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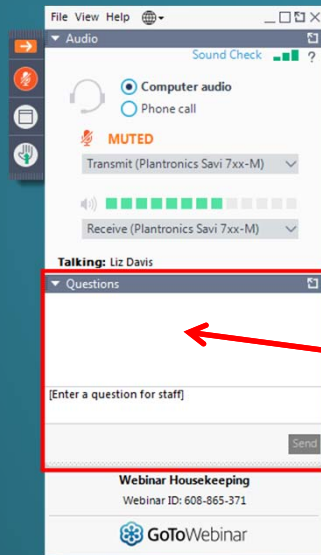

**Unpacking the "Black Box":
Understanding and Using Advanced Data
Analytics to Optimize Operations**

Thursday July 23, 2020
1:00 – 3:00 PM ET

2

How to Participate Today

- **Audio Modes**
  - Listen using Mic & Speakers
  - Or, select "Use Telephone" and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**

3

Today's Presenters

- Mark Harris, Town of Hillsborough, Ca. (Moderator)
- Dr. Andrew Shaw, Black & Veatch
  - Advanced Data Analytics
- Richard Loeffler IV, EmNet
  - Case Study: Real Time Decision Support Systems (RT-DSS)
- Ryan Sanford, P.E., DHI
  - Digital Twin Solution & Case Study
- Andy Crawford, Woodard & Curran
  - Operator Rounds: Real Time Analytics To Give Perspective

4

Dr. Andrew Shaw
Global Practice & Technology
Leader

5

Advanced Data Analytics

Introduction

6

Outline

- Get M.A.D.
- Data Integration
- Digital Twins

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Get M.A.D.

Smart Water Utilities
Complexity Made Simple

Pernille Ingildsen and Gustaf Olsson

IWA PUBLISHING

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Get M.A.D.

Measure

Analyze

Decide

9

The **important** thing about **measuring** is to give you feedback

10

The **important** thing about **analysis** is

to make sure you understand deeply

Without it you are roaming in the dark
Without it you decide poor things
To many it seems difficult
When you succeed in solving the puzzle
it is a great sentiment

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The **important** thing about **decisions** is
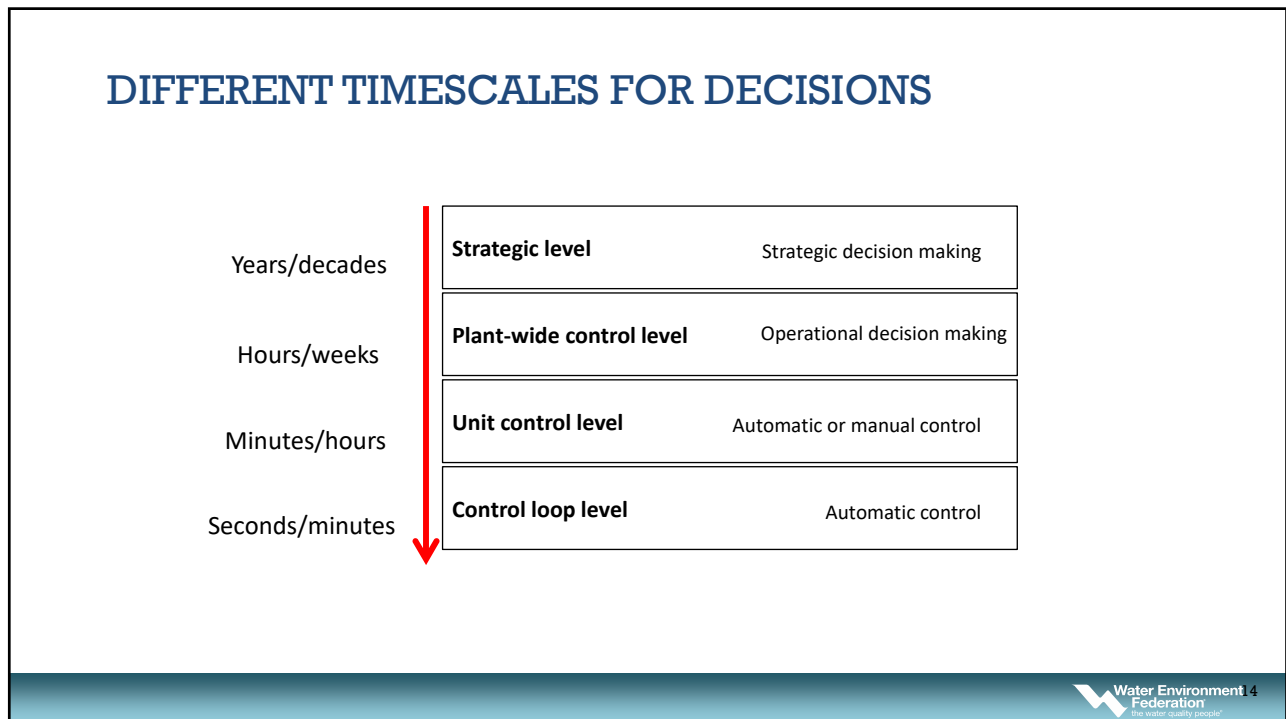
that you make them before you must

To lead is to make right-minded decisions
To react is to wait
until only one option is available
Your largest obligation is to make good decisions
that are serving the common good

12

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DATA INTEGRATION

13

DIFFERENT TIMESCALES FOR DECISIONS

Years/decades	**Strategic level**	Strategic decision making
Hours/weeks	**Plant-wide control level**	Operational decision making
Minutes/hours	**Unit control level**	Automatic or manual control
Seconds/minutes	**Control loop level**	Automatic control

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ANALYTICAL TOOLS

Single signal analysis
- Filtering
- Outlier detection
- Repairing datasets
- Statistical process control

Mathematical models
- Linear regression
- Multivariate regression
- Diagnosis
- Simple dynamic models
- Hydraulic models
- Biological reaction models

Performance indicators
- KPI
- Benchmarking

Seconds   Minutes   Hours   Days   Months   Years

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BUILDING AN INTEGRATED APPROACH

- Leverage same assets across more than one application, especially for:
  - *Connectivity*
  - *Analytics*

- Data layer and analytics capabilities aggregated in center of solutions

DATA HUB

LIMS

SCADA

BUSINESS SYSTEMS

CMMS

MDM

MODELING

GIS

NOAA

ENERGY
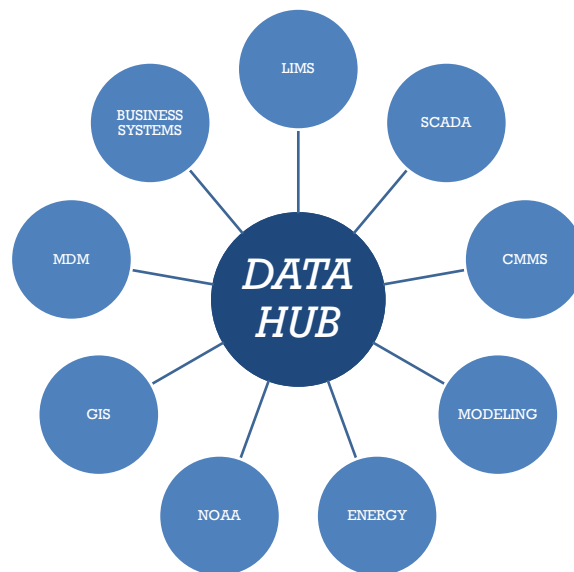
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BRAINSTORMING DATA SILOS
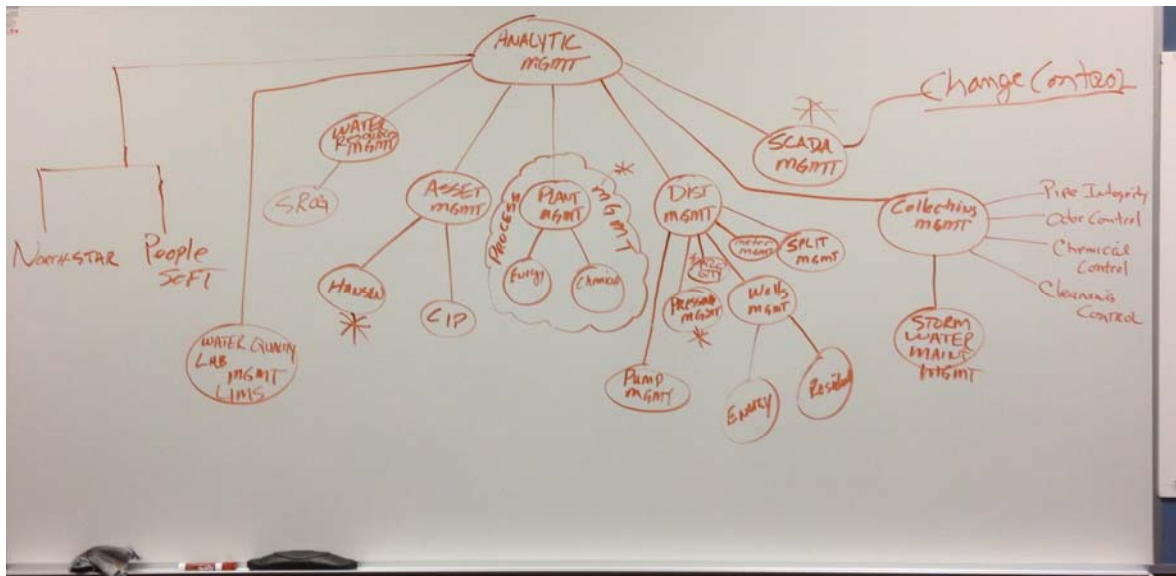
17

MONITORING & DIAGNOSTIC CENTER

- Gathers, filters and analyzes plant data
- Identifies emerging issues
- Quantifies the cost and risk
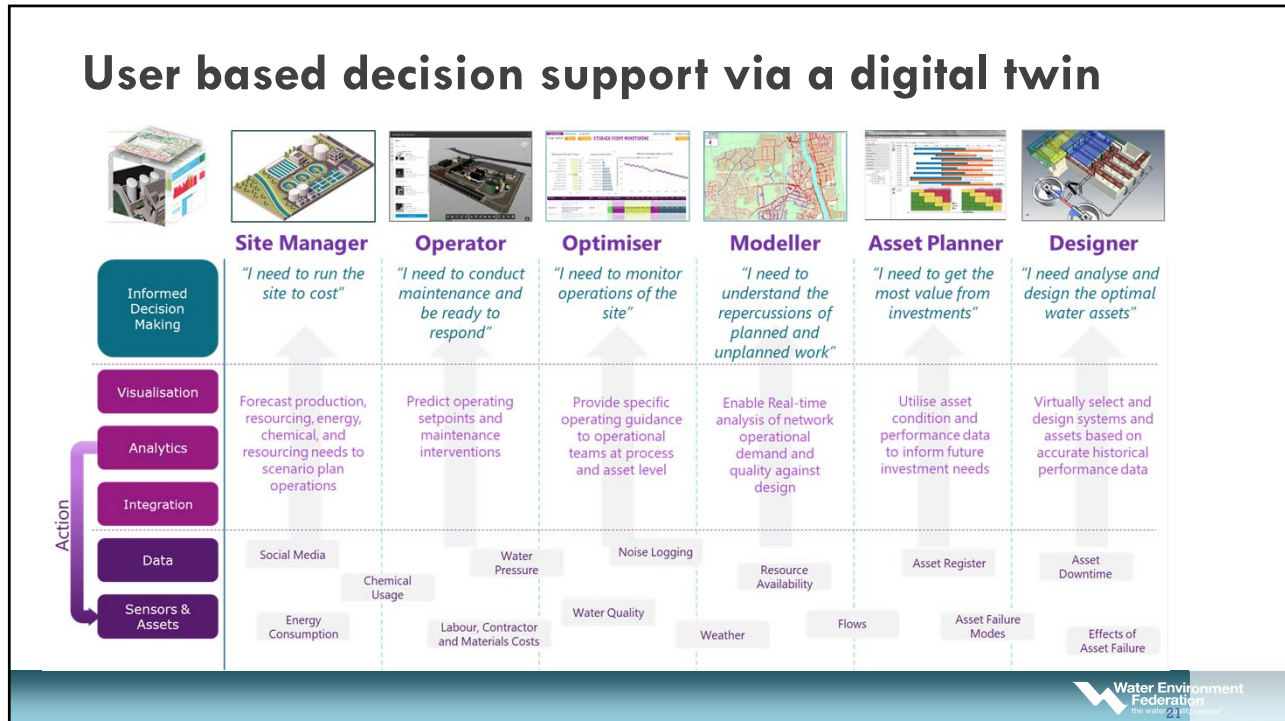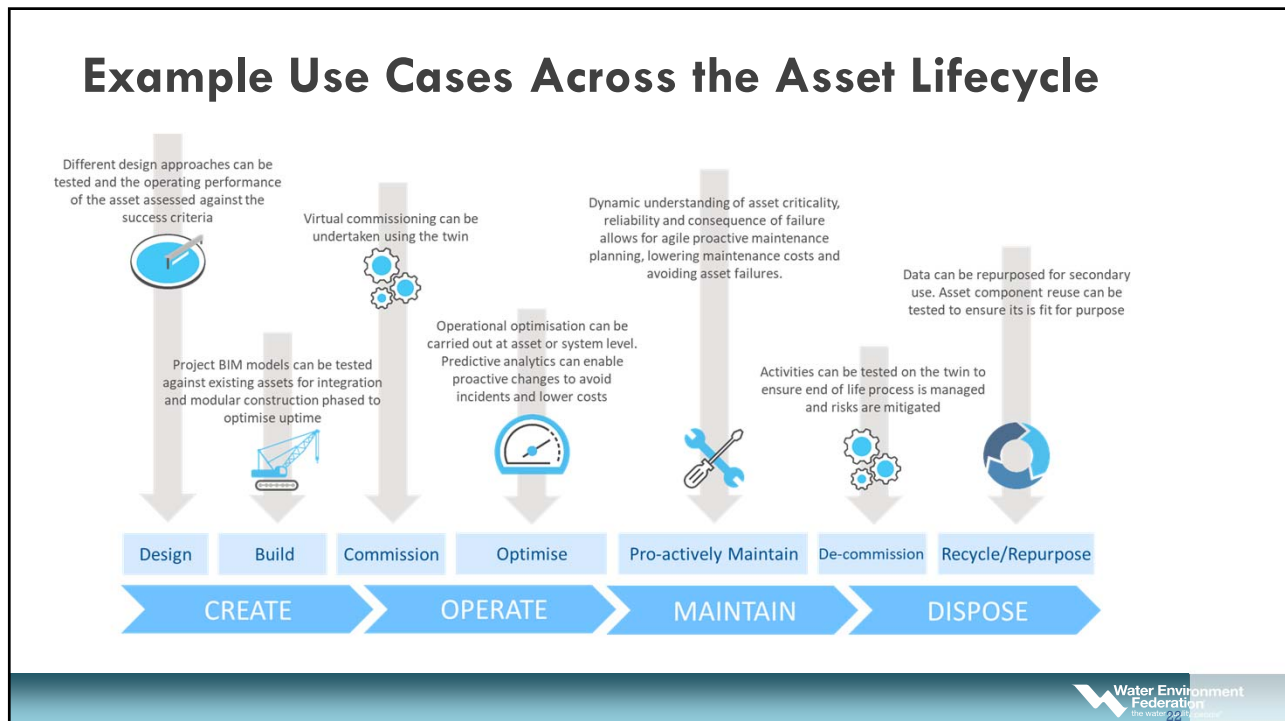- Makes recommendations for corrective action

