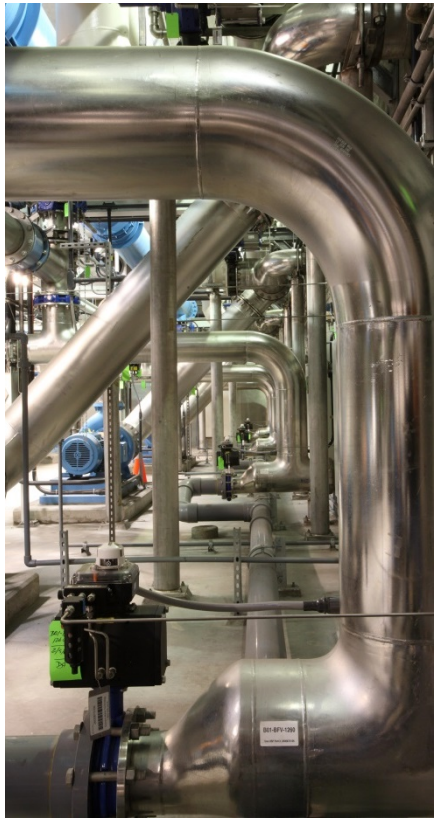
Digital Water Applications for System Reliability in Water Systems

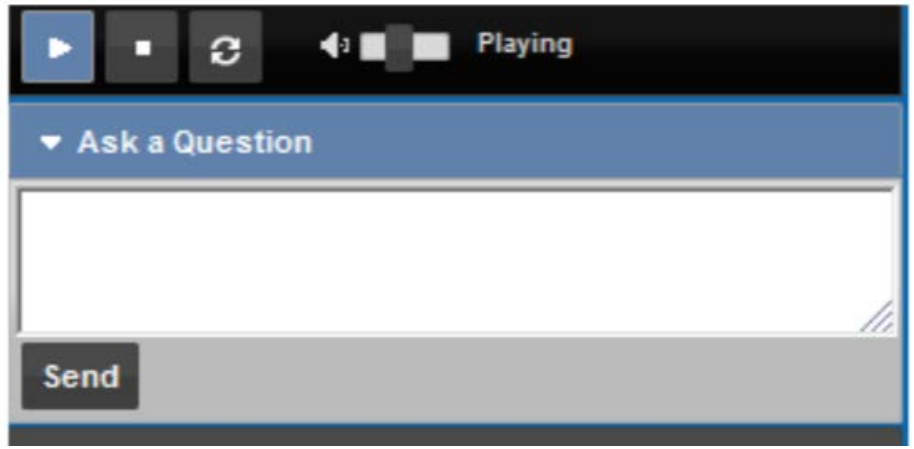
May 13, 2020



WateReuse Webcast Series

A Few Notes Before We Start…

- Today's webcast will be 60 minutes.
- There is one (1) Professional Development Hour (PDH) available for this webcast.
- A PDF of today's presentation will be shared via email
- Please type questions for the presenters into the chat box located on the panel on the left side of your screen.



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Today's Presenters

Jesper Kjelds
Chief Digital Information Officer
Aarhus Vand, Denmark

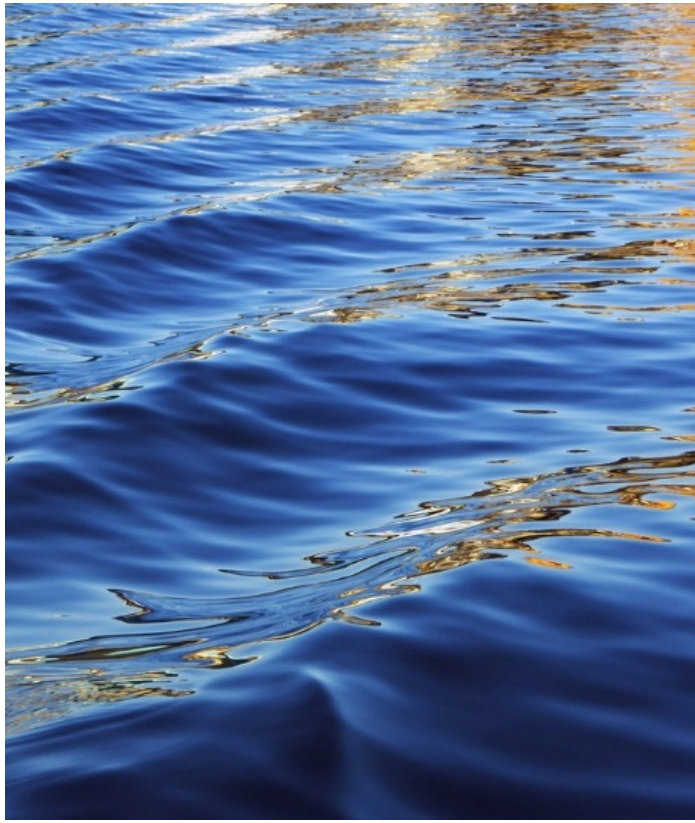
Zeynep Erdal
Integrated Solutions Leader
Black & Veatch

Mark Kaney
Director of Asset Management (Europe)
Black & Veatch

WaterReuse aarhusvand BLACK & VEATCH

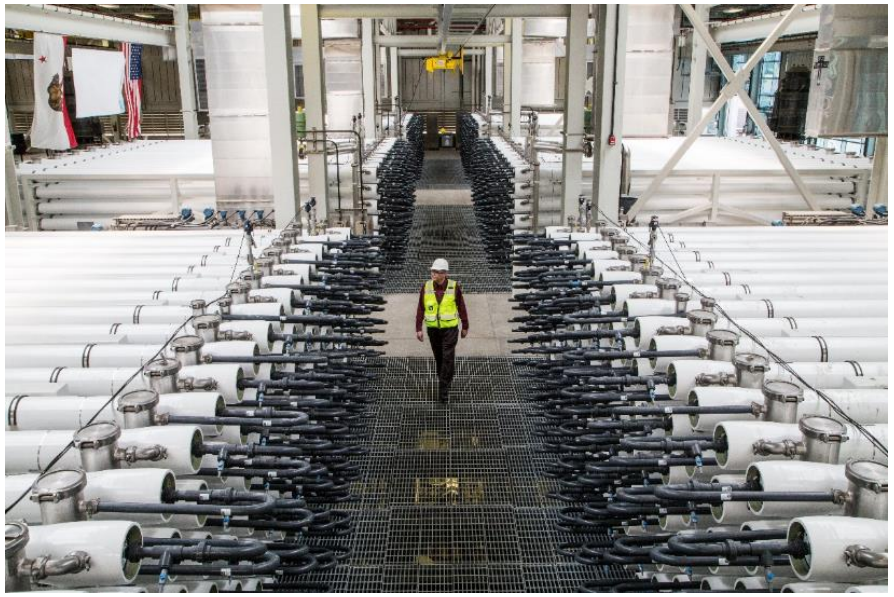
BLACK & VEATCH

Zeynep Erdal, PhD, PE
Integrated Solutions Leader



Water Supply Reliability

- ✓Having a reliable water supply that can adapt and respond to change
- ✓Address key factors:
  - Include treatment flexibility to manage variable feed quality and quantity with product water quality and quantity certainty
  - Be robust to produce high quality water as designed
  - Minimize environmental pollution
  - Safeguard public health
  - Be affordable



OCWD/OCSD – Groundwater Replenishment System

Our Water Infrastructure is Planned and Built as a System

Deep Tunnel Sewerage System

Singapore PUB, DTSS

Network of

- Tunnels
- Pump Stations
- Integrated Used Water Reclamation Plants
- Energy Recovery
- Support systems

Developed to meet Singapore's long term clean water needs through collection, treatment, reclamation and disposal of industrial and municipal used water.

