Sustainable

1 : capable of being sustained

2 a : of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged

b : of or relating to a lifestyle involving the use of sustainable methods

Source: Merriam-Webster Online Dictionary
“Protect and enhance water so that it is clean, safe and secure for all Canadians and supports healthy ecosystems.”


“Preparing a system to operate sustainably allows utilities to optimize processes in terms of environmental impact, social aspects, as well as economics.”

Source: America Water Works Association (AWWA) website
Smart Utilities

Smart City
Building Tomorrow's Cities

Industry
Security
Retail
Society
Healthcare
Home
Energy
Mobility

https://www.arcweb.com/industries/smart-cities
“According to the American Water Works Association, an estimated $1 trillion is necessary to maintain and expand service to meet demands over the next 25 years.”

Source: American Society of Civil Engineers
It is expected that more than 56 million new users will be connected to centralized treatment systems over the next two decades, and an estimated $271 billion is needed to meet current and future demands.

Source: American Society of Civil Engineers
Value of Water

$1.99 = $10/oz

$3.62 / 1000 Gallons = $3/1000 oz
Smart Utilities

Infrastructure

People

Systems & Data
What is Data Maturity?

What is a Smart Water Network?

A Smart Water Network is the collection of data-driven components helping to operate the data-less physical layer of pipes, pumps, reservoirs, and valves. Water utilities are gradually deploying more data-enabled components. It’s up to us to make the most out of them, by turning the discrete elements into a cohesive ‘overlay network’.

Collecting and using comprehensive data about water network operations offers the promise of better operations through better knowledge and tighter control of the network’s extensive and complex assets. The water industry is not traditionally a fast-moving early adopter of such solutions, but it is rapidly adjusting to this new necessity. Data technologies for water networks span water sources and production, transmission and distribution, consumer endpoints, and internal piping.

Smart Water Networks are ‘layered’, as any data ecosystem is, starting from sensors, remote control, and enterprise data sources, through data collection and communications, data management and display, and up to data fusion and analysis. The latter covers many categories, from decision support, automation to analytic solutions.

Smart Water Network solutions improve the efficiency, longevity, and reliability of the underlying physical water...
<table>
<thead>
<tr>
<th>SWAN Layer</th>
<th>Data Maturity Level</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer 5 – Data Fusion &amp; Analytics</td>
<td>Emerging Technologies</td>
<td>Predictive modeling, real-time decision support recommendations, responsive automated control.</td>
</tr>
<tr>
<td>Layer 4 – Data Management and Display</td>
<td>Advanced</td>
<td>Broader distribution of information, easier to see patterns, used to change operational decisions, support longer-term planning with “facts”, use data to produce meaningful information.</td>
</tr>
<tr>
<td>Layer 3 – Collection and Communication</td>
<td>Moderate</td>
<td>Current &amp; historical perspectives from plants, remote site and system-wide data.</td>
</tr>
<tr>
<td>Layer 2 – Sensing and Control</td>
<td>Basic</td>
<td>Current operating status &amp; historical trend lines from plant and remote site data.</td>
</tr>
<tr>
<td>Layer 1 – Physical Layer</td>
<td>None</td>
<td>Chart Recorders</td>
</tr>
</tbody>
</table>
What is Data Maturity?

www.swan-forum.com
Defining Smart Water

1. Physical layer
2. Sensing and Control
3. Collection and Communication
4. Data Management and Display
5. Data Fusion and analysis
Defining Smart Water

Pump
Treatment Plant
Valve
Combined Sewers
Collection/Distribution System
Gravity Sewer
DATA MATURITY LEVEL: None

Chart Recorders

Manual Data Collection
DATA MATURITY LEVEL: None

Chart Recorders

Manual Data Collection

Smart Utilities
Smart Utilities

DATA MATURITY LEVEL: None

Chart Recorders

Manual Data Collection
Defining Smart Water

Instrumentation
Equipment Status
Water Quality
Energy
Flow
River Levels
Level
DATA MATURITY LEVEL: Basic