18
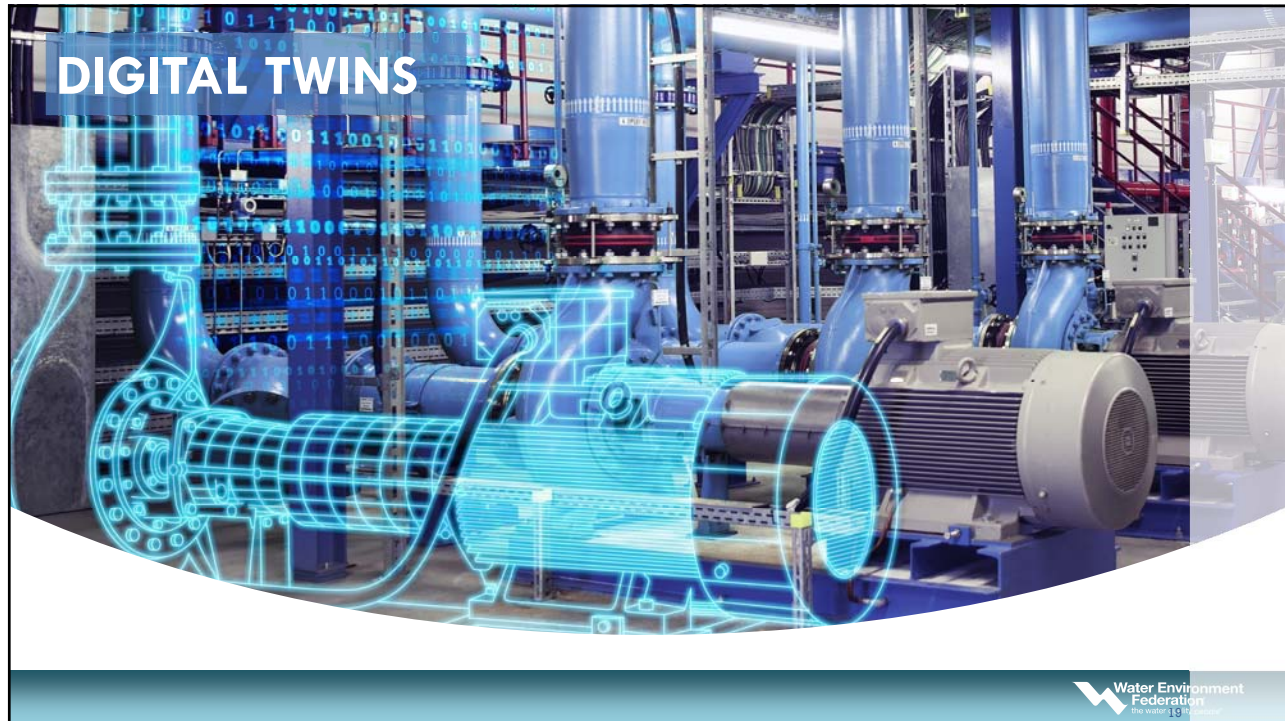
DIGITAL TWINS

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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".*

20

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 / Analytics / Integration	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

Data / Sensors & Assets:
- Social Media
- Chemical Usage
- Energy Consumption
- Water Pressure
- Labour, Contractor and Materials Costs
- Noise Logging
- Water Quality
- Resource Availability
- Weather
- Asset Register
- Asset Failure Modes
- Flows
- Asset Downtime
- Effects of Asset Failure

Action

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

Virtual commissioning can be undertaken using the twin

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

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

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

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

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

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

CREATE → OPERATE → MAINTAIN → DISPOSE

Dr. Andrew Shaw

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ShawAR@bv.com   AndyRShaw

BLACK & VEATCH

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Case Study:

Real Time Decision Support Systems (RT-DSS)

emnet
a xylem brand

HYDROCONSULT
ENGINEERS, INC.

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Speakers

Beth Goldstein
- Principal
- HydroConsult Engineers

Richard Loeffler IV
- Client Solutions Manager
- EmNet, a Xylem brand

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What's RT-DSS

Computer-based <u>information system</u> that **assists** in decision-making activities in <u>real time</u>.

- process collection system and watershed data,
- approximate the impact of rainfall,
- evaluate and optimize operational strategies

Combined, these can provide **real-time operational recommendations to operators.**

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What's RT-DSS

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What's RT-DSS
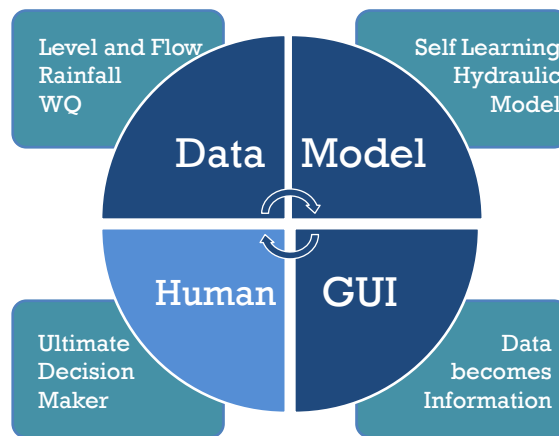
- Level and Flow
  Rainfall
  WQ
- Self Learning
  Hydraulic
  Model
- Data
- Model
- Human
- GUI
- Ultimate
  Decision
  Maker
- Data
  becomes
  Information

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"Glass Box" Implementation

- Co-design and Collaboration
- Open Modular Architecture
- Sensor/Model Agnostic
- Operations focus
- Leverages Investments
- Real Time Decision Support Framework

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Data + Model Integration = Predictions
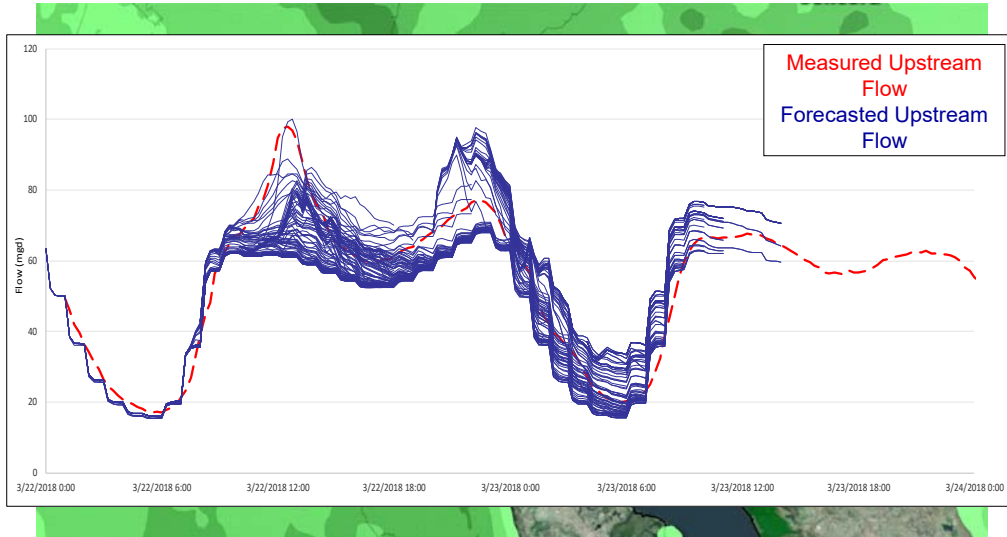
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Recommend + Act

34

Applications:

- Enhance information re: what's happening in the collection system

- Reduce sewer overflows (wet & dry weather)

- Maximize storage and conveyance in collection system

- Predict peak WWTP flow timing to balance out diurnal flows

- Provide operational decision recommendations

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Coordinated Decision Support

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Coordinated Decision Support
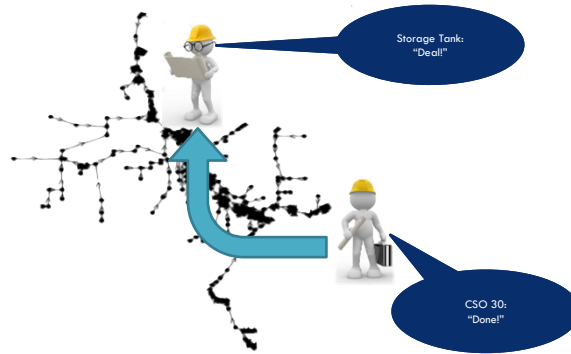
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Outcomes – South Bend, IN
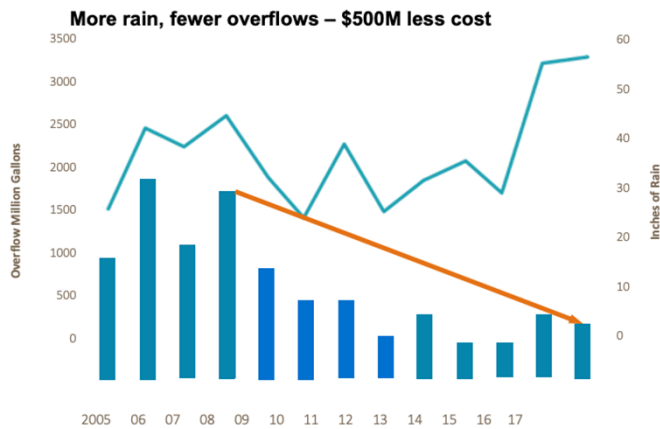
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Automated Systemwide Storage
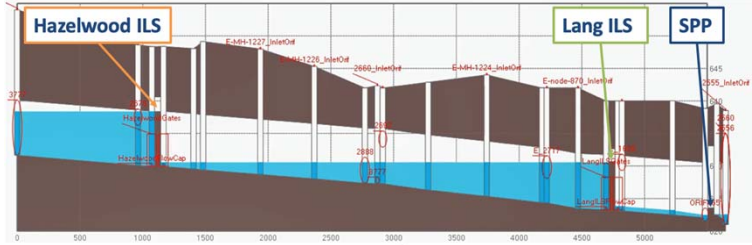
Selected 16 inline storage facility sites based on volume of sewer, impact on overflow reduction, constructability, and LEAF as possible

All sites communicate via SCADA and DCS system

~$145M in capital project savings

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Automated Systemwide Storage
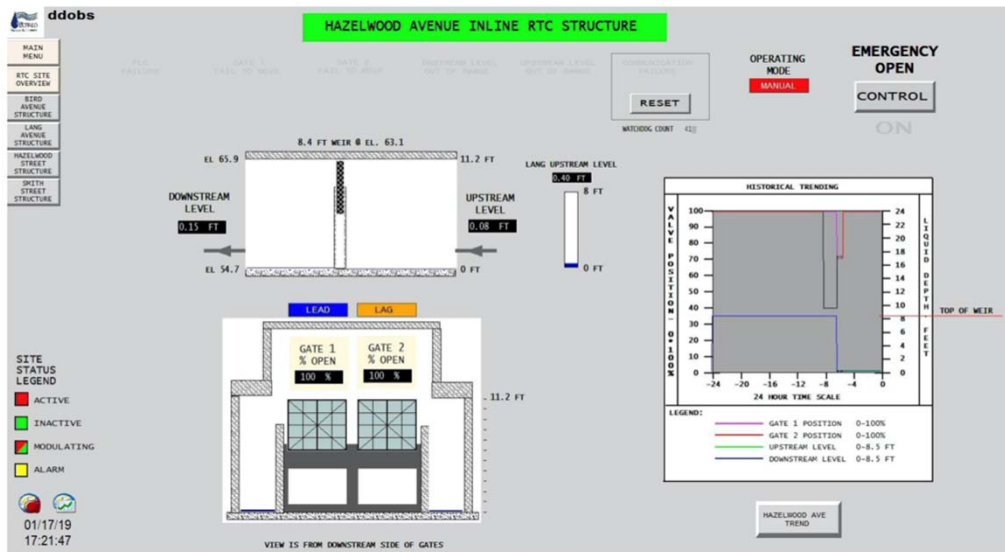
40

Enhance Data Use + Optimize WWTPs
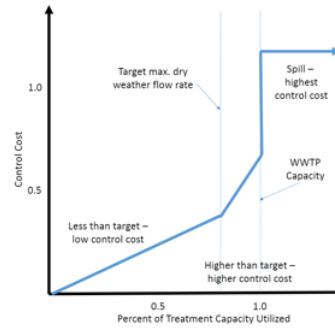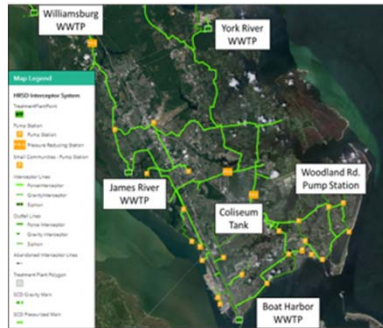
- Eliminate SSOs, manage peak flows across 3 main WWTPs
  - Leverage data from 700+ installed sensors and meters
  - Minimize time plants operate near peak capacity (adapt to seasons, capacity)
  - Reduce/eliminate major CIP projects
  - I/I reduction
  - Load balancing for indirect potable reuse system implementation

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Wet Weather Storage Activation
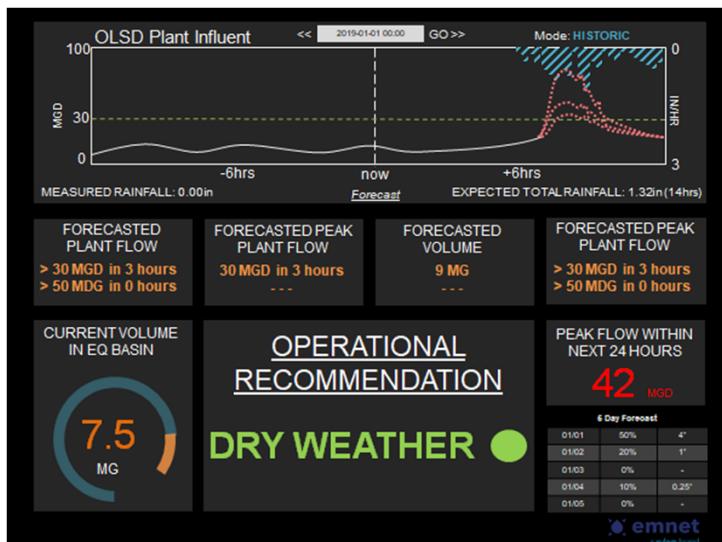
- Full model+data engine
- Runs 100 sims every 15 minutes
- Current conditions +/- 12 hours
- Probabilistic estimage of future flows
- Comprehensive situational awareness
- Provides high-level recommendations

Outcomes:
- Increased continuity of operations
- Operational knowledge aggregator
- Training tool for new recruits
- Forensic analysis

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Summary

- RT-DSS represents an open, extensible framework that uses existing utility assets and information to put more data in front of operators and decision makers.

- Co-design ensures operations provides critical feedback necessary for to develop the most impactful tools.

- Enhanced collection system knowledge can have watershed scale impacts for collections and treatment assets.

- Involving all stakeholders in RT-DSS development ensures the entire team designs the system, and identifies/mitigates all possible challenges and needs.

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Thanks for your time!!