Our Water Infrastructure is Planned and Built as a System

City of San Diego, CA, Pure Water Program

Pure Water San Diego, CA

Network of

- Pipelines
- Pump Stations
- Water Reclamation Plants
- Reservoirs
- Support systems

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- ***Reliability*** represents the ability of the system to provide water that consistently meets the public health protection provided by existing drinking-water supplies.
- **Redundancy, robustness and resiliency** collection of measures instituted to ensure the expected level of service and reliability

What are the Critical Control Points?

World Health Organization, 2017

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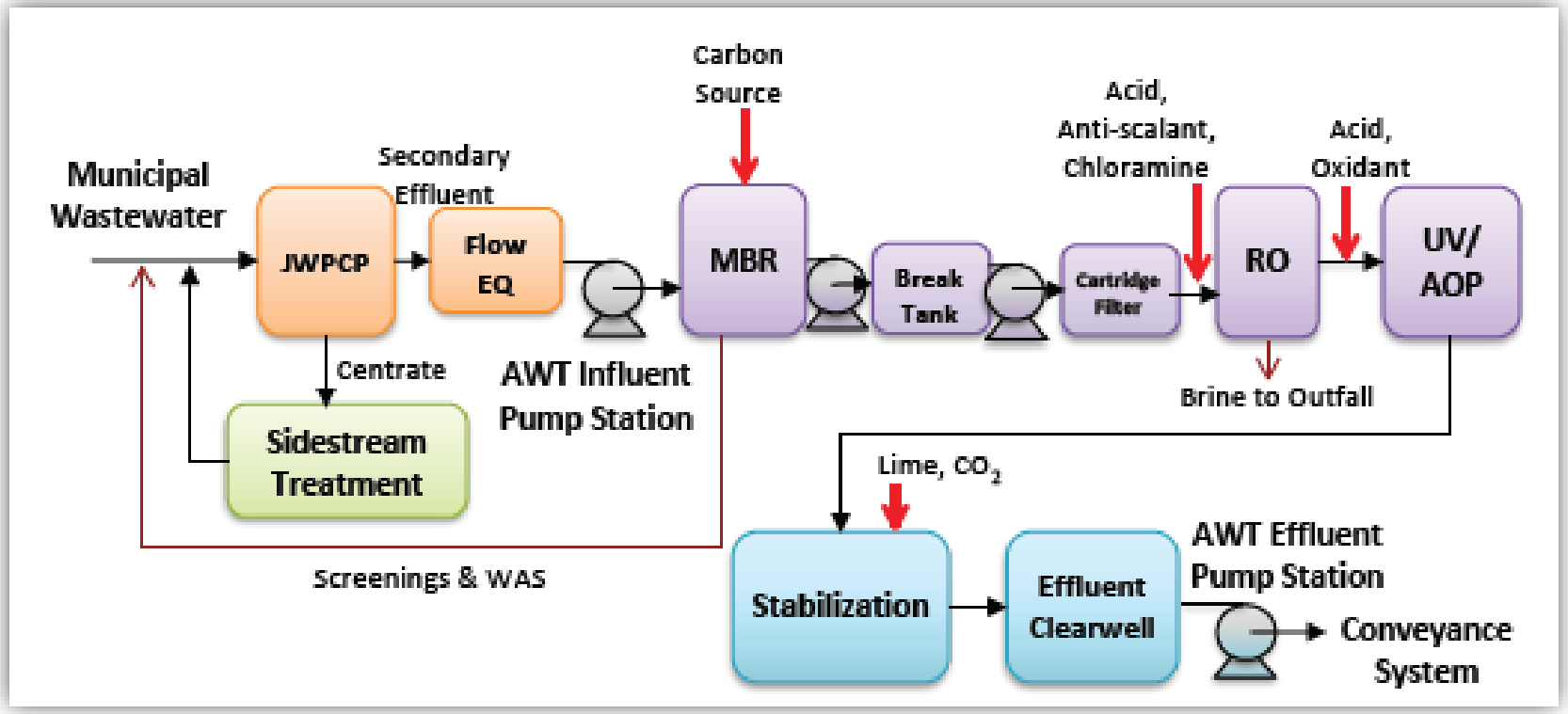
Critical Control Points and Critical Operations Parameters

- Failure Response at a Treatment Facility

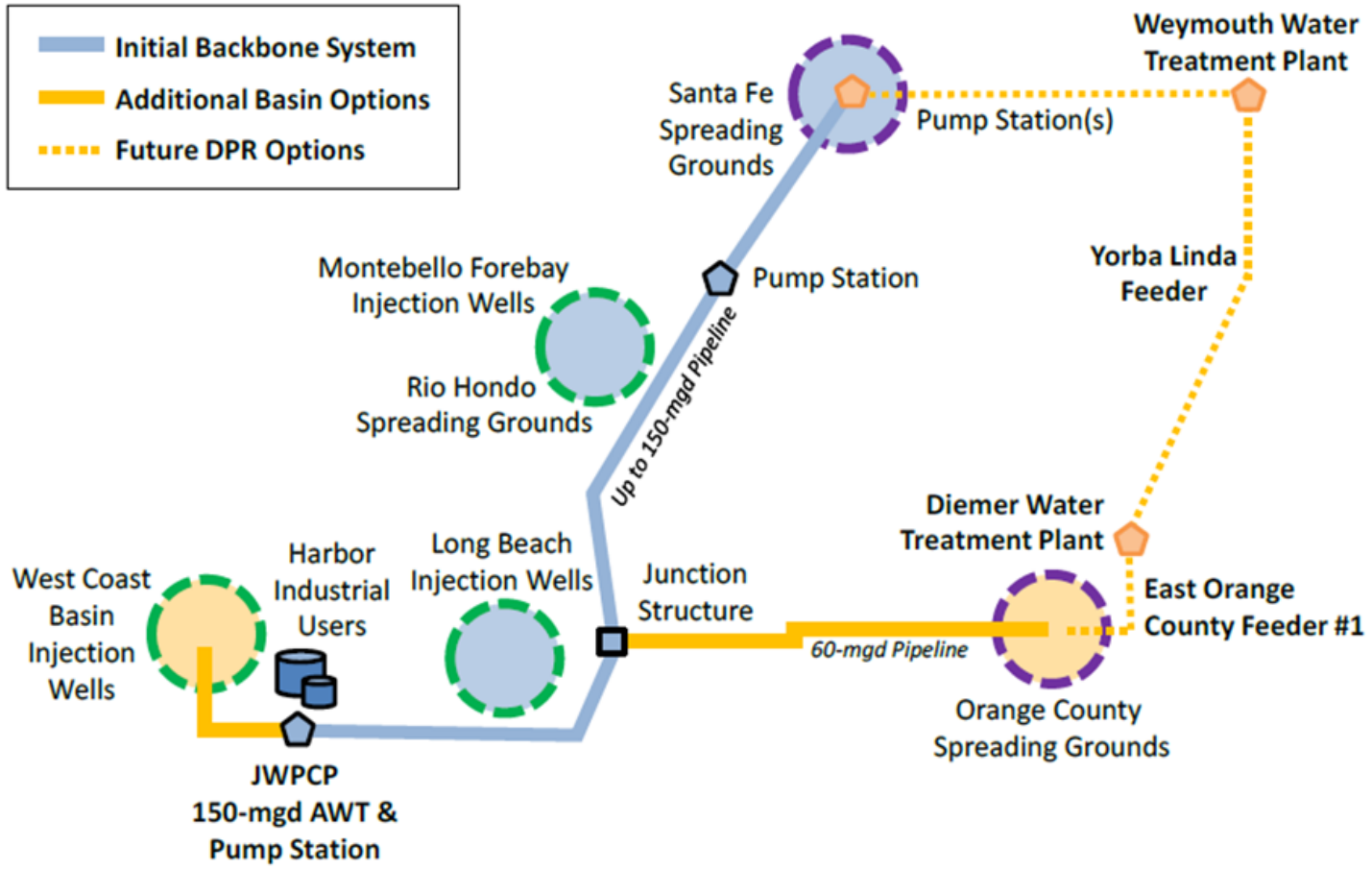
Flows
BOD
TSS
Nitrogen
pH
TDS
Metals
CECs
Chemical Dosing
Pathogens
Turbidity
TOC
NDMA
1,4 dioxane
…



