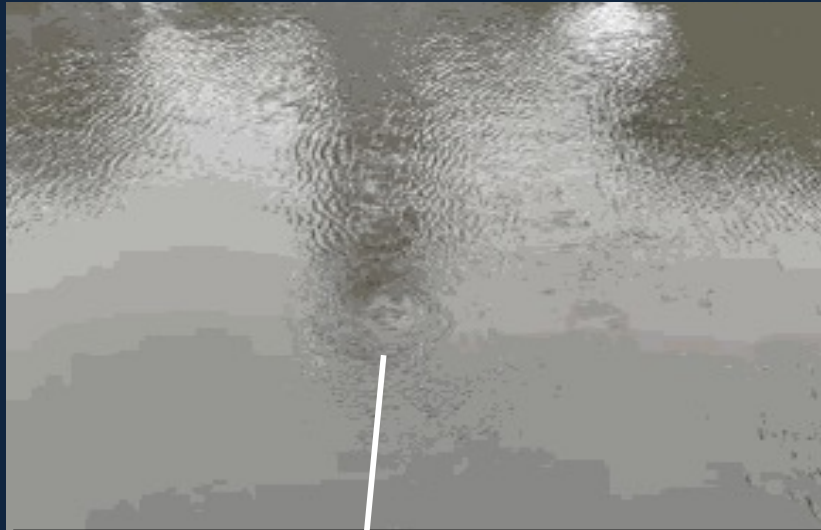
Past Success Story - Case Study

Leak at Dunearn Road Potable Water (PW) 700 and PW500 Repair

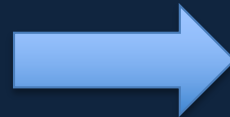


Past Success Story – Case Study

Water surfacing from the canal



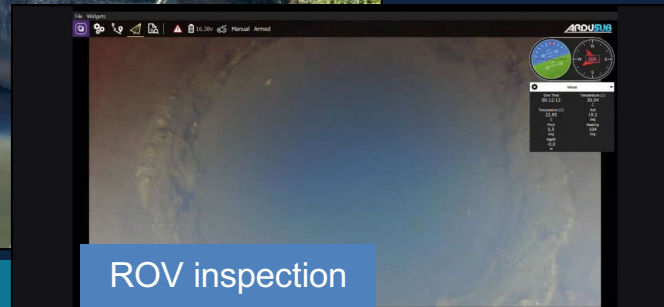
bubbling



Excavation Process to expose the pipe



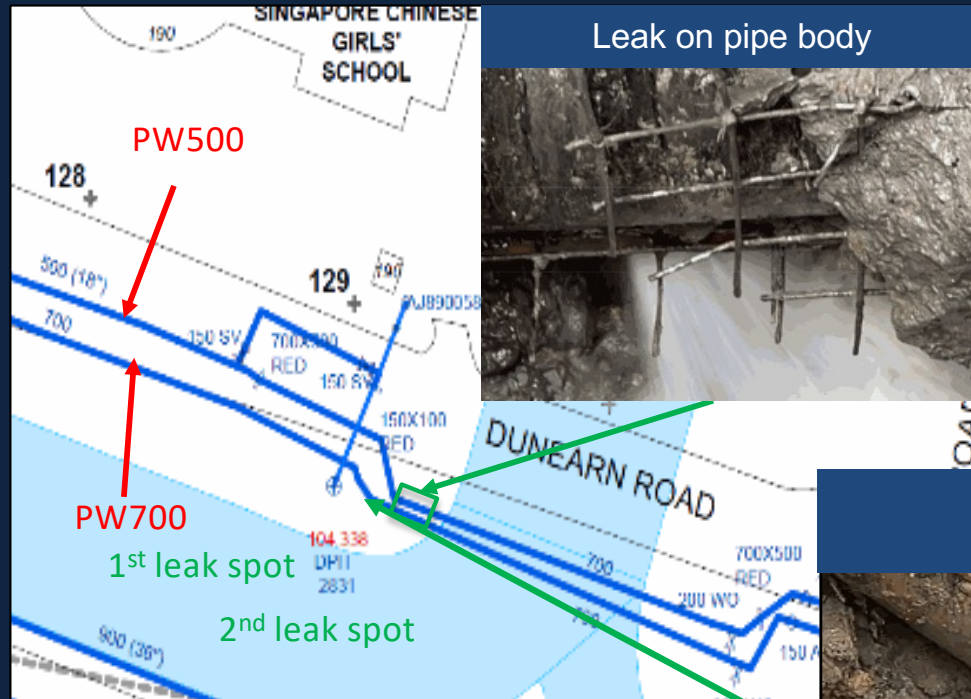
Water ingress
from canal



ROV inspection

Past Success Story – Case Study

Leak at Dunearn Road PW700 and PW500 Repair



Leak on pipe body



Repaired Leakspot

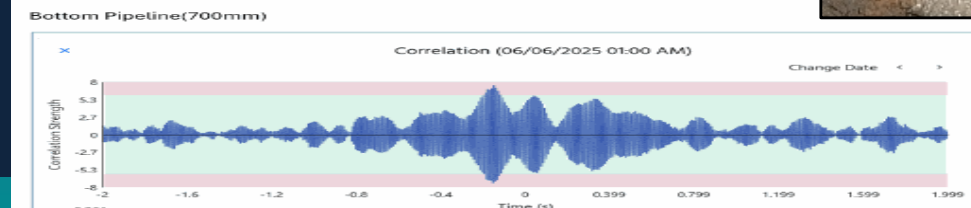
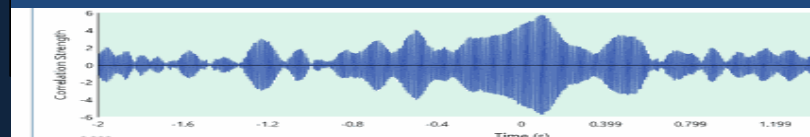


Leak on Bend (haunched)



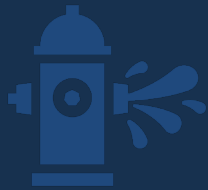
Water flowing from weephole

Acoustic reading from both pair of sensors post



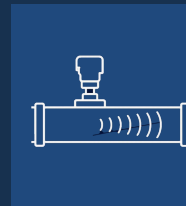
Key Takeaways from Case Study

Permanent sensors reveal leaks that would otherwise stay hidden



Hidden leaks made visible

Leaks on transmission mains are picked up with no surface signs at all.



Daily monitoring

Acoustic sensors listen to the mains around the clock, every day of the year.



Faster, targeted repair

Both sensor pairs narrow the leak to a short stretch, cutting excavation time.



Major bursts avoided

Early action prevents supply interruption, traffic disruption and asset damage.