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richard.loeffler@xyleminc.com

emnet
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Beth Goldstein, PE
bgoldstein@hydroce.com

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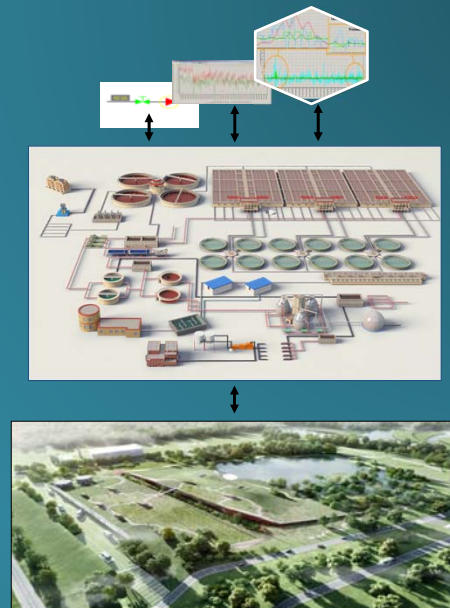
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Digital Twin

Three Dimensional Interactions:

1) Company performance models
2) Asset database(s)
3) Model simulations physical systems
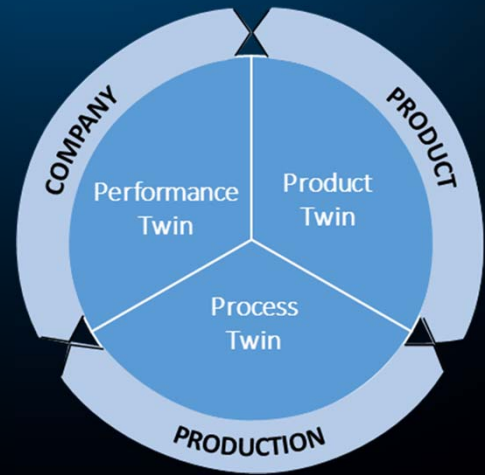
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Digital Twin- Integration of Cyber and Physical System
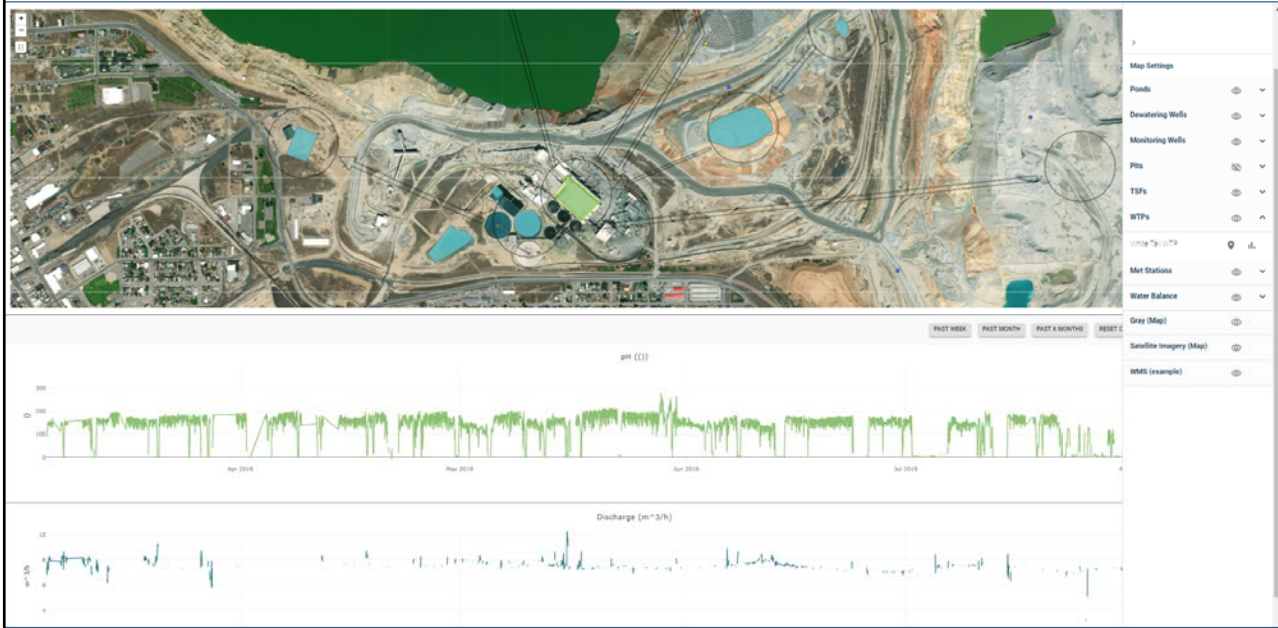
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Digital Twin
Integration of Cyber and Physical System
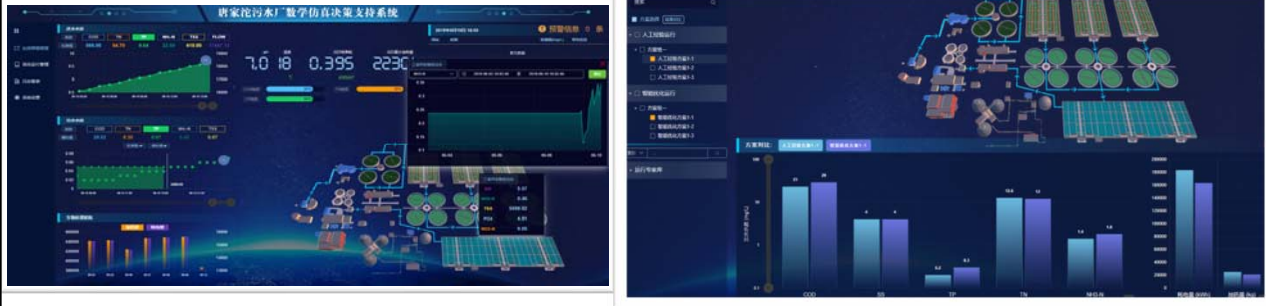
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WWTP Capacity Expansion for under $2M

Advanced Modelling, Real-time Control, and Densified Activated Sludge

Viby WWTP
case study

50

Viby WWTP – The Problem
90,000 PE to 120,000 PE

- Influent load is rapidly increasing by 33%

- WWTP to be consolidated in 10yrs

- Tight nitrogen & phosphorus limits

Aarhus Water: "Can the short-term capacity expansion be done for $2M?"

We think it might be possible.

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Project Approach

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Project Approach

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WEST Modeling

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Sidestream Hydrolysis (Bio-P)

vs.

Extra N/dN Volume (Chem-P)

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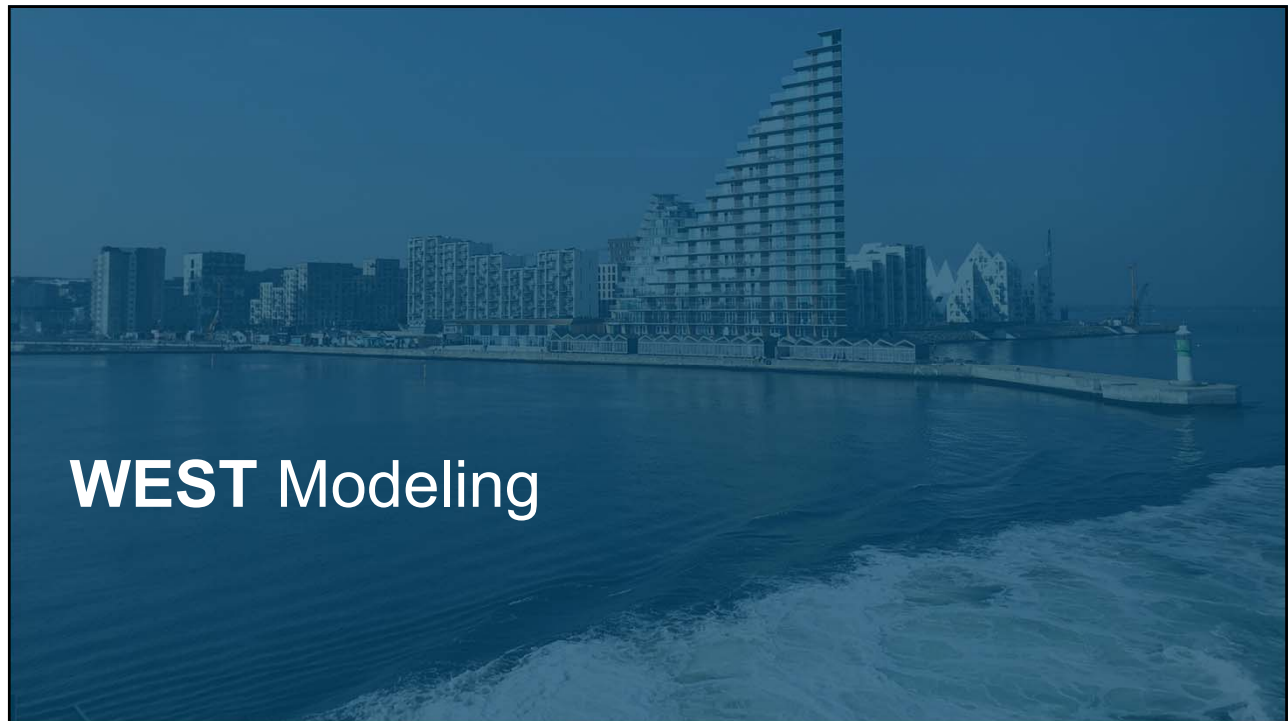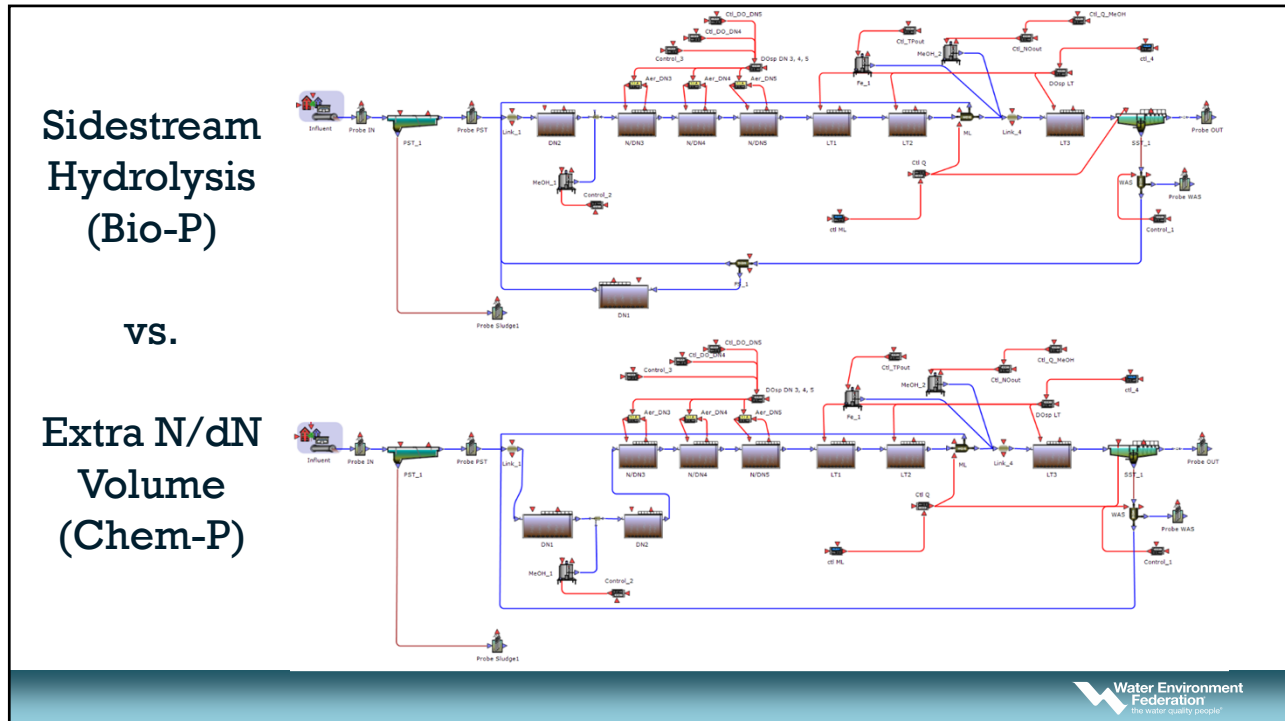
The solution