Adapted from MWD of SoCal, CA – Regional Recycled Water Program

Critical Control Points and Critical Operations Points

- Failure Response in a System



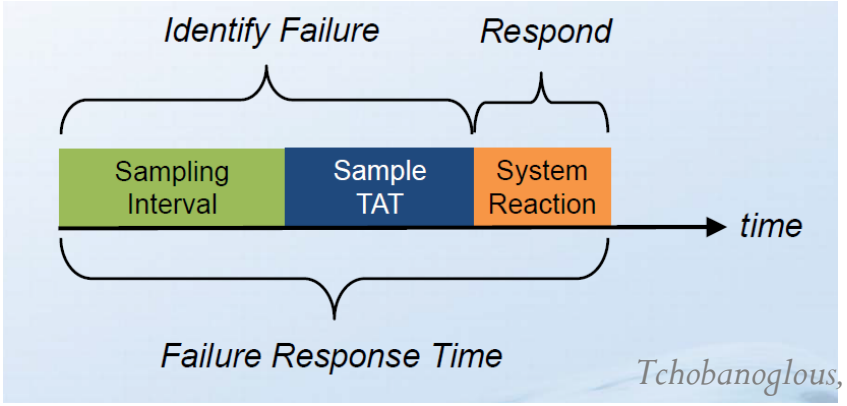
Network of

- Pipelines
- Pump Stations
- Water Reclamation Plants
- Spreading Grounds
- Water Treatment Plants
- Support systems

Metropolitan Water District of Southern California, Regional Recycled Water Program

System monitoring via manual and online tools – data streams frequency, accessibility, quality, security

System Factors	Data Type Examples
Flows, system operations parameters	Online, metered readings
WWTP influent quality, facility performance, daily and seasonal variability	Manual, grab & composite samples, online sensors, source control, biological performance monitoring
AWT performance monitoring	Online water quality, surrogates, water stability
Barrier integrity monitoring	Online, integrity tests, surrogates, water quality
Pipelines and system blending points	Stability, mixing, detention time, water quality
Reservoir, GW, WTP	Flow, water quality, surrogates



Tchobanoglous, 2015

¹ Secondary treatment usually based on activated sludge and in most examples includes nutrient reduction.
² DWTP = drinking-water treatment plant.
³ UOSA = Upper Occoquan Service Authority.

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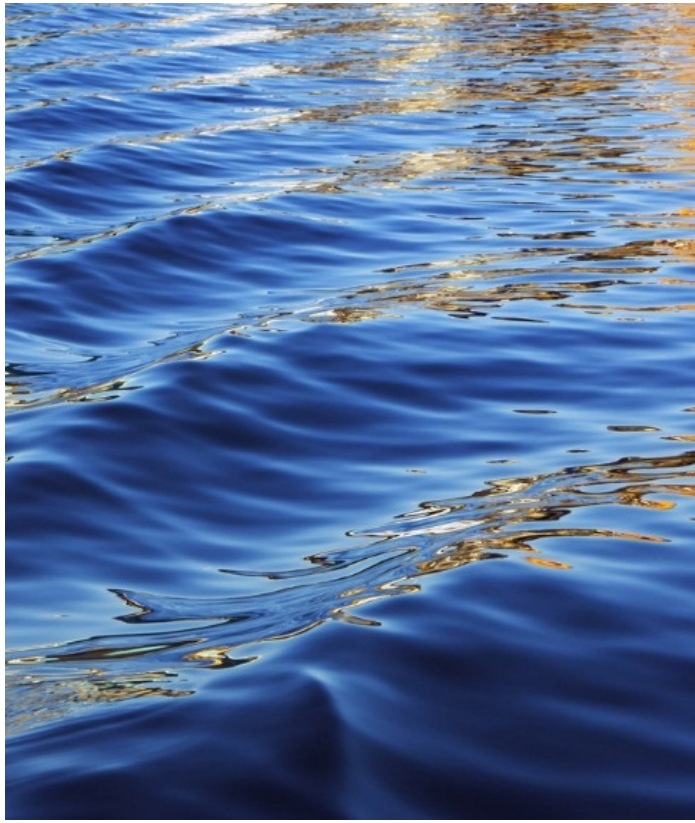
Mark Kaney
Director of Asset Management, Europe



Resilience

"the ability of assets, networks and systems to anticipate, absorb, adapt to and/or rapidly recover from a disruptive event."