Plant SCADA

Trends

☑️ Real-Time Decision Support

Water Quality Standards

Regulatory Reports

Table 1: Water Quality/Treatment Standards

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total coliform</td>
<td>Less than one total coliform bacteria detectable per 100 mL in all treated and distributed water</td>
</tr>
<tr>
<td>E. coli</td>
<td>Less than one E. coli bacteria detectable per 100 mL in all treated and distributed water</td>
</tr>
<tr>
<td>Chlorine residual</td>
<td>A free chlorine residual of at least 0.5 mg/L in water entering the distribution system following a minimum contact time of 20 minutes</td>
</tr>
<tr>
<td>Ultraviolet Disinfection</td>
<td>95% of water produced per month is disinfected within validated conditions</td>
</tr>
<tr>
<td>Bromate</td>
<td>Less than or equal to 0.01 mg/L</td>
</tr>
<tr>
<td>Bromine</td>
<td>Less than or equal to 0.9 mg/L</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Not exceed 0.3 NTU for more than 12 consecutive hours of the effluent from each operating filter</td>
</tr>
<tr>
<td>Total Trihalomethanes (THMs)</td>
<td>Less than or equal to 0.10 mg/L, as locational running annual average of quarterly samples</td>
</tr>
<tr>
<td>Total Haloacetic Acids (HAA5)</td>
<td>Less than or equal to 0.08 mg/L, as locational running annual average of quarterly samples</td>
</tr>
<tr>
<td>LID</td>
<td>Less than or equal to 0.01 mg/L, in the water distribution system</td>
</tr>
</tbody>
</table>
DATA MATURITY LEVEL: Basic
DATA MATURITY LEVEL: Basic

PAST
- Plant SCADA
- Trends
- Water Quality Standards
- Regulatory Reports

Now
- Real-time Decision Support

FUTURE
- DEMO.ROCKS.F200
- DEMO.WELL-001.FIC002-PV
- DEMO.BUFFER.SINE
### Table 1: Water Quality/Treatment Standards

<table>
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<tr>
<th>Parameter</th>
<th>Quality Standard</th>
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<tr>
<td>Total coliform</td>
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</tr>
<tr>
<td>E. coli</td>
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</tr>
<tr>
<td>Chlorine residual</td>
<td>A free chlorine residual of at least 0.5 mg/L in water entering the distribution system following a minimum contact time of 20 minutes</td>
</tr>
<tr>
<td></td>
<td>A free chlorine residual of at least 0.1 mg/L at all times at any point in the water distribution system</td>
</tr>
<tr>
<td>Ultraviolet Disinfection</td>
<td>95% of water produced per month is disinfected within validated conditions</td>
</tr>
<tr>
<td>Bromate</td>
<td>Less than or equal to 0.01 mg/L</td>
</tr>
<tr>
<td></td>
<td>Less than or equal to 0.3 NTU in 95% of the measurements in a month of the effluent from each operating filter</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Not exceed 0.3 NTU for more than 12 consecutive hours of the effluent from each operating filter</td>
</tr>
<tr>
<td></td>
<td>Not exceed 1.0 NTU for any measurement in the effluent from each operating filter</td>
</tr>
<tr>
<td>Total trihalomethanes (THMs)</td>
<td>Less than or equal to 0.10 mg/L as locational running annual average of quarterly samples</td>
</tr>
<tr>
<td>Total Haloacetic Acids (HAAs)</td>
<td>Less than or equal to 0.08 mg/L as locational running annual average of quarterly samples</td>
</tr>
<tr>
<td>Lead</td>
<td>Less than or equal to 0.01 mg/L in the water distribution system</td>
</tr>
</tbody>
</table>
Defining Smart Wastewater

Smart Utilities

PAC/RTU/DCS/PLC

Monitoring
Network Infrastructure

Data Loggers
Data Sets
Control

Historians

IIoT

1. Physical layer
2. Sensing and Control
3. Collection and Communication
4. Data Management and Display
5. Data Fusion and analysis
Smart Utilities

DATA MATURITY LEVEL: Moderate

AMR/AMI Systems

Mobile/Remote Device Collection

Asset Management Plans

- Real-Time Decision Support
- Preventative/Predictive Maintenance
- Water Loss Prevention Strategies

Leak Detection

Data Users
Smart Utilities

DATA MATURITY LEVEL: Moderate

Hybrid Drive-By AMR & Fixed Base AMI Systems

AMR/AMI Systems

Asset Management Plans

- Real-Time Decision Support
- Preventative/Predictive Maintenance
- Water Loss Prevention Strategies

Mobile/Remote Device Collection

Leak Detection

Data Users
Defining Smart Wastewater

SCADA
GIS
Dashboard
Reporting
CMMS
Asset Management
Information
AMI
DATA MATURITY LEVEL: Advanced

Real-time System Monitoring

- Real-Time Decision Support
- Preventative/Predictive Maintenance
- Water Loss Prevention Strategies

- Asset Monitoring / Integrated with Maintenance
- Enhanced Analytics
- Data Management & Visualization
DATA MATURITY LEVEL: Advanced
DATA MATURITY LEVEL: Advanced

Pump Power (A) vs. Flow (Q)
DATA MATURITY LEVEL: **Advanced**

**Real-time System Monitoring**

- ✔ Real-Time Decision Support
- ✔ Preventative/Predictive Maintenance
- ✔ Water Loss Prevention Strategies
- ✔ Asset Monitoring / Integrated with Maintenance
- ✔ Enhanced Analytics
- ✔ Data Management & Visualization

**Pump Power (A) vs. Flow (Q)**

Asset Performance Monitoring
Pressure Data + Acoustics

City of Kitchener Main Break

Waiting to hear...
Smart Utilities

Pressure Data + Acoustics

Leak Detected

Low Pressure

Repair Period
Pressure Data + Acoustics
Defining Smart Wastewater

Planning

Modelling

Decision Support

RTC (Real Time Control)