Maximize Oxic Volume

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The solution

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The solution

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The solution

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The solution

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The solution

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The solution

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The solution

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The solution
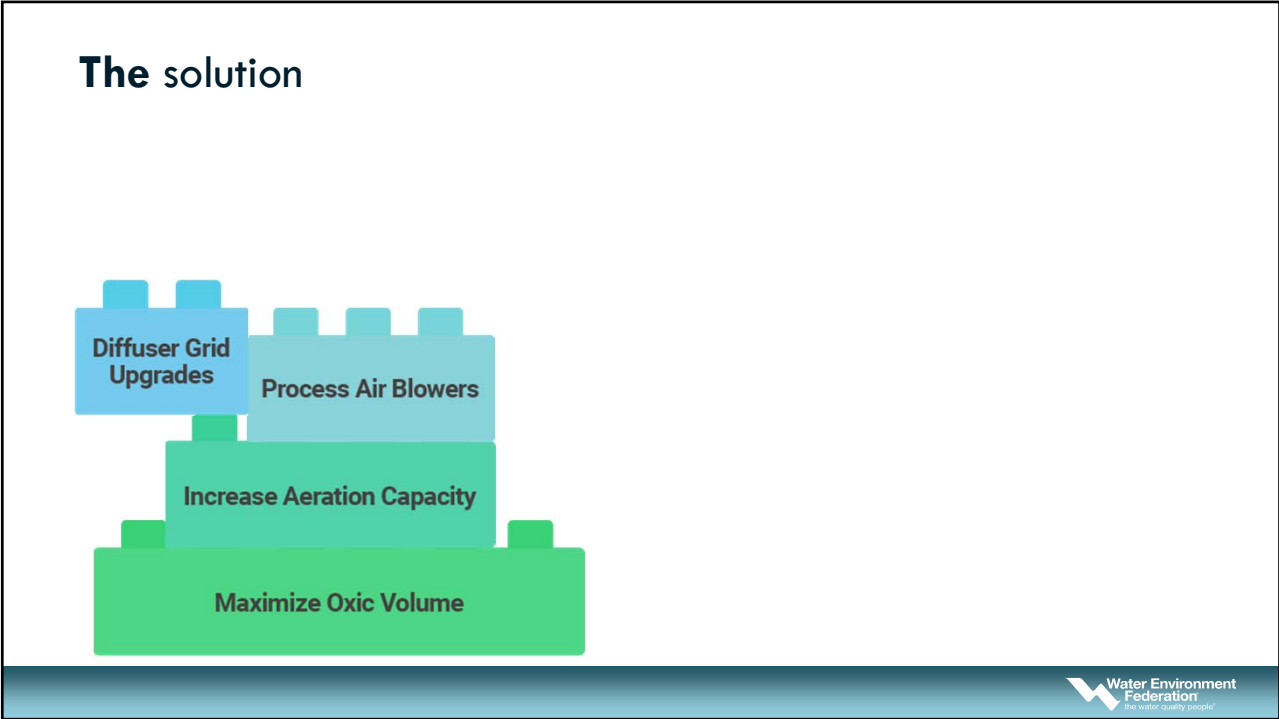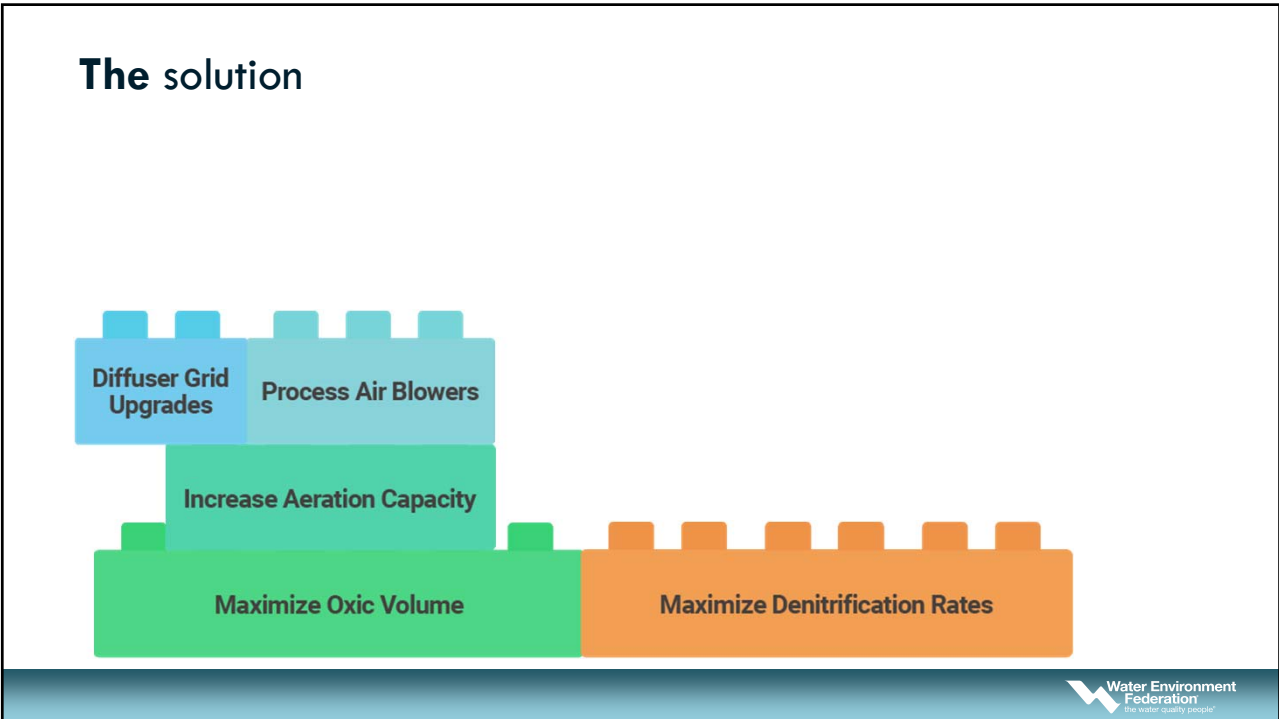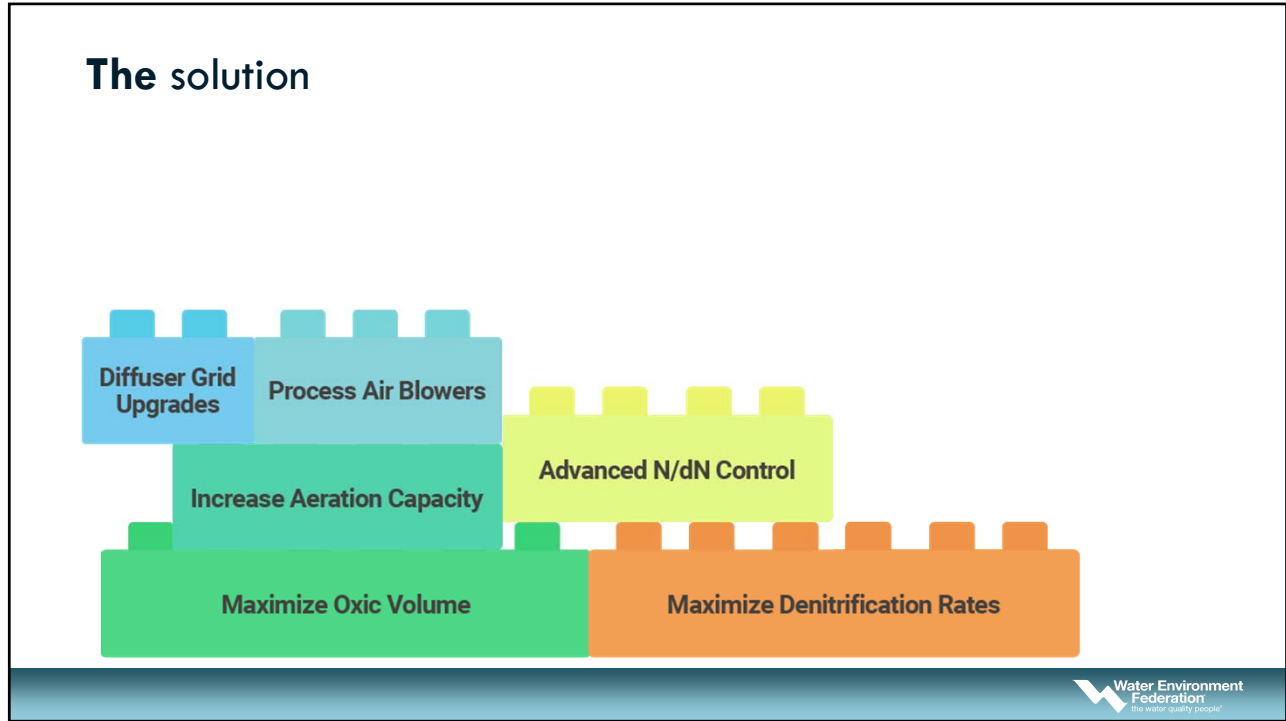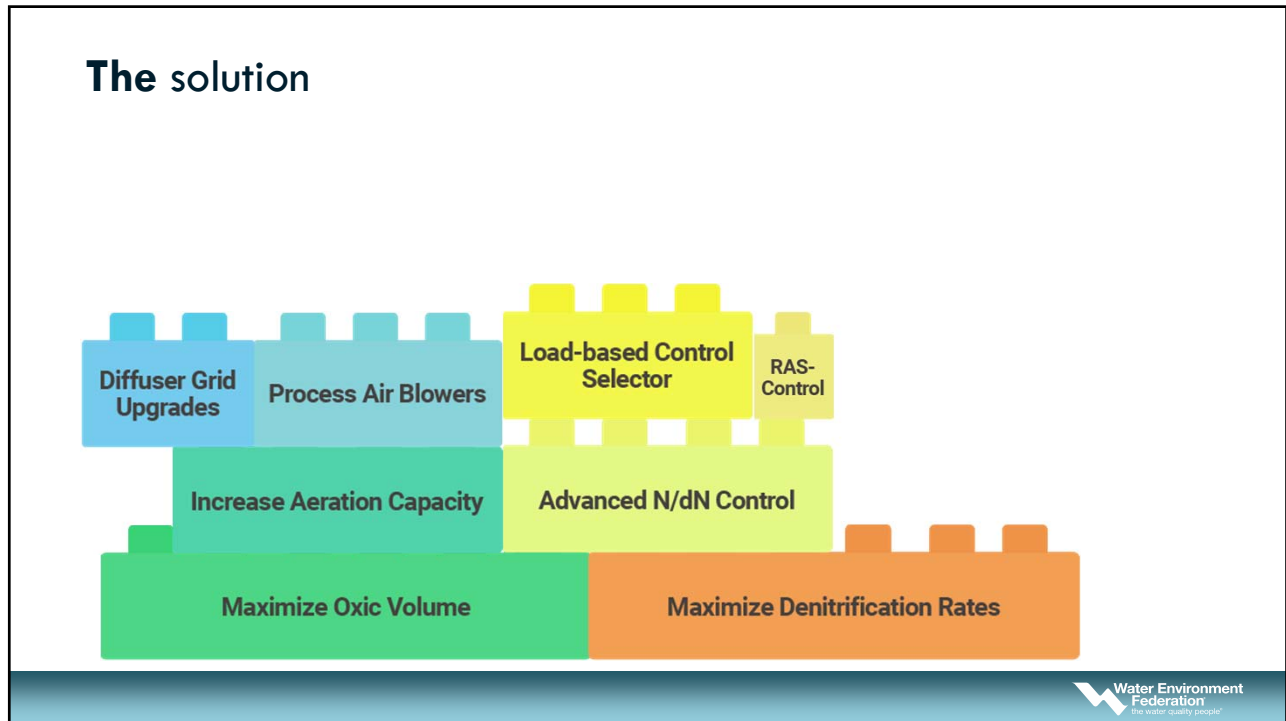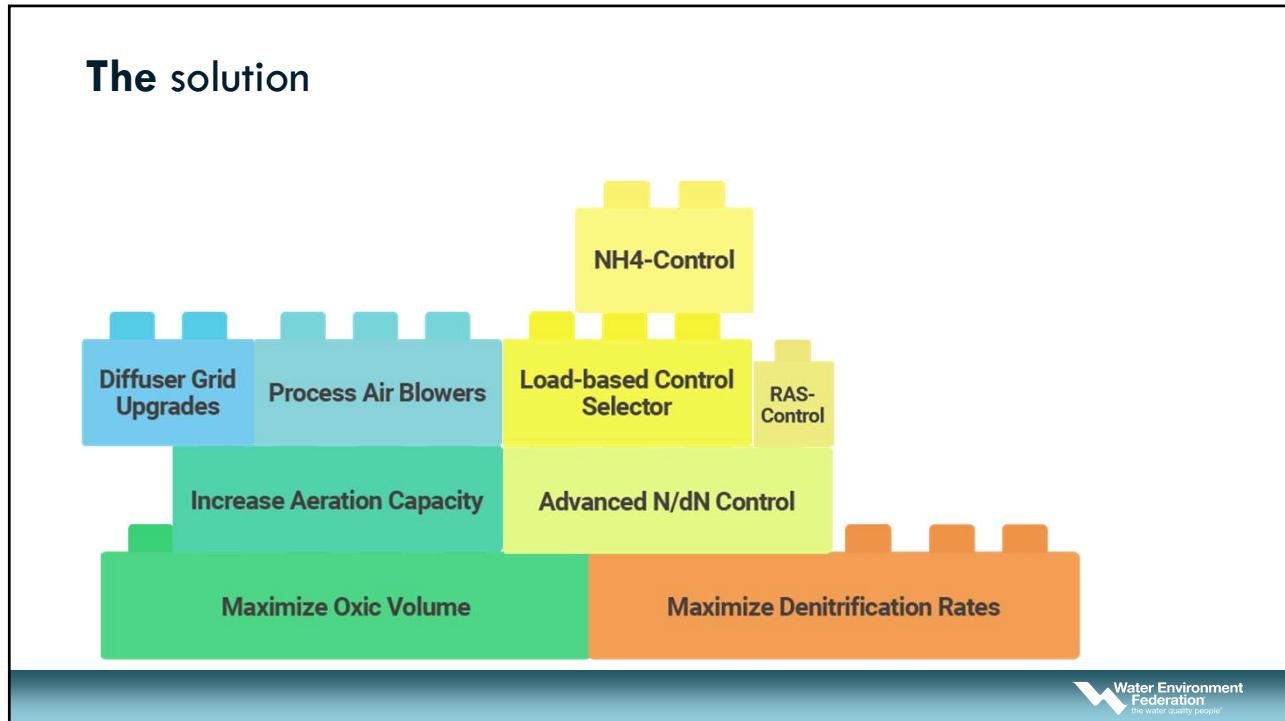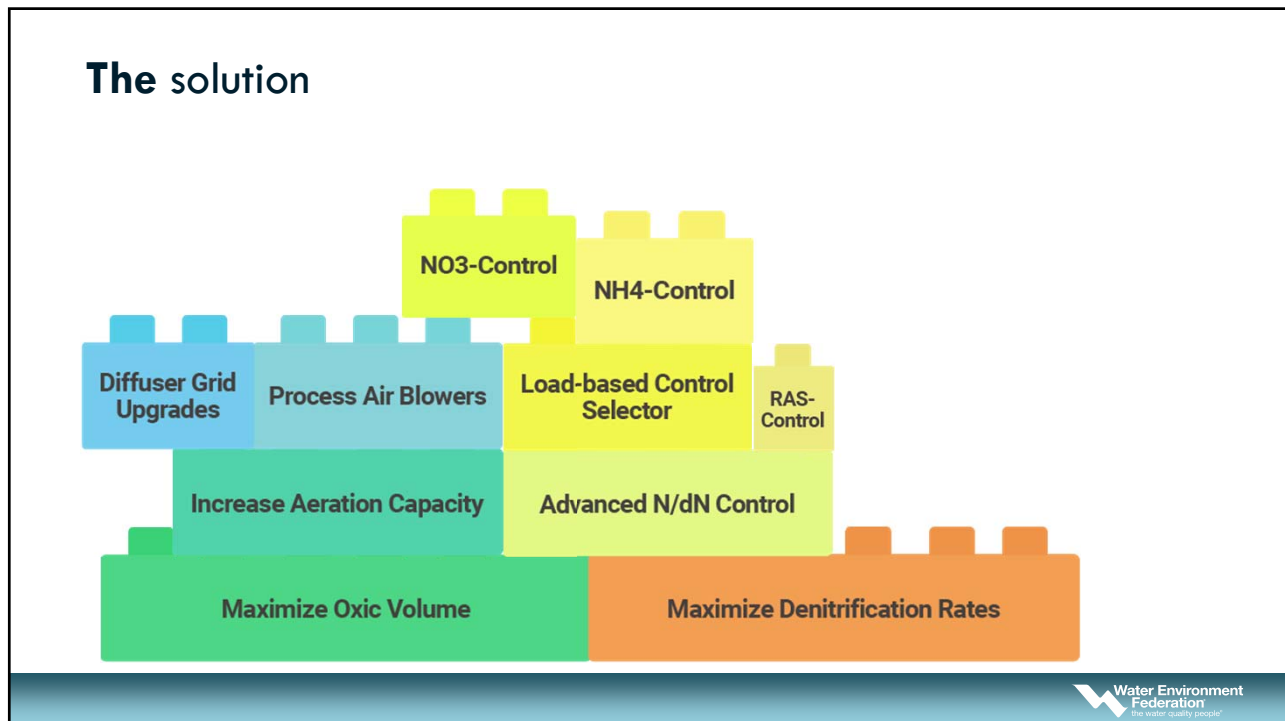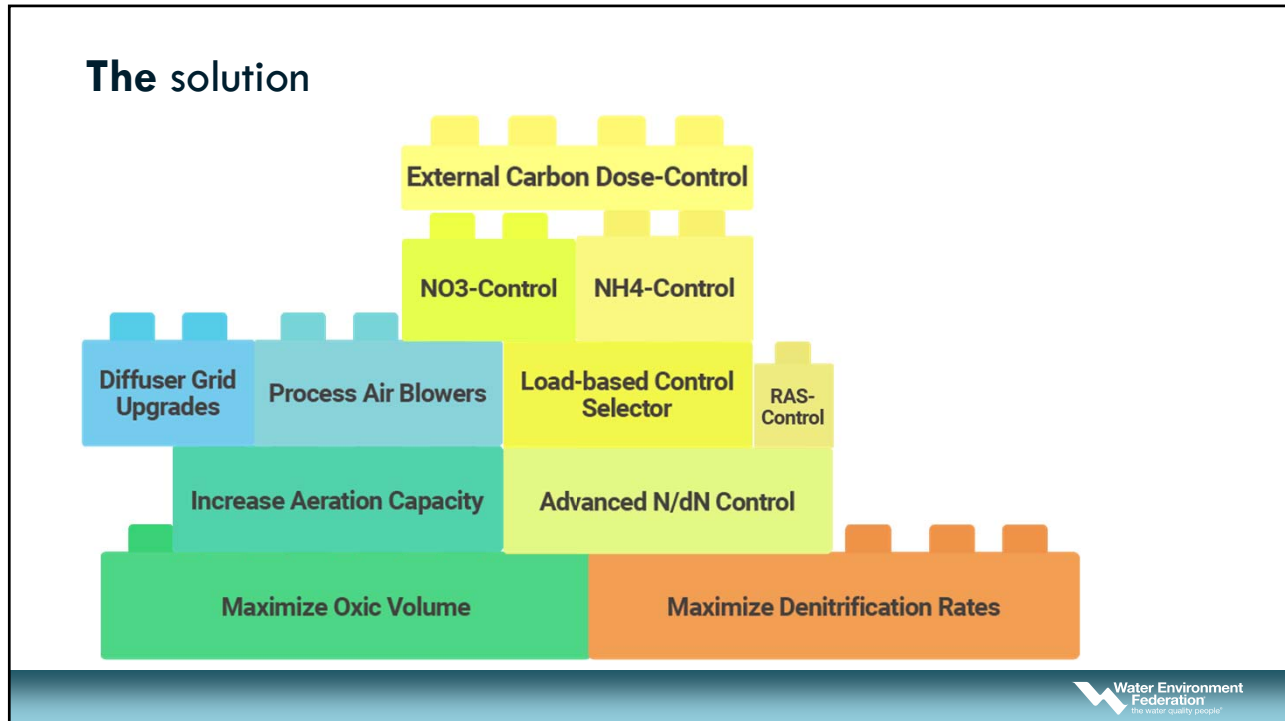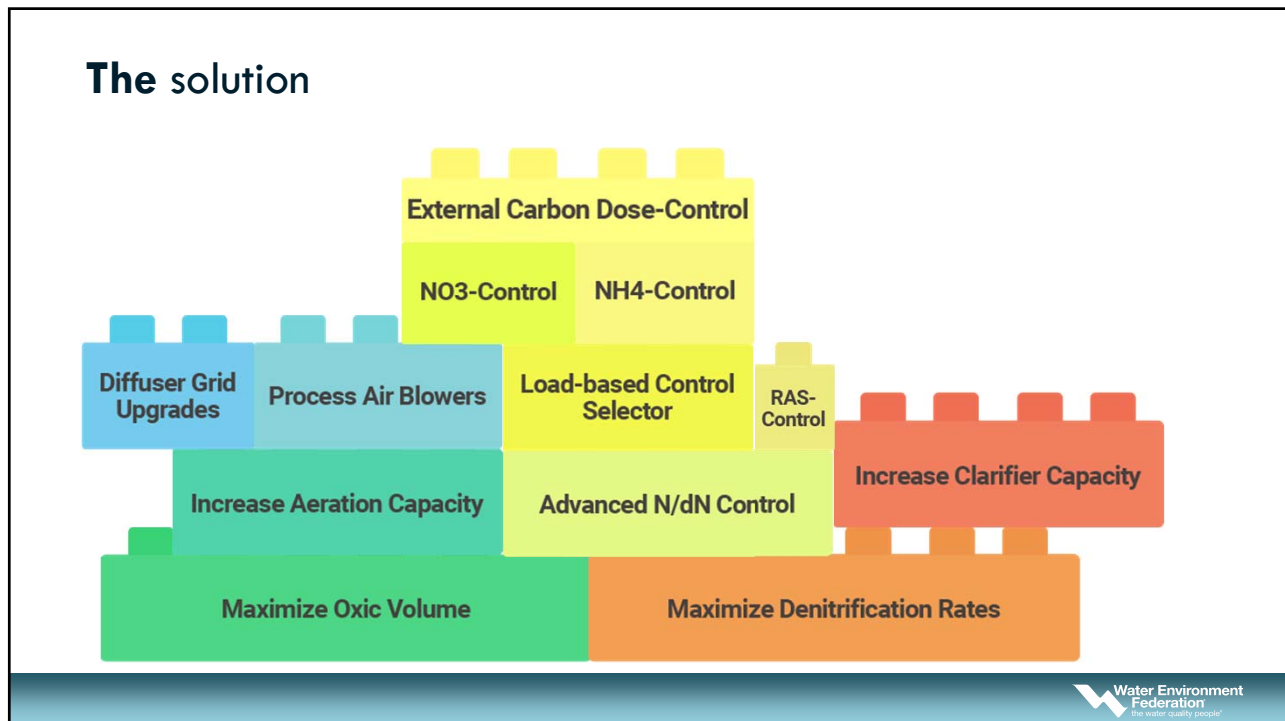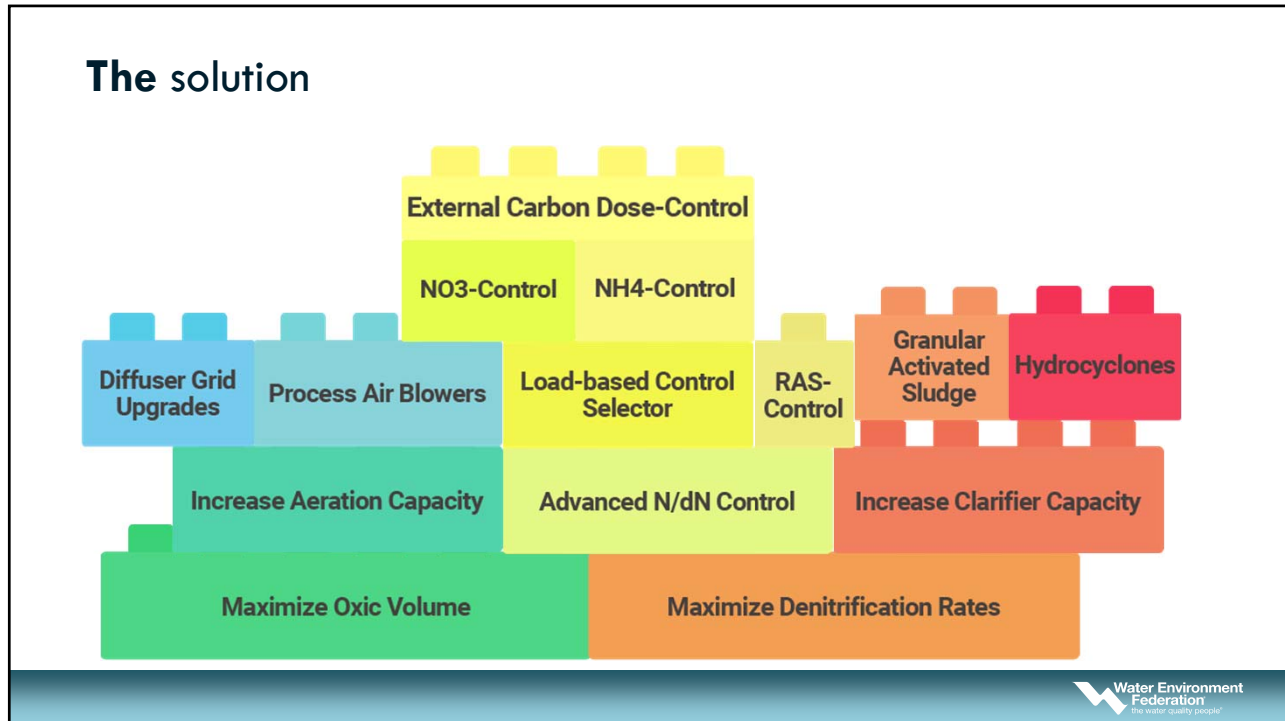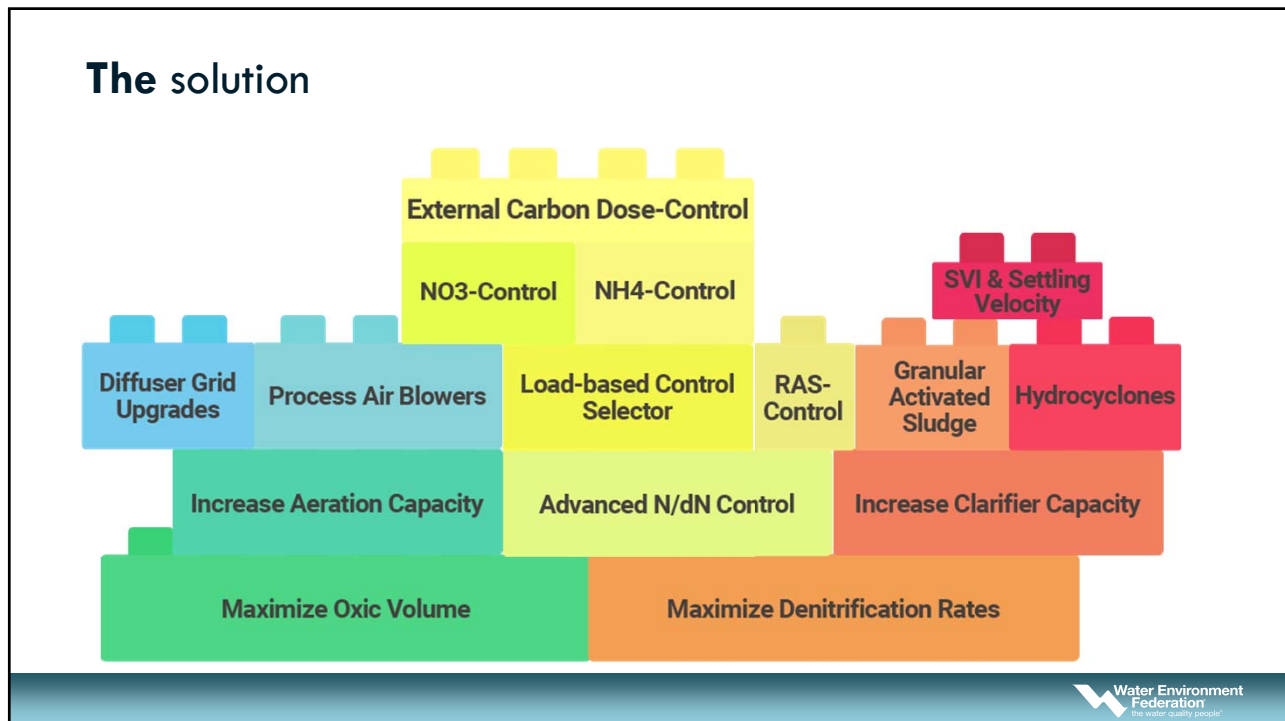
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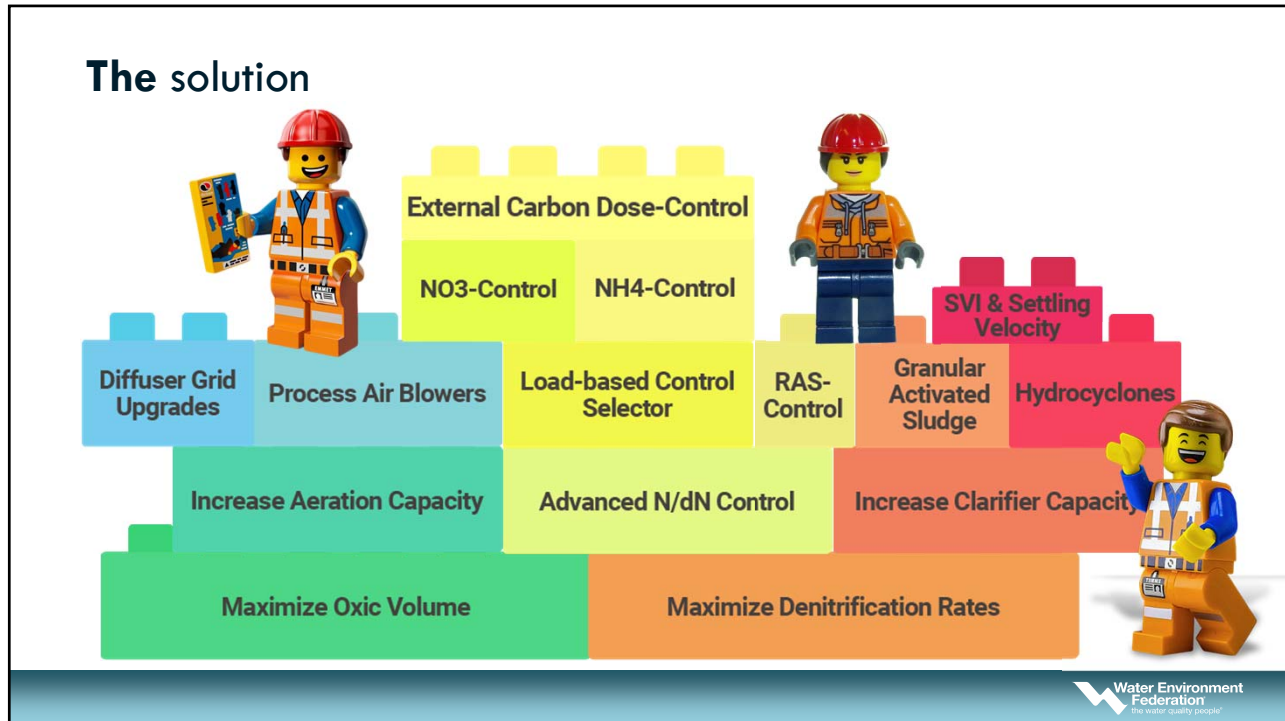
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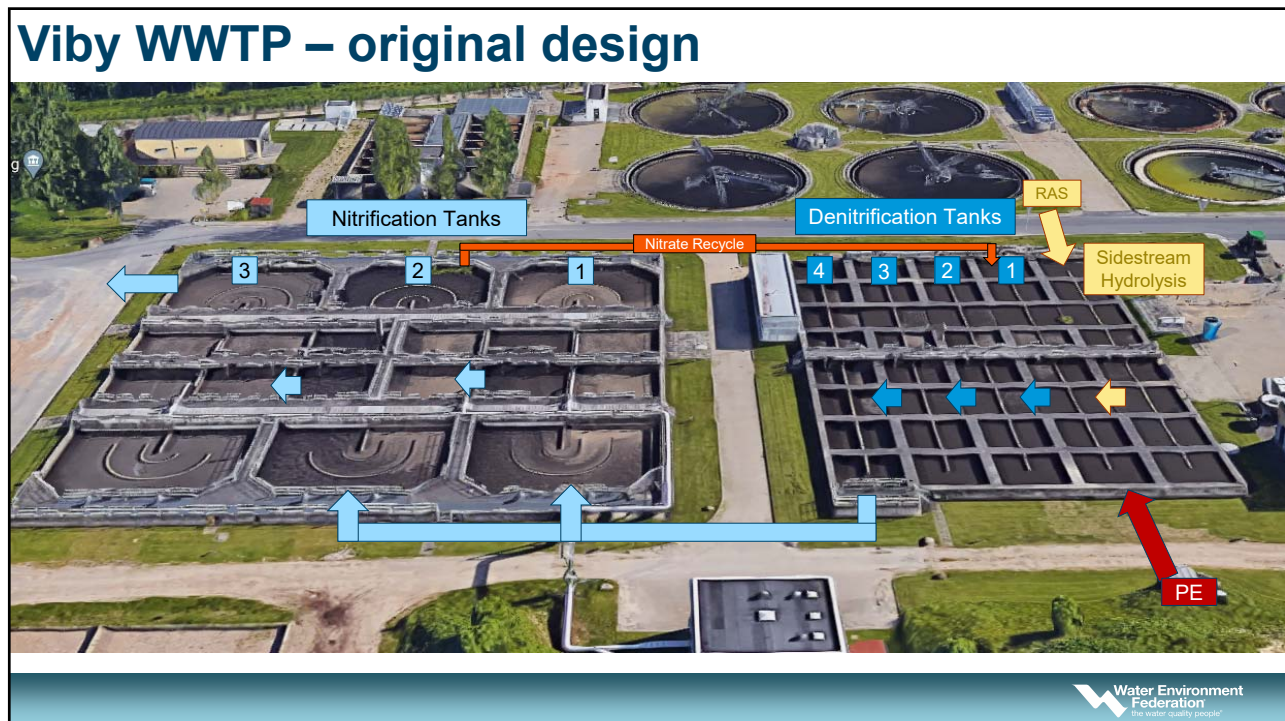
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Viby WWTP – optimized design