Resilience provision can be assessed against "the four Rs":

- Redundancy (avoiding dependencies on single assets)
- Resistance (proofing the system so that it is resistant to known risks – for example, flood defences or access procedures)
- Reliability (a system that operates effectively, irrespective of whether or not risks materialise – for example, design standards)
- Response/recovery (the ability to recover quickly so that service is not unduly impacted – that is, tested procedures and appropriate resources)

Reliability

"the ability of a system or component to function under stated conditions for a specified period of time"

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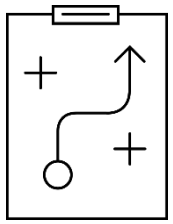
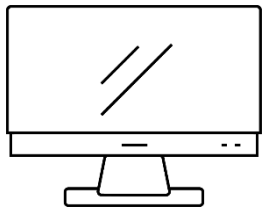
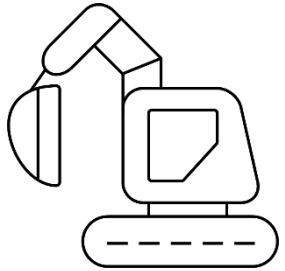
Good systems resilience relies upon:



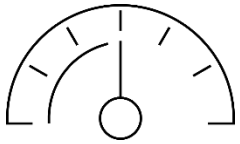
GOOD PLANNING



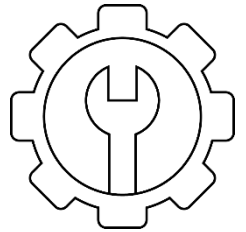
GOOD DESIGN



GOOD CONSTRUCTION/ ENHANCEMENT



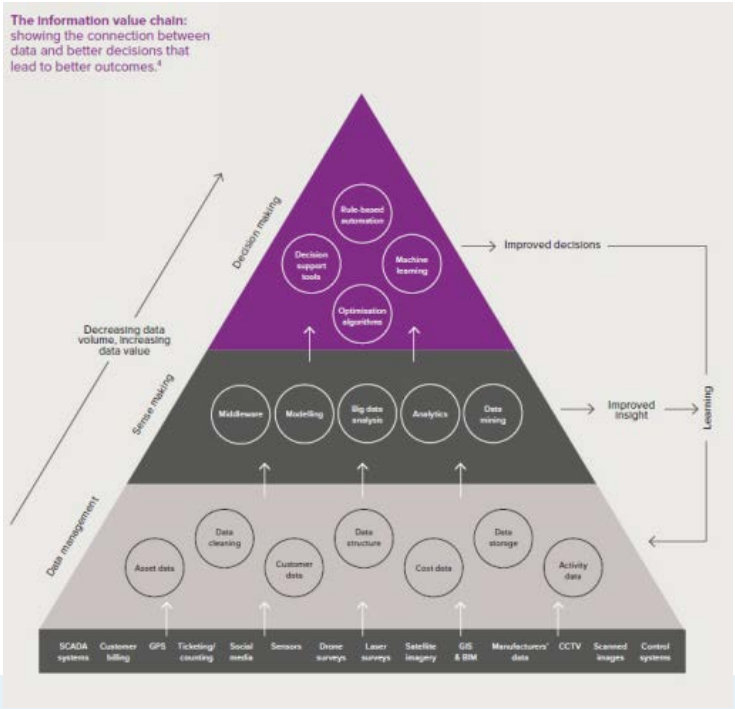
GOOD OPERATION



GOOD MAINTENANCE

How do we know what “Good” looks like?

- Effective benchmarking and validation
- Ability to measure actual/predicted performance against the targets



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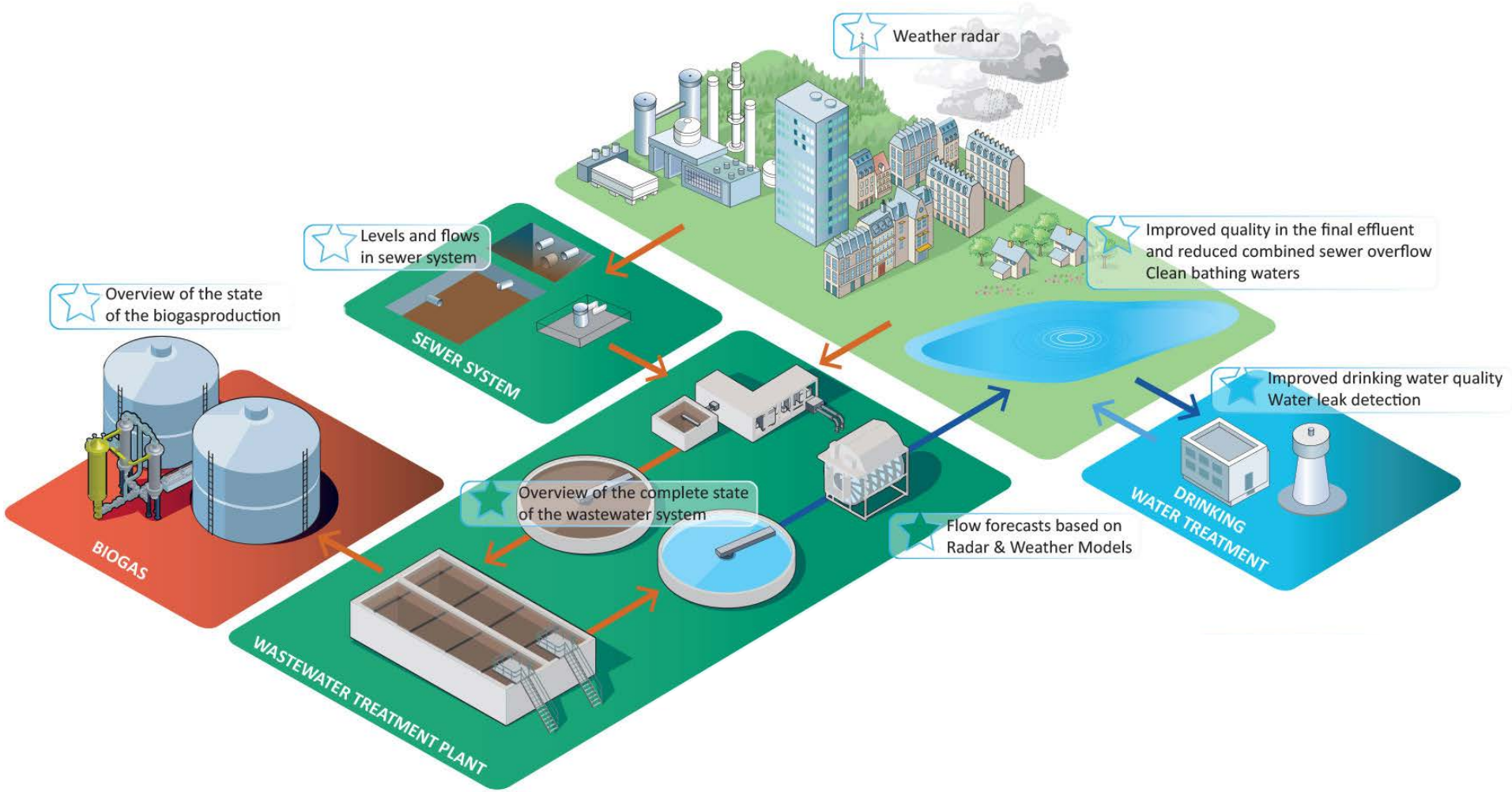
From Data to Decision – How We Capture Performance