Predictive Operation

Optimization
Smart Utilities

DATA MATURITY LEVEL: **Advanced**

(CONTINUED)

- Access to External Data Sources
  - Weather
  - Water Quality

**Dashboards**
- ✔️ Real-Time Decision Support
- ✔️ Preventative/Predictive Maintenance
- ✔️ Water Loss Prevention Strategies
- ✔️ Asset Monitoring / Integrated with Maintenance
- ✔️ Enhanced Analytics
- ✔️ Data Management & Visualization
Smart Utilities

DATA MATURITY LEVEL: **Advanced** (CONTINUED)

Access to External Data Sources

Dashboards

- ✔ Real-Time Decision Support
- ✔ Preventative/Predictive Maintenance
- ✔ Water Loss Prevention Strategies
- ✔ Asset Monitoring / Integrated with Maintenance
- ✔ Enhanced Analytics
- ✔ Data Management & Visualization
DATA MATURITY LEVEL: **Emerging Technologies**

**TRANSMISSION OPERATIONS OPTIMIZER (TOO)**

- **Past**
  - Demand Model
  - Historical Demand Data
  - Real-time Weather Data

- **Now**
  - Hydraulic and Quality Model
  - Data Analysis Component
  - Analysis Constraints
  - SCADA Data
  - Hydro Rates
  - Control Strategy Component
  - Control Constraints (minimum levels, pressures, etc.)

- **Future**
  - Solution Acceptable? Yes: SCADA System, Operator Approval
  - Solution Acceptable? No: Monitoring, Control Strategy Component

**Modeling**

**Data Analytics**

**Automated System Optimization**
**DATA MATURITY LEVEL:** Emerging Technologies

**TRANSMISSION OPERATIONS OPTIMIZER (TOO)**

- **Past**
  - Historical Demand Data
  - Real-time Weather Data

- **Now**
  - Demand Model
  - Hydraulic and Quality Model
  - Data Analysis Component
  - Solution Acceptable?
    - Yes: SCADA System, Operator Approval
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  - Control Strategy Component
    - Hydro Constraints (minimum levels, pressures, etc.)
    - SCADA Data
    - Hydro Rates

- **Future**
  - Modeling
  - Data Analytics
  - Automated System Optimization
Bernoulli’s Equation

\[ Q_2 = A \sqrt{2gH_1} \]

Predictive Diagnostics for Asset Management

Use SCADA and work order historical data to predict failures of critical assets (i.e. pumps, water mains)

Outcome: Prioritize capital replacement projects

Predictive Control Systems for Operations

Use SCADA and external datasets to optimize control setpoints in real-time

Outcome: Reduce operational costs via improved energy usage, process efficiency
DATA MATURITY LEVEL: Emerging Technologies (CONTINUED)

Return on Investment

<table>
<thead>
<tr>
<th></th>
<th>Average Day Demand</th>
<th>Maximum Day Demand</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Energy Consumption (MWh)</td>
<td>36</td>
<td>50</td>
<td>14,277</td>
</tr>
<tr>
<td>Baseline Energy Distribution Cost ($)</td>
<td>5,531</td>
<td>7,357</td>
<td>2,182,992</td>
</tr>
<tr>
<td>Optimized Energy Consumption (MWh)</td>
<td>24.1</td>
<td>7.4</td>
<td>7,304</td>
</tr>
<tr>
<td>Optimized Energy Distribution Cost ($)</td>
<td>4,434</td>
<td>5,531</td>
<td>1,717,239</td>
</tr>
<tr>
<td>Annual Savings (%)</td>
<td></td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>Annual Cost Savings ($)</td>
<td></td>
<td>465,754</td>
<td></td>
</tr>
</tbody>
</table>
Smart Utilities

DATA MATURITY LEVEL: Emerging Technologies (CONTINUED)

MSD Smart Sewers

No Central Control Room

Live Operational State

Many graphics for the entire collection system.
If you paste them together, you get an idea of the scale of it.
This is the Mill Creek Sewershed

Reese Johnson
Top Prize: Best Water Projects (ELGL) & Atlas Marketplace

PAST
Now
FUTURE
What is the industry doing?
Energy Management: Class A Facilities

- Understanding Billing & Opportunities
  - Class A > 1MW (optional participation)
  - Global Adjustment Costs
  - Ontario Peak Periods

- Data Sources
  - IESO (historical and predicted)
  - Power Monitoring (plant)
  - SCADA (flows & operational status)

- Normal Operation typically avoids Peak Hours
Conclusion

Sustainable
or using a resource so that the resource is not depleted or permanently damaged

Improved Management of:

- Infrastructure
- People
- Systems & Data

Produces:

- Improved Efficiency
- Cost Savings
- Improved Insight & Information Retention
Thank You

Tim Kruse

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