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Post DN Tank

nitrate concentration

ammonium concentration

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Results!

2019

(5.7 MGD)

(30.8 MGD)

2020

(13.7 MGD)

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Nitrate Profile

2019

2020

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Ammonium Profile

2019

2020
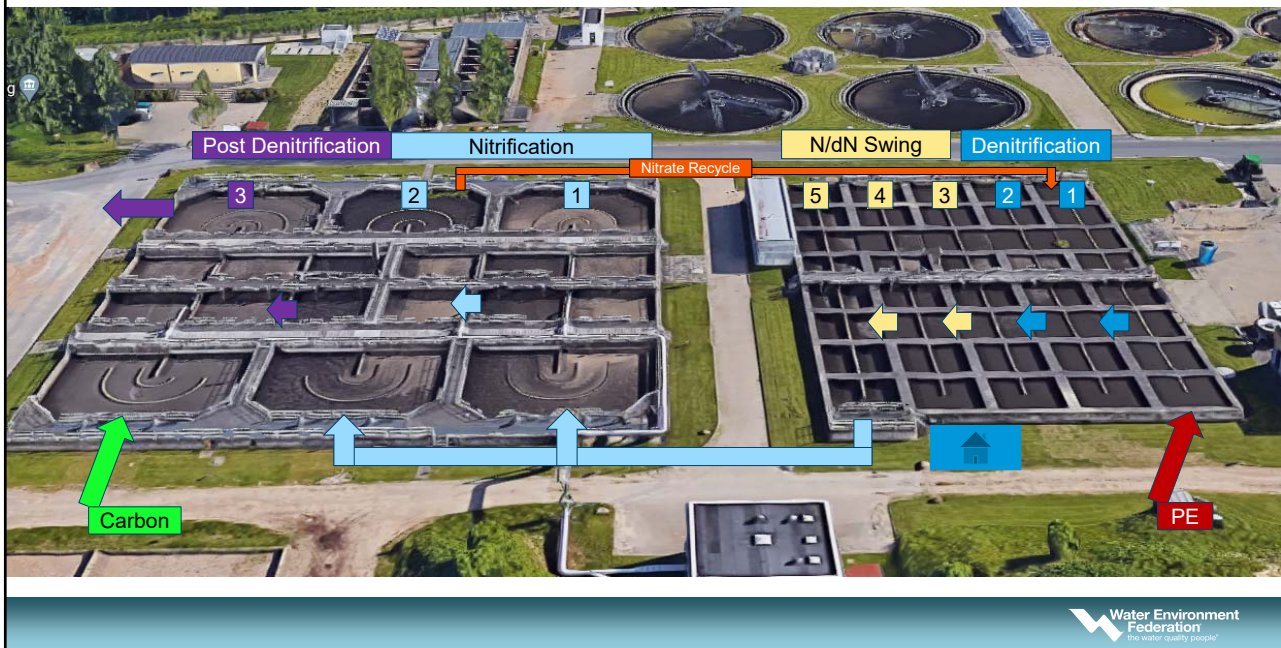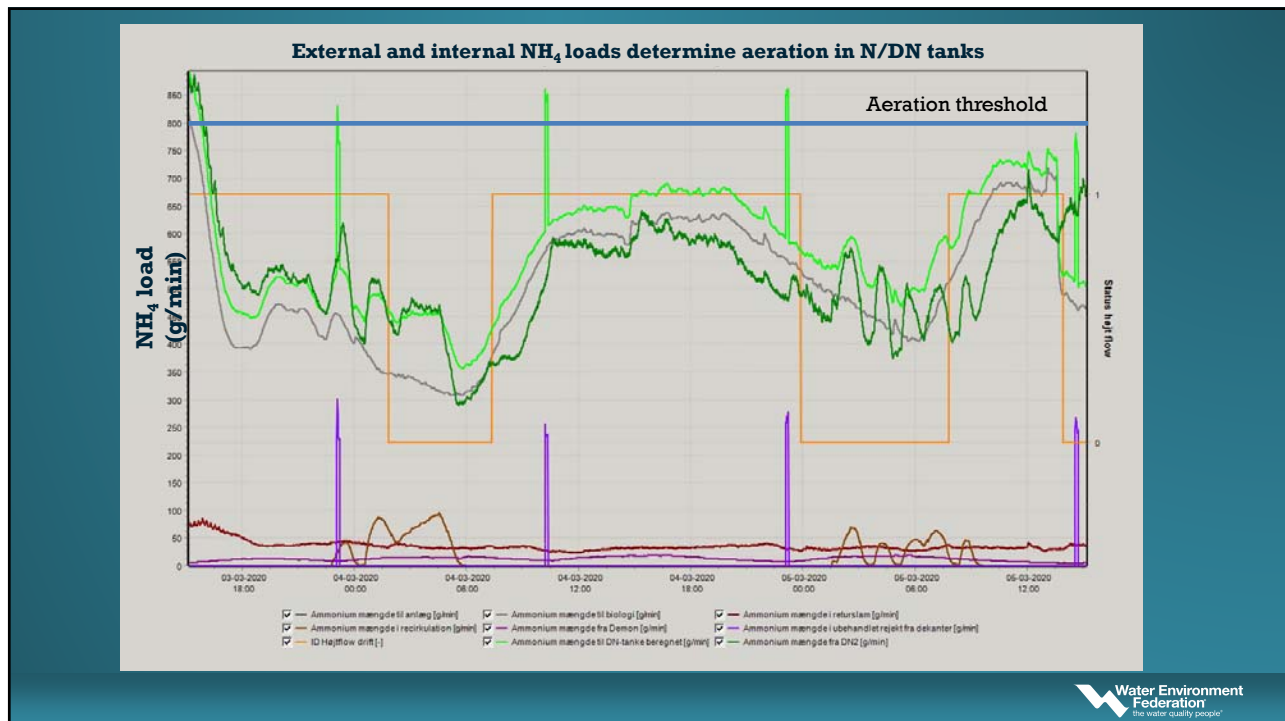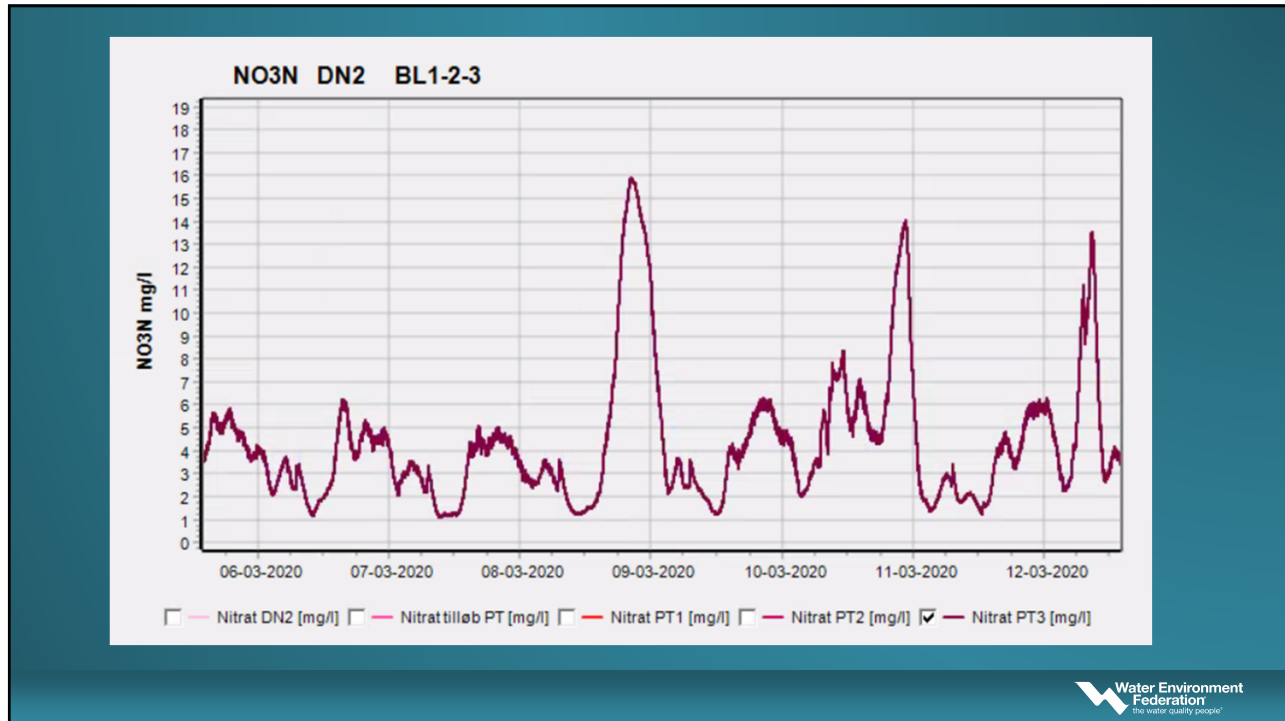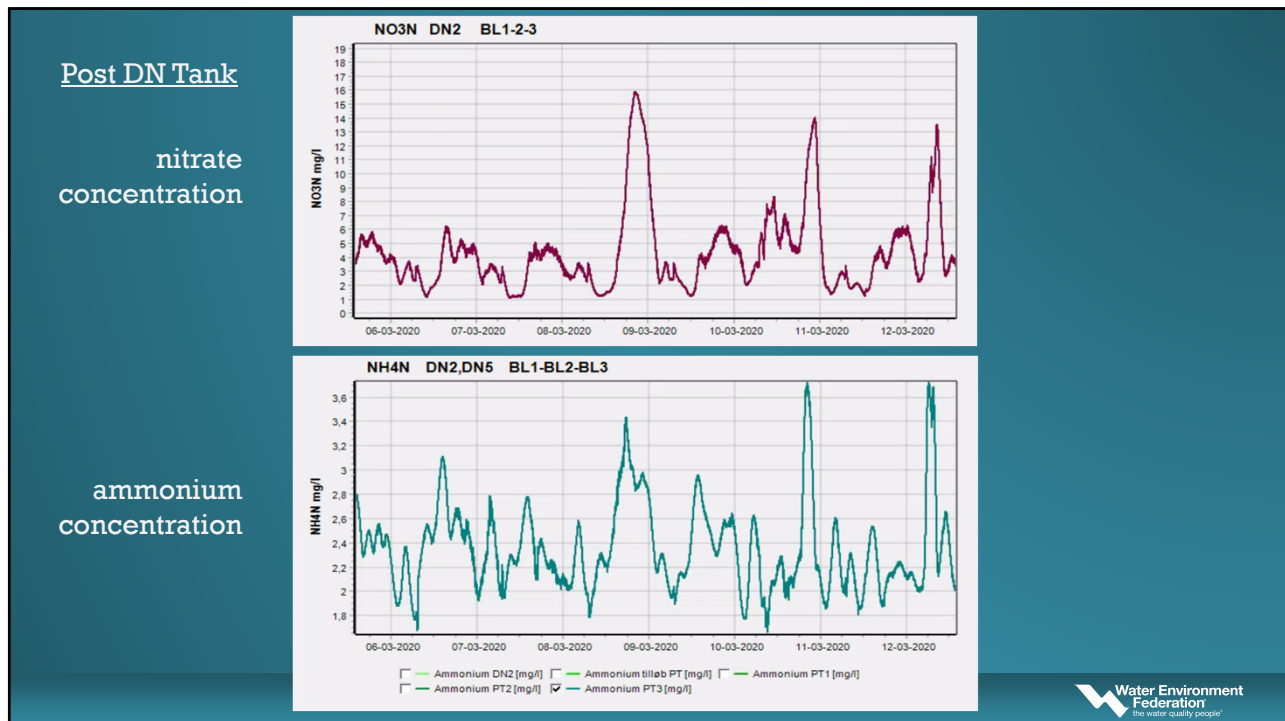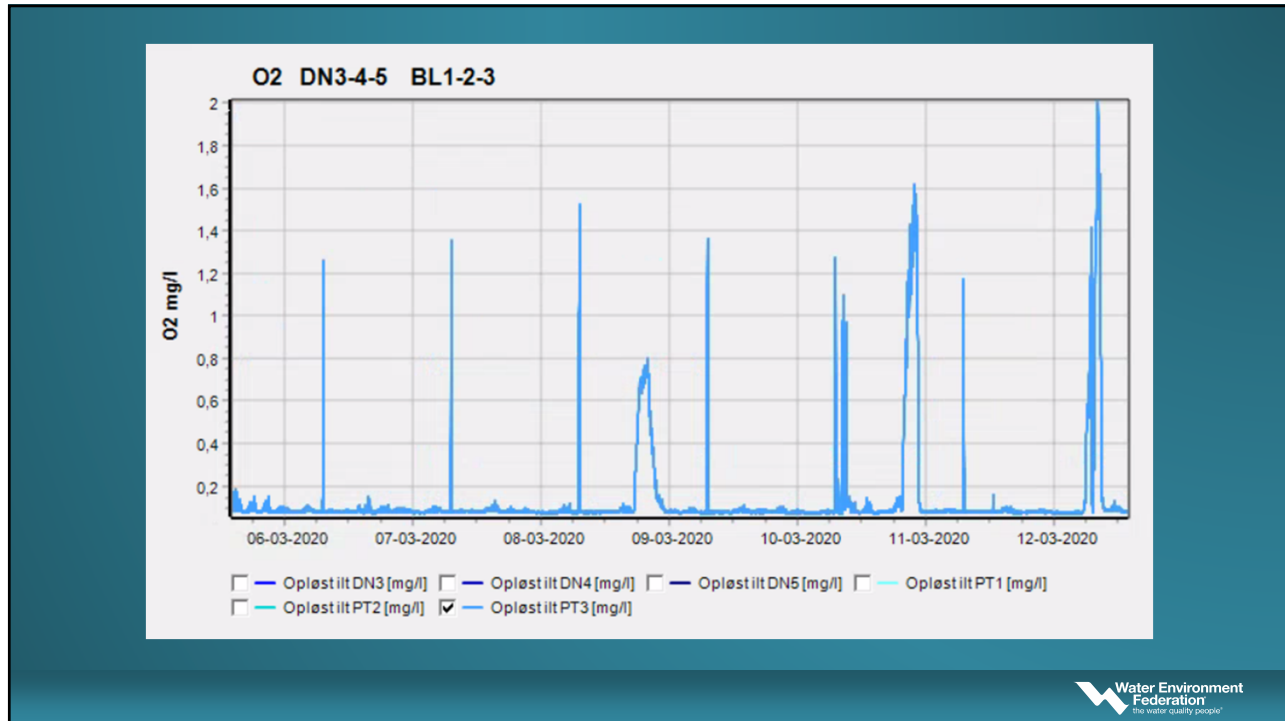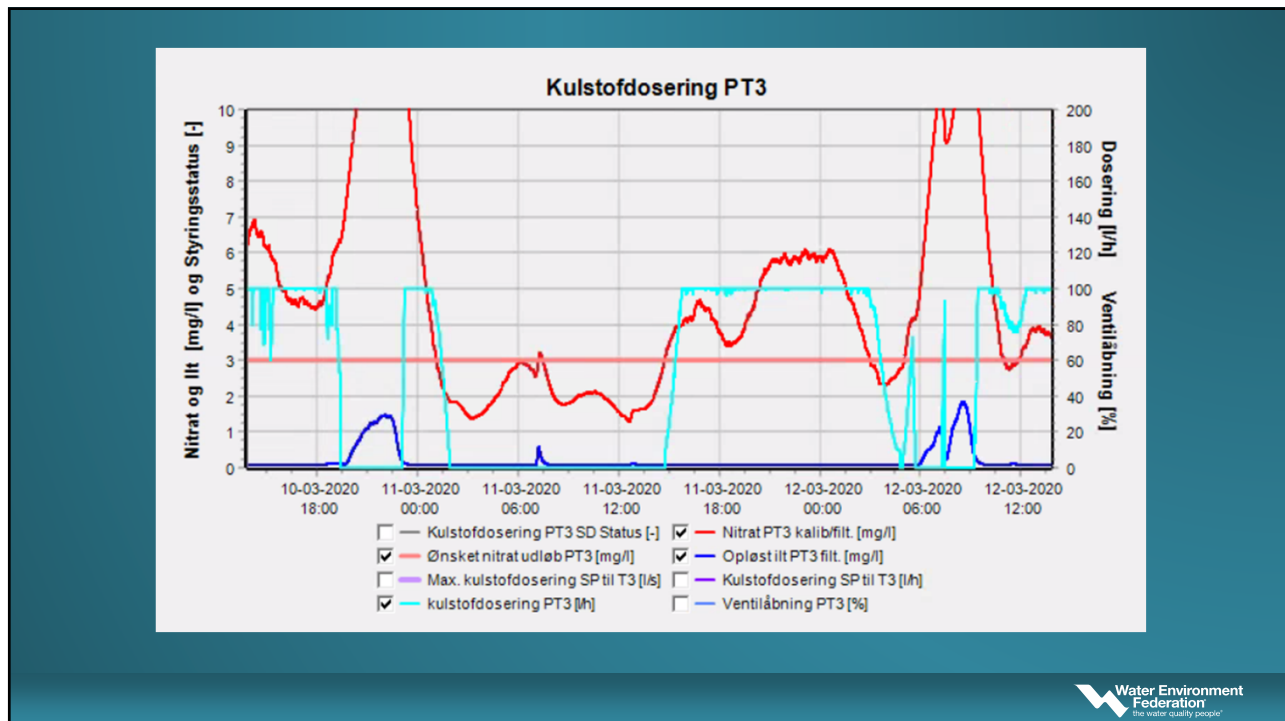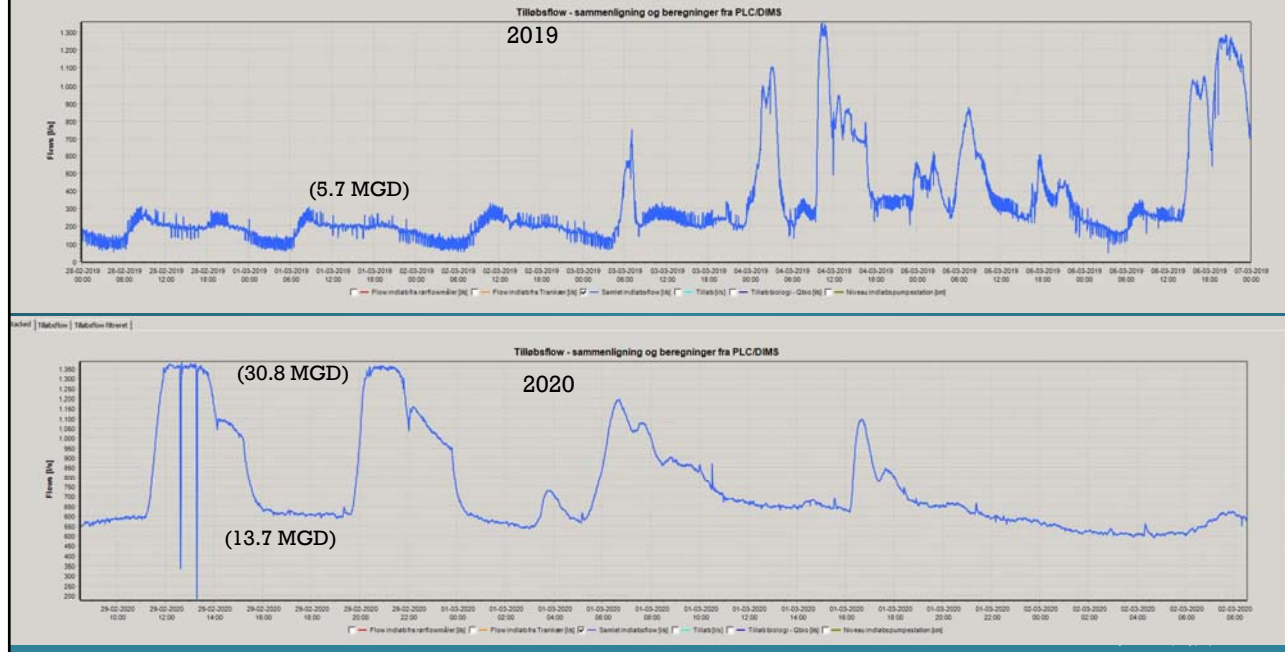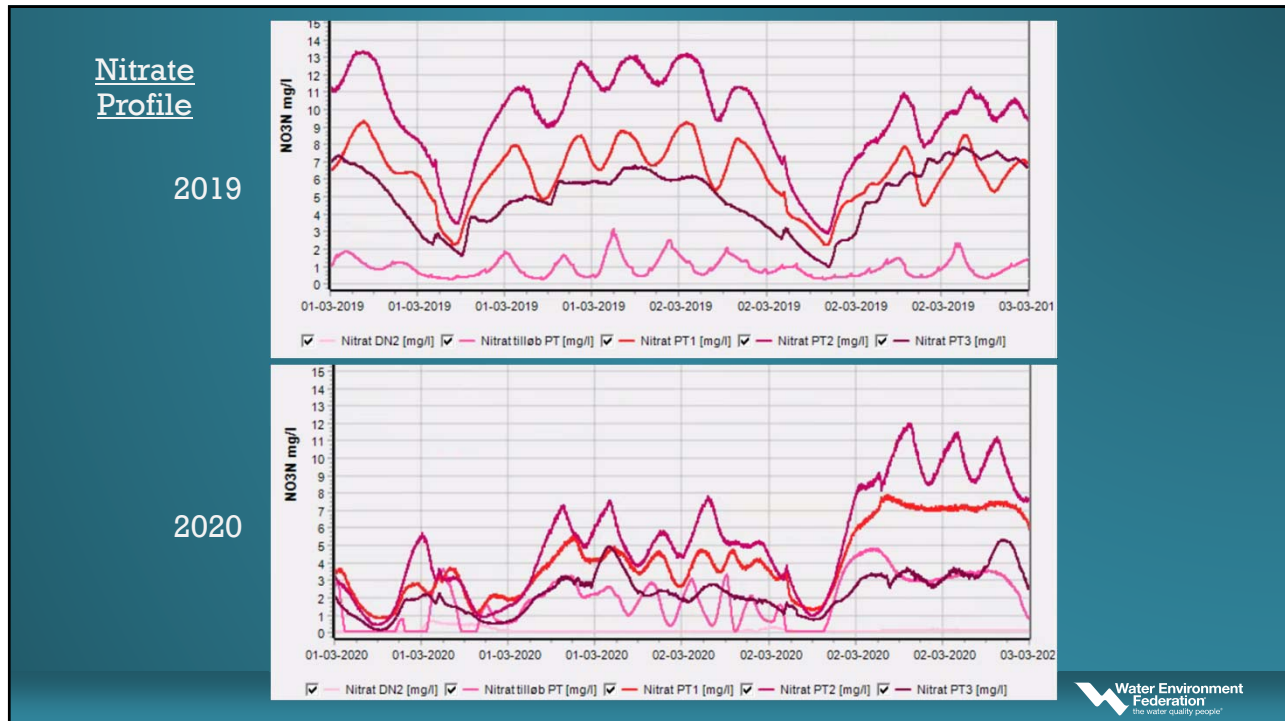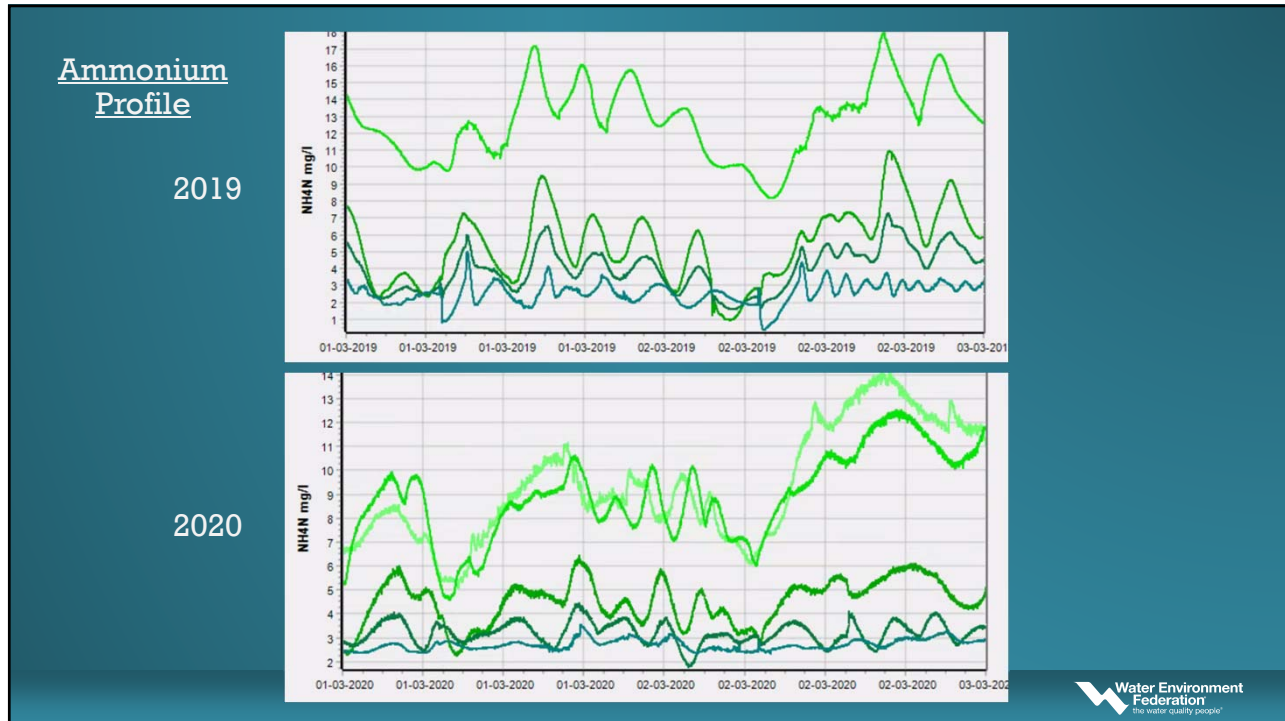
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DIMS.CORE – Advanced Controllers