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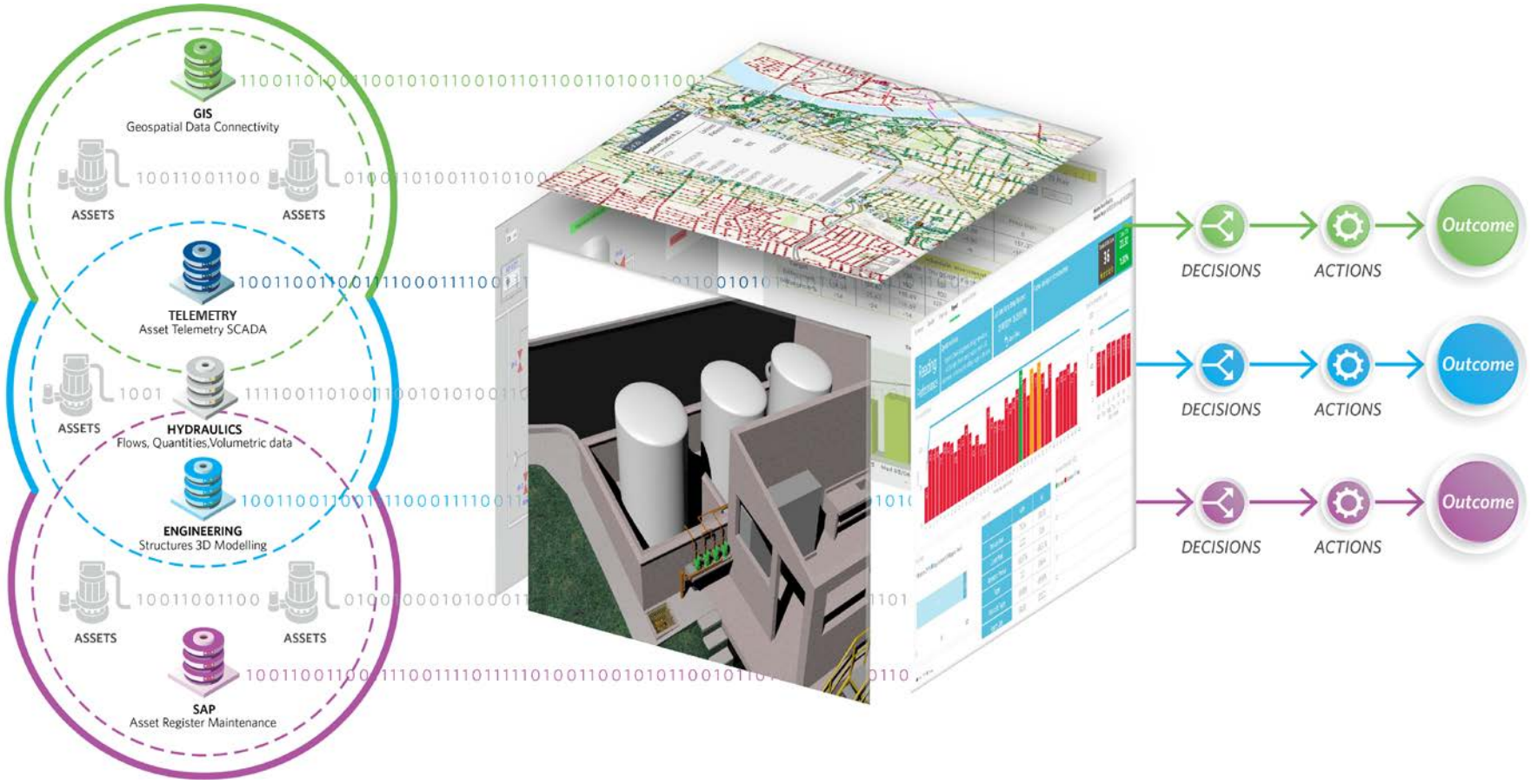
DIGITAL TWINS

Digital Twins in the Water Sector

*"A Digital Twin can be defined as an **integrated accurate digital representation** of our **physical assets, systems and treatment processes**. It will **unlock value** by **enabling improved insights that support better decisions, leading to better outcomes** in the physical world".*



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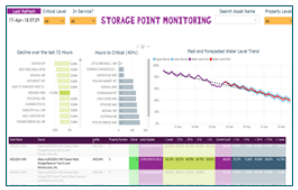
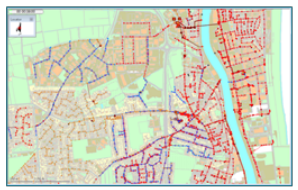
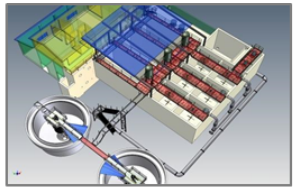
User based decision support via a digital twin







	Site Manager	Operator	Optimiser	Modeller	Asset Planner	Designer
Informed Decision Making	*"I need to run the site to cost"*	*"I need to conduct maintenance and be ready to respond"*	*"I need to monitor operations of the site"*	*"I need to understand the repercussions of planned and unplanned work"*	*"I need to get the most value from investments"*	*"I need analyse and design the optimal water assets"*
Visualisation	Forecast production, resourcing, energy, chemical, and resourcing needs to scenario plan operations	Predict operating setpoints and maintenance interventions	Provide specific operating guidance to operational teams at process and asset level	Enable Real-time analysis of network operational demand and quality against design	Utilise asset condition and performance data to inform future investment needs	Virtually select and design systems and assets based on accurate historical performance data
Analytics						
Integration						
Data	Social Media; Chemical Usage; Energy Consumption	Water Pressure; Labour, Contractor and Materials Costs	Noise Logging; Water Quality; Weather	Resource Availability; Flows	Asset Register; Asset Failure Modes	Asset Downtime; Effects of Asset Failure
Sensors & Assets						

Action

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Example Use Cases Across the Asset Lifecycle

Different design approaches can be tested and the operating performance of the asset assessed against the success criteria

Project BIM models can be tested against existing assets for integration and modular construction phased to optimise uptime

Virtual commissioning can be undertaken using the twin

Operational optimisation can be carried out at asset or system level. Predictive analytics can enable proactive changes to avoid incidents and lower costs

Dynamic understanding of asset criticality, reliability and consequence of failure allows for agile proactive maintenance planning, lowering maintenance costs and avoiding asset failures.

Activities can be tested on the twin to ensure end of life process is managed and risks are mitigated

Data can be repurposed for secondary use. Asset component reuse can be tested to ensure its is fit for purpose

Design	Build	Commission	Optimise	Pro-actively Maintain	De-commission	Recycle/Repurpose