~10 leaks detected each year

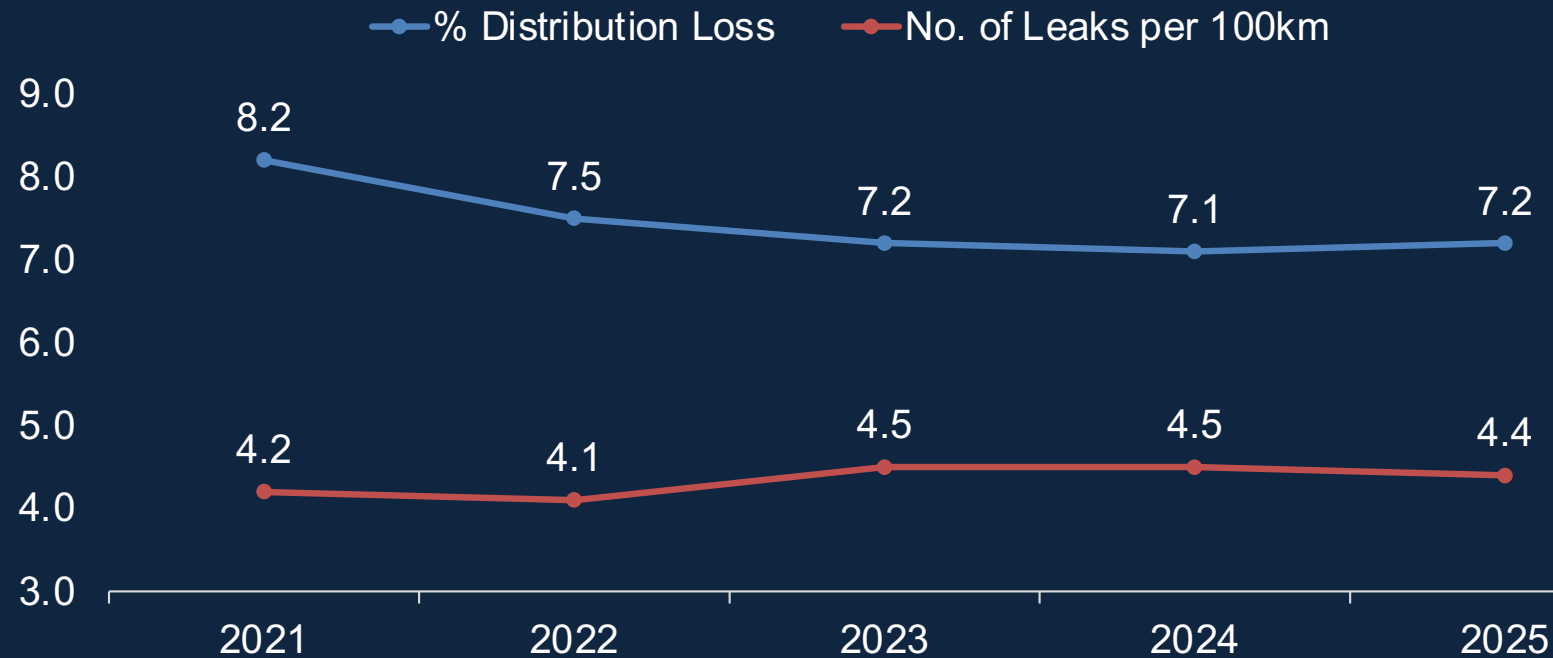


0.6 MGD water saved



78% of leaks within sensor coverage

Network Performance



Losses down from 8.2% to 7.2% - sustained by the four pillars of the Leak Management Framework



**Pipeline
renewal**



**Surveillance
and
enforcement**



**Proactive
leak detection**



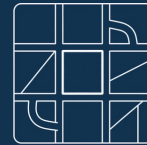
**Prompt
response
and repair**

The Human Side: From Night Tests to Smart Sensors

Today's capabilities are built on the shoulders of our previous generation.



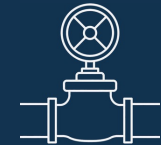
Then: 1980s - 1990s



Zoned into DMAs



Leak Detection Night tests



Manual, valve-dependent, disruptive

Today



Noise loggers and acoustic sensors



Data-driven deployment

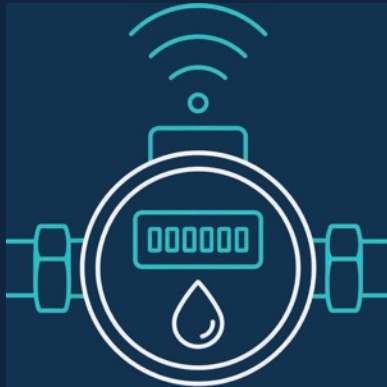


Pioneer know-how carried forward

- Mandatory AI training course for public officers
- Adoption of AI Assistant such as Pair (secure, gen ai assistant developed by GovTech).



Looking Ahead: Towards a Smart Water Network



Next phase of AMI deployment From 300k to 1.7m

Insights from Phase 1 AMI deployment of 300,000 smart meters are shaping the future deployment island wide



Smart Meters with Leak Detection Capabilities

Exploring smart meters with in built network leak detection capabilities for 15mm to 100mm meters



To achieve more targeted leak detection efforts

Data driven approach to optimise logger deployment survey and sensor monitoring coverage

Security and cost stay the guardrails on our AI journey

every new capability is weighed for data security and value for money before we scale it

Thank you