- Data assimilation
- Data Validation
- Automated reporting

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Andy Crawford
Woodard & Curran

Asset Management Services Manager

- 10 years experience
- MS Env. Engineering
- Licensed Operator; NY, NJ

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Operator Rounds:
Real Time Analytics To Give Perspective
Andy Crawford
Woodard & Curran

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Agenda

- Rounds – What is it REALLY?

- Rounds Design

- Data Collection Tools – Form Applications

- Leveraging Data – Do more with less

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About Us

- Woodard & Curran is an integrated engineering, science, and operations company servicing public and private clients nationwide.

1,000+ **45**

PEOPLE **PLANTS**

Laguna Hills, CA | Los Angeles, CA | Sacramento, CA | San Diego, CA | San Francisco, CA | San Jose, CA | Walnut Creek, CA
Lakewood, CO | Enfield, CT | Middletown, CT | Lakeland, FL | Atlanta, GA | Andover, MA | Dedham, MA | Northampton, MA
Bangor, ME | Portland, ME | St. Charles, MO | Bozeman, MT | Butte, MT | Great Falls, MT | Cherry Hill, NJ
East Windsor, NJ | Elmira, NY | White Plains, NY | Tunkhannock, PA | Pittsburgh, PA | Providence, RI | Casper, WY
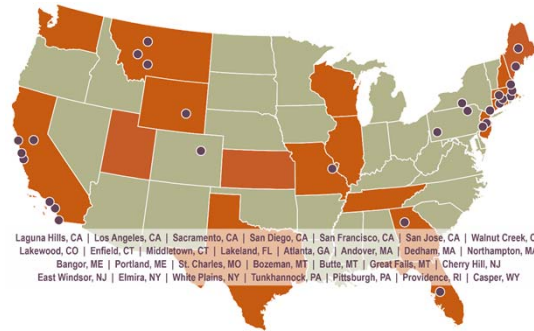
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Rounds – What is it REALLY?