CREATE → OPERATE → MAINTAIN → DISPOSE

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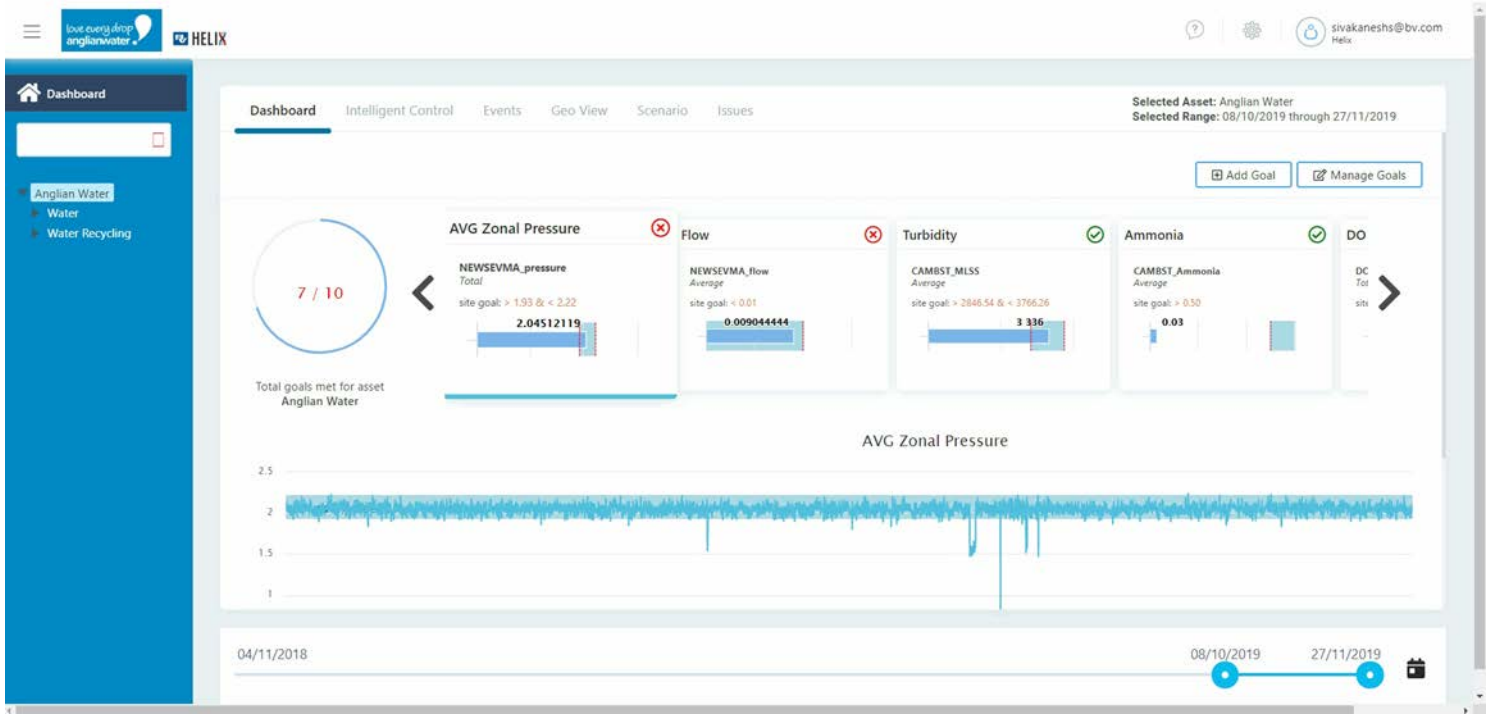
CASE STUDY

PROBLEM: To build a digital twin of the £500m strategic pipeline enabling design scenarios to be tested and optimised operational regimes to be developed in line with performance requirements.

SOLUTION: Integration of network models, real time operation technology data, project design BIM data, service performance data and whole life cost data through HELIX, BVs DT platform. Development of user stories and user based UI/UX to allow better insights and support to data driven decision making.

BENEFITS: Ability to test a wide range of design and operational scenarios to set the outline design for the delivery partners to complete. Proof of Concept for the proposed approach to managing the asset base through the application of digital twin technologies



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Jesper Kjelds

Chief Digital Information Officer
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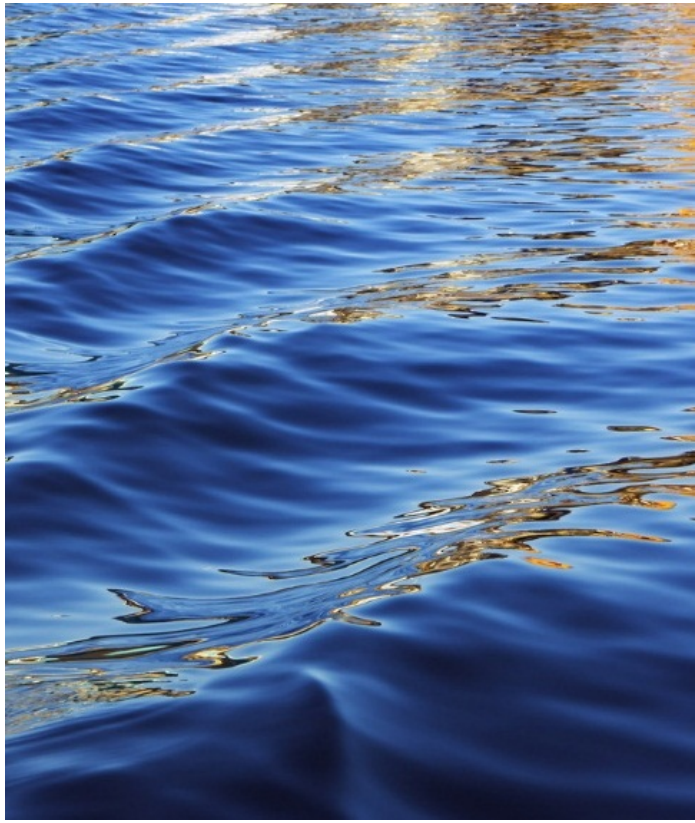

TOWARDS THE DIGITAL WATER UTILITY

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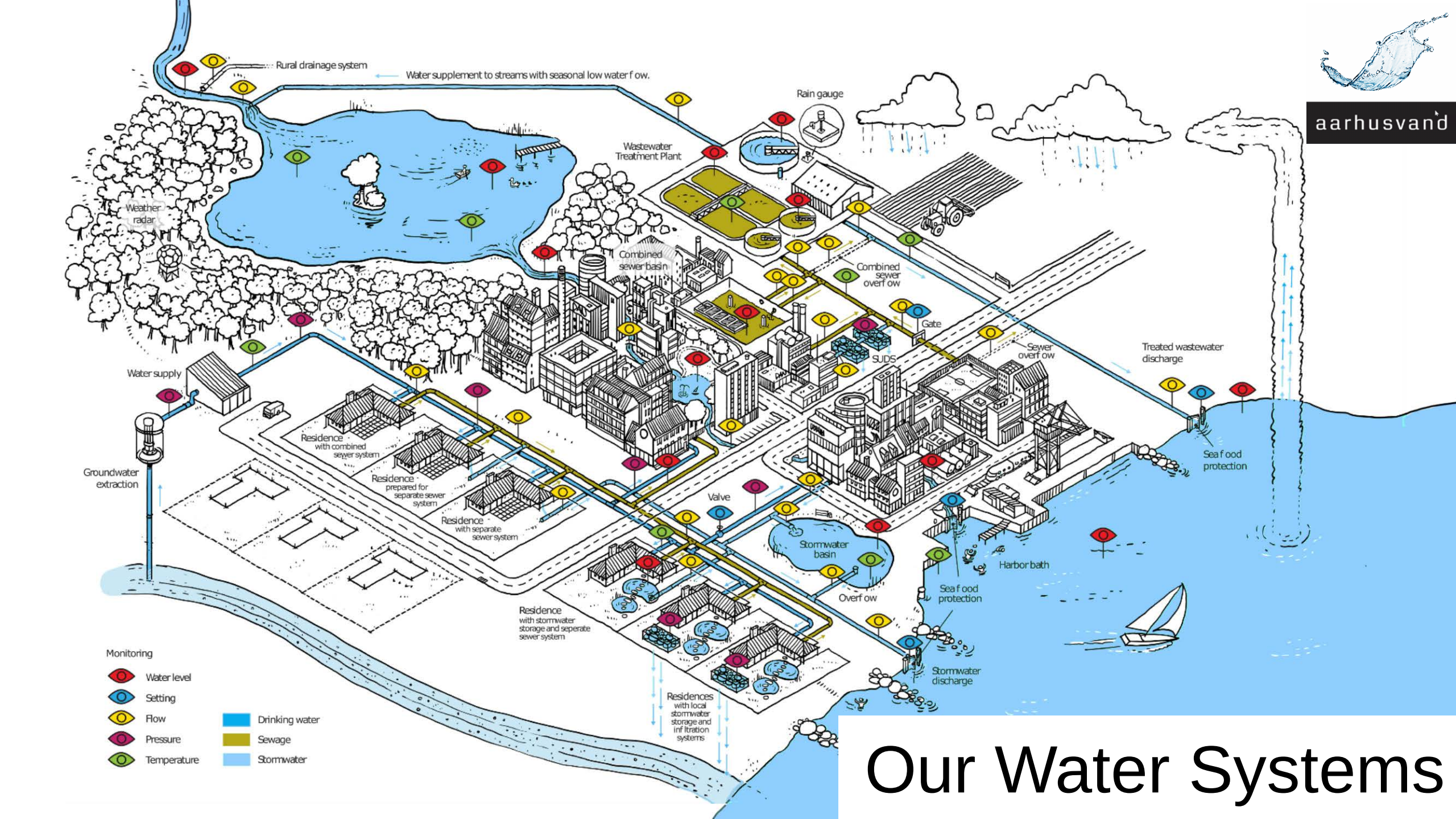

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Our Water Systems

Our Strategy

PURPOSE
Aarhus Vand creates health through the supply of clean water – to people and the planet

VISION
Creation of a national platform
as a driver for local and global solutions to a healthier water cycle

CROSS-CUTTING STRATEGIC PRINCIPLES
Customised solutions – partnership formation – investment in new technology – sustainable action

STRATEGIC FOCUS AREAS

COMMERCIALISATION
Exploiting the commercial potential to establish an independent business arm

INNOVATION
Accelerate development of knowledge and technology for future solutions

GLOBALISATION
Spread national solutions to the wide world and bring home new knowledge

AN EXCELLENT BASIC SERVICE
Treatment of wastewater and supply of clean and healthy drinking water – resource-efficiently and climatically optimised

A PURPOSE-DRIVEN ORGANISATION
Strengthen the organisation through the development of a company culture and leadership

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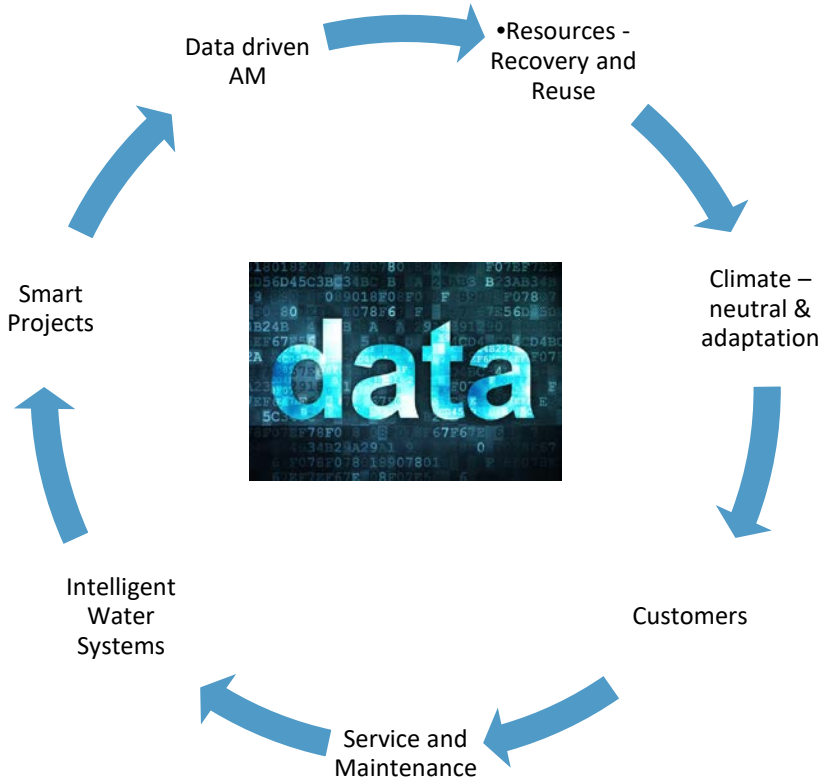
Our Focus….

- Data - Digital Technologies
- Competencies – Digital workforce
- Ingenuity – Curiosity and Innovation



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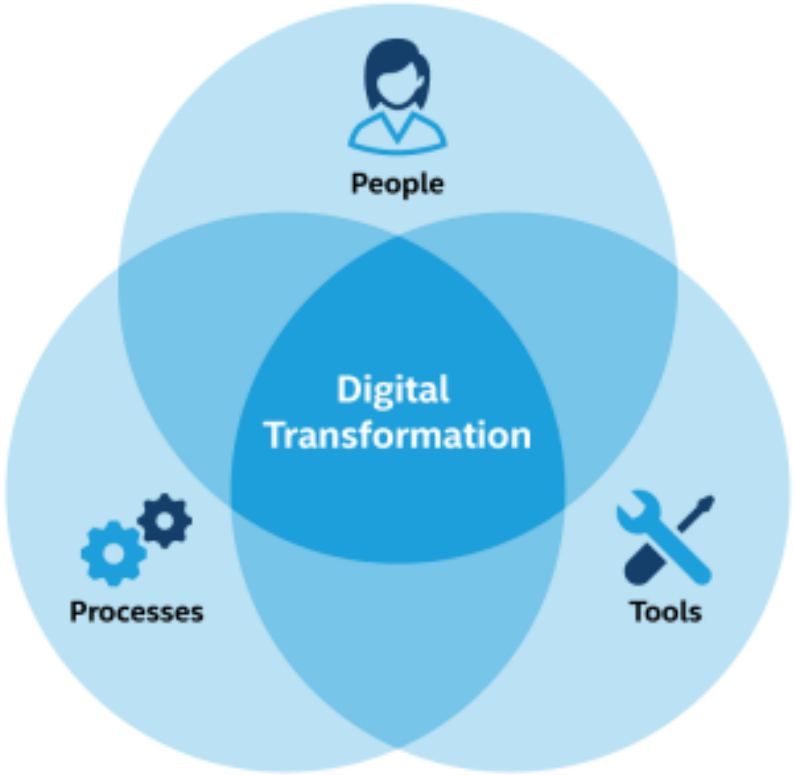
Our Blended & Digital Workforce ….