- Appearance, Color, Smell

- Measure
  - Trust   but Verify

- Inspection
  - Maintenance
  - Process

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Data Collection Tools – Form Applications
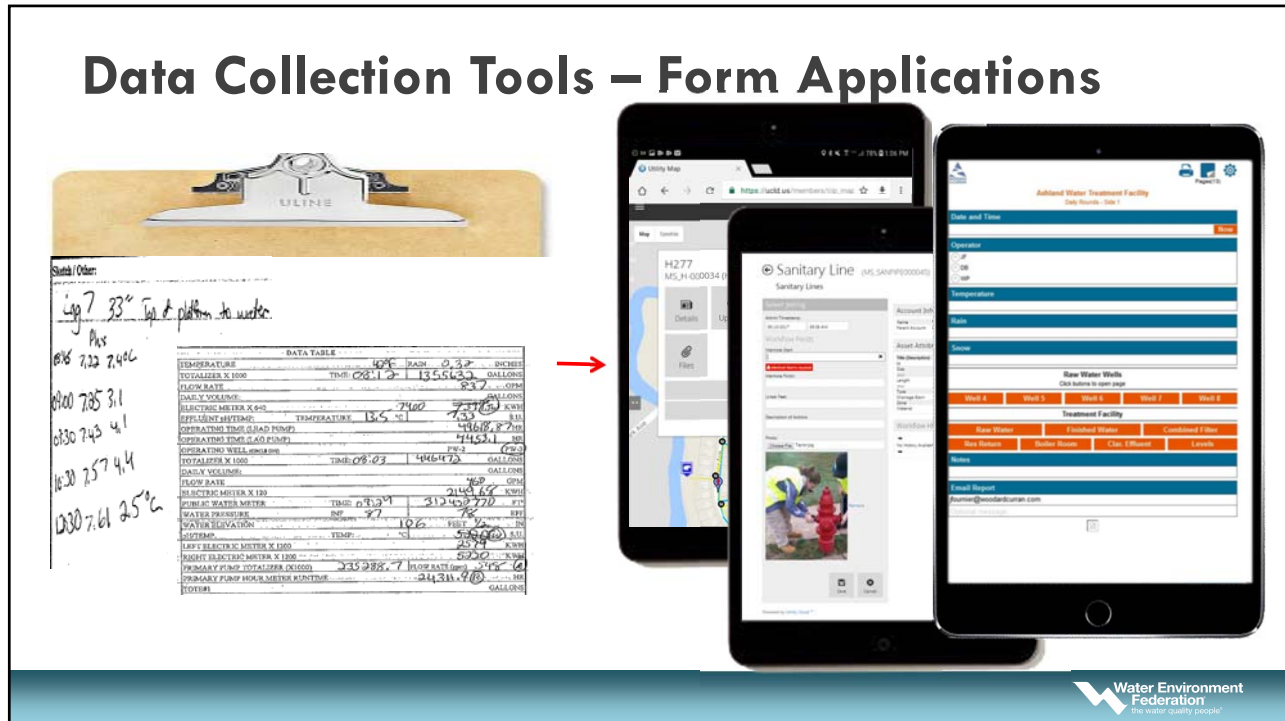
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Key Ideas – Rounds/Form Design

- QA/QC
  - Expand
- Real-Time Analytics
- Embed Experience
- Follow up
- Integrate!
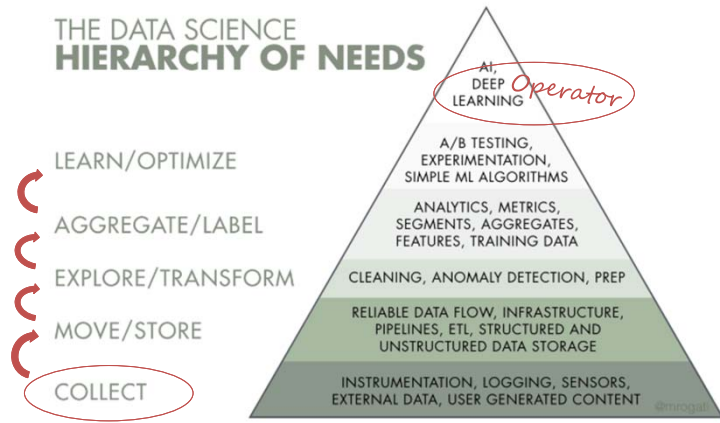
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Collect Key Features
QA/QC Data Collection

- Structured Data Types
- Required Fields
- Min/Max Constraints
- Pick List / Radio Options

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Explore/Transform
Real Time Analytics

- Historical Comparison
- Embedded Calculations
- Alert on bad entry

Actual Reading

Vs

Real – Time Calculation

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Learn / Optimize

- Conditional Questions

- Automated Follow Up
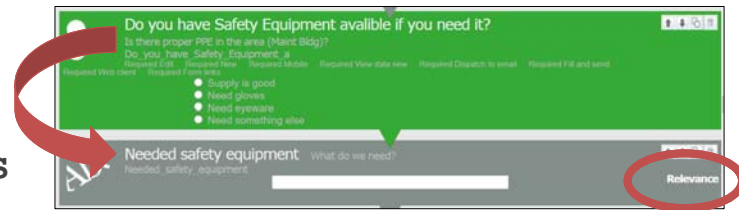
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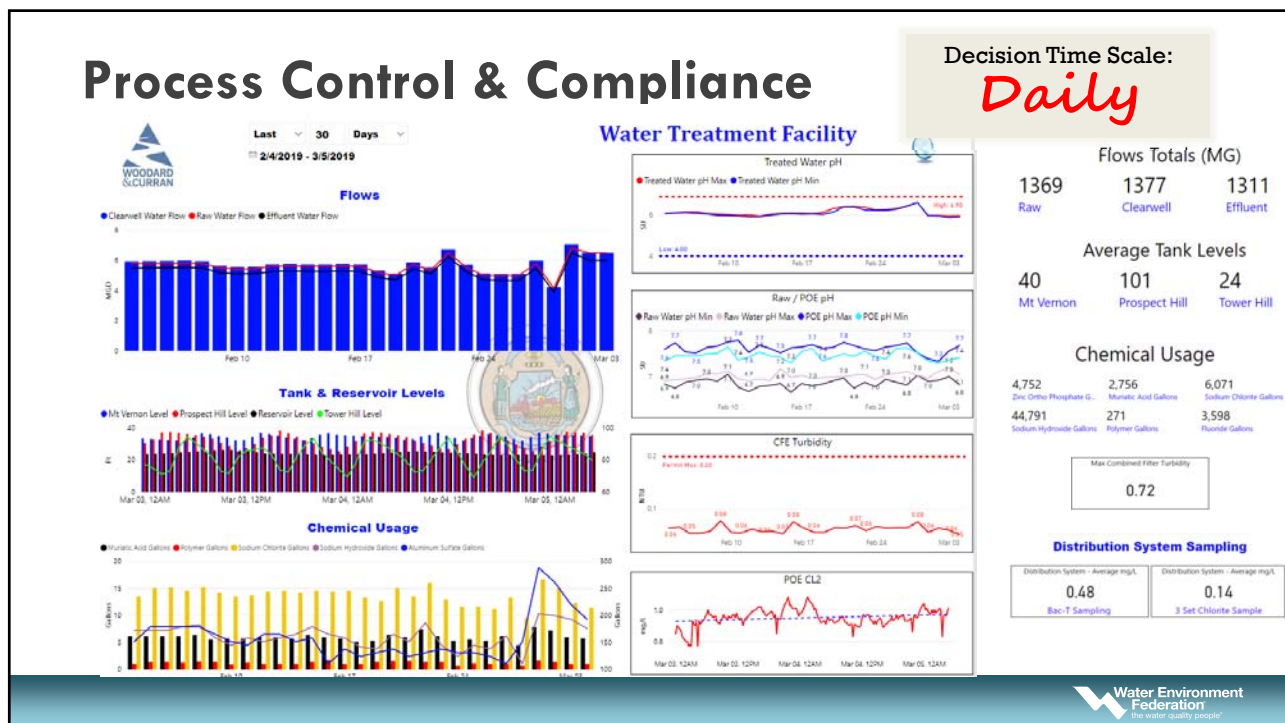## Learn/Review
Leverage Data – Do More with Less

- Digitize

- Integrations to..
  - BI Platforms
  - CMMS
  - GIS
  - Financial
  - Anything….

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Our **people** are our

best **decision-makers**.

Ultimately, **we trust them** to interpret data best.

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Process Control & Compliance

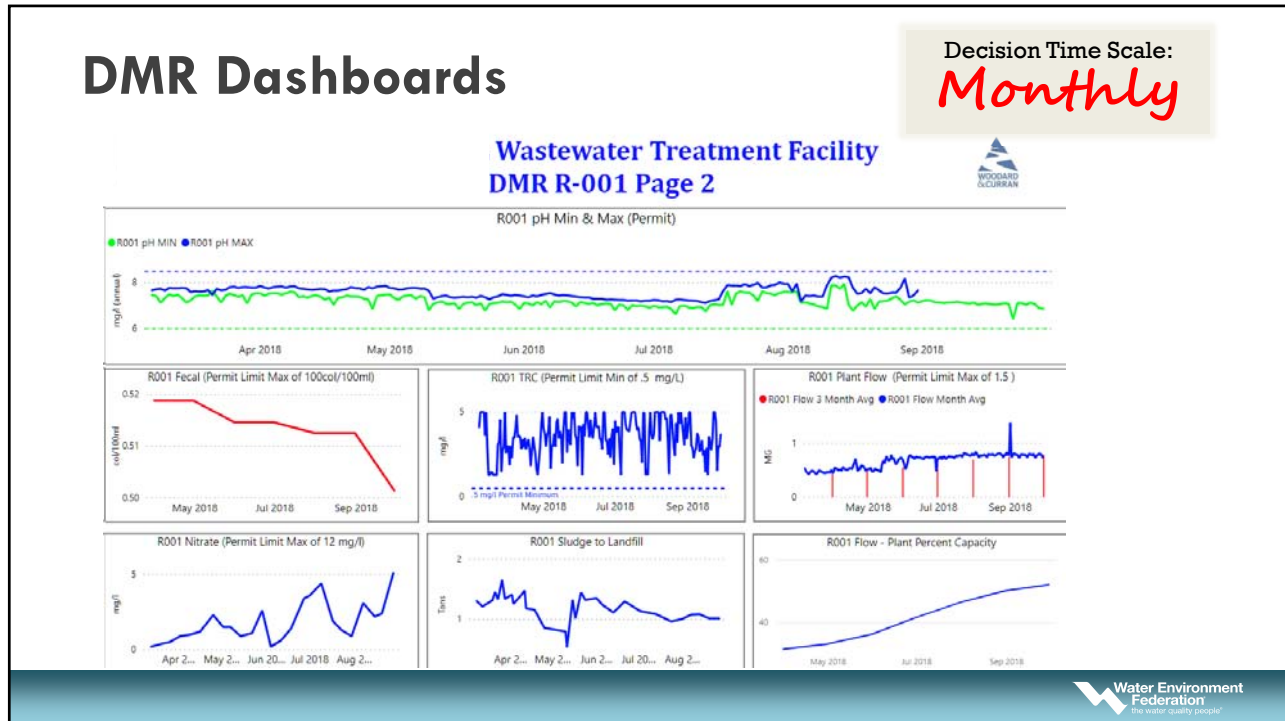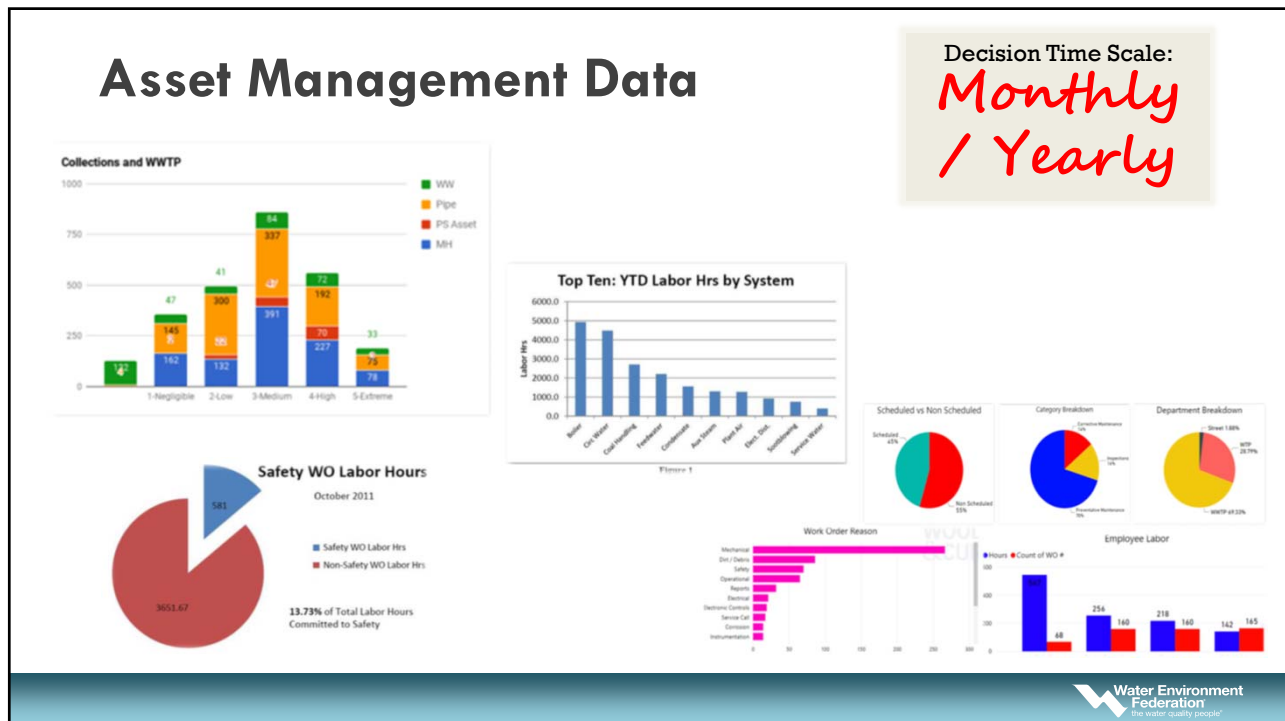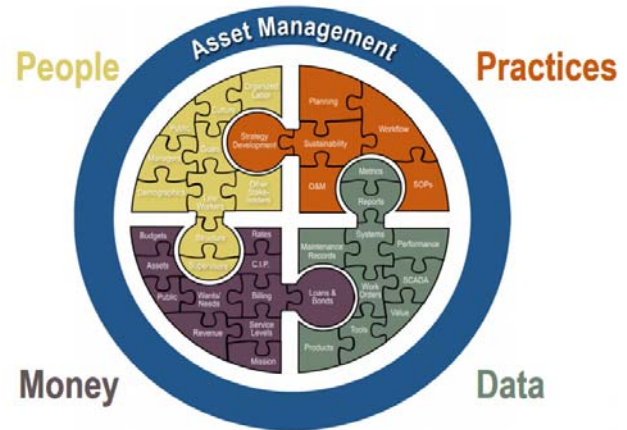Decision Time Scale:
Daily

94
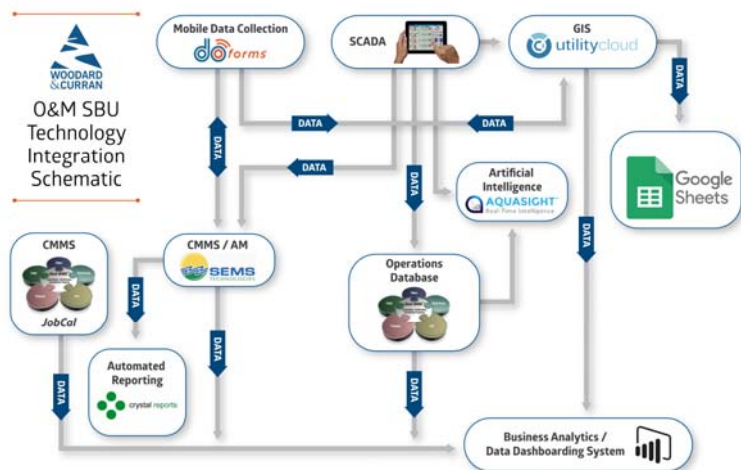
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Conclusion

- Advance Rounds Design
- Integrate Business Systems
- Leverage Data

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Questions?

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