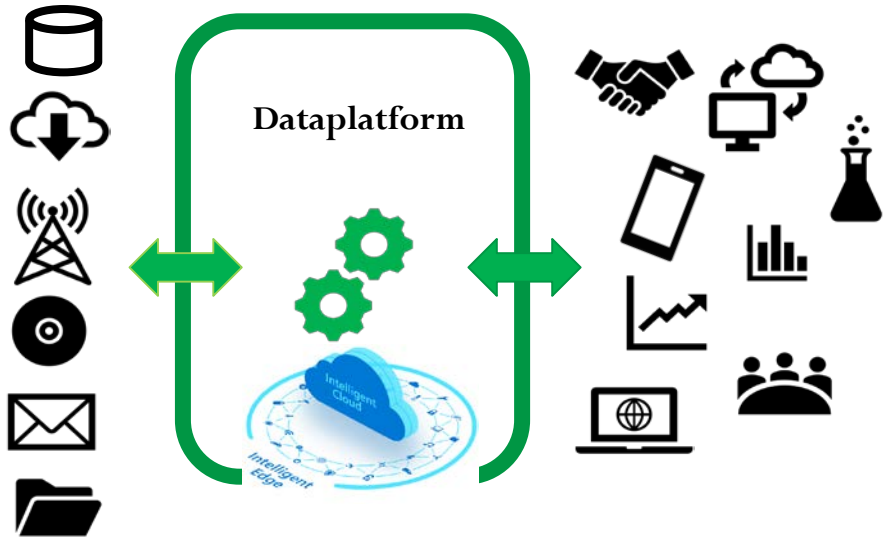
- Need to train and upgrade digital skills
- Retain institutional knowledge
- Motivation to do things differently
- Innovative culture

And the future…..

- High volume transactional activities
- Always on (24/7) – from anywhere
- Train once, repeat often
- High speed to value
- Help to de-risk skills shortage

If digital transformation is the goal, **DATA** is the fuel to get us there

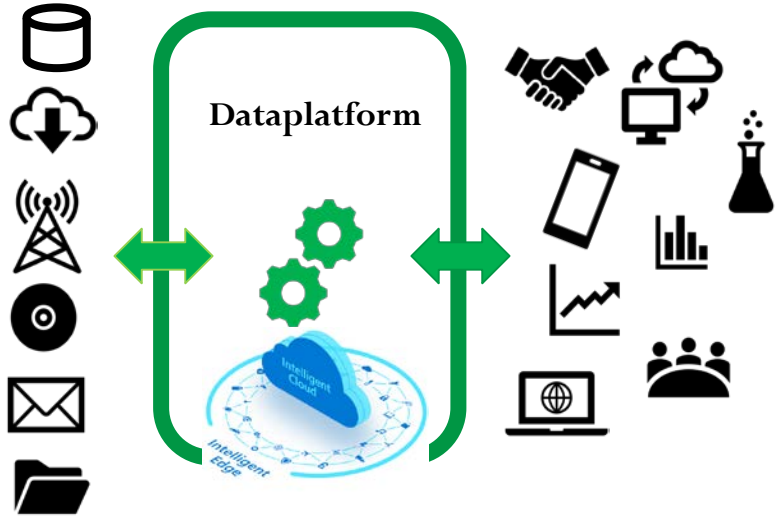
Instrumented, Interconnected, Intelligent



- Open And Accessible – data sharing
- Standard Data Exchange Interfaces / Data models
- Secure
- Interoperability
- Curation and Quality

REUSE

Instrumented, Interconnected, Intelligent



- Advanced IoT sensor platforms (standardization….)
- Augmented (Artificial) Intelligence and Machine Learning
- Digital Twins – adaptive modelling – real time – predictive
- Mixed Reality (virtual – augmented)
- “Build it before you build it”
- Data Science

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Aarhus ReWater – worlds most resource efficient wastewater treatment plant

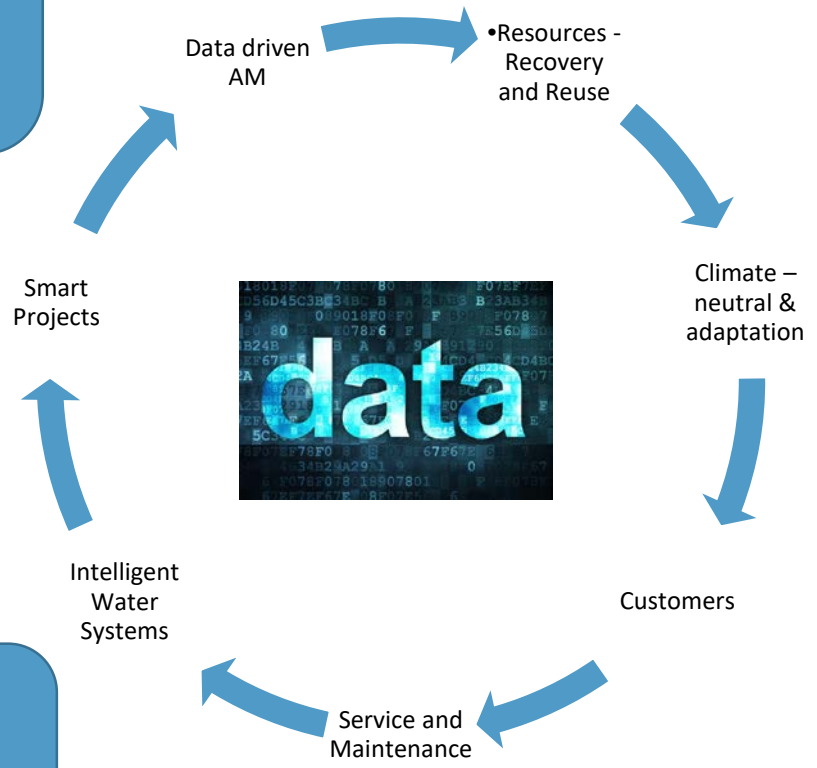
- Scada & IOT sensor platforms
- Digital Twins (ML) –plant and process optimization
- xR for design, build and service
- AI data analytics
- Robotics for service and maintenance

Customer Service

- Digital self service
- Leakage detection and alarm
- Cognitive Assistants

Intelligent water networks

- Scada & IOT sensor platforms
- Digital Twins (ML) – system control and optimization
- xR for design, build and service
- AI data analytics



Digital Workplace

- Digital Data Self Service
- RPA to automate manual work

Service and Maintenance

- Scada & IOT sensor platforms
- AI/ML predictive maintenance- leakage detection
- VR/AR for field crews
- Robotics (heavy lifting, inspections..)

Smart Construction Projects

- Data Driven AM – project prioritization
- Digital Twins - "build I before you build it"
- AI for decision support
- xR for design, build and service

Water Symbiosis

- IOT sensor platforms
- Digital Twins (ML) – system control and optimization
- Blockchain for smart contracts

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Digital Technologies are critical enablers and means to achieve (exceed) our business goals

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Q&A

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