USING DATA TO OPTIMIZE WATER AND WASTEWATER PROCESSES

PRESENTED BY:

Vicki McCorkle, PE
T&M Associates

WEA 2019

Outline

1	2	3	4
PROCESS DATA OVERVIEW	OTHER SOURCES OF DATA	CASE STUDY	APPLICATIONS FOR WASTEWATER

Automation Terminology

Instrument

PLC

HMI

SCADA

Instruments *Generate* Data

Flow Meters — Pressure Transmitters — Level Indicators — Various Switches — Various Analyzers — VFDs

PLC *Processes* Data

Programmable Logic Controller   – Input / Output Modules

HMI *Displays* Data

Human -Machine Interface

SCADA *Stores* Data

|	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1			Temp	Hi	Low	Hum	Dew	Wind	Wind	Wind	HiWind	iWind	Wind	Heat	THW	THSW	Baro.		Rain	Solar	Solar	Hi Solar	UV	UV	Hi	Heat	Cool	In	In	In	In	In	In Air		Wind	Wind	ISS	Arc.
2	Date	Time		Temp	Temp		Pt.	Speed	Dir	Run	Speed	Dir	Chill	Index	Index	Index	ressure	Rain	Rate	Rad.	Energy	Rad.	Index	Dose	UV	D-D	D-D	Temp	Hum	Dew	Heat	EMC	Density	ET	Samp	Tx	Recept	Int.
3			(°F)	(°F)	(°F)	%	(°F)	(mph)			mph	mph	(°F)	(°F)	(°F)	(°F)	(in. Hg)	(in.)	(in/hr)									(°F)	(°F)		(°F)	(°F)						
20477	1/17/18	1:25	7.6	7.6	7.5	84	3.8	0	---	0	0	---	7.6	7.5	7.5	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.5	57	-5.5	6.2	6.2	0.0863	0.00	115	1	100	5
20478	1/17/18	1:30	7.5	7.6	7.5	84	3.7	0	---	0	0	---	7.5	7.4	7.4	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.5	57	-5.5	6.2	6.2	0.0863	0.00	116	1	100	5
20479	1/17/18	1:35	7.4	7.6	7.4	84	3.6	0	---	0	0	---	7.4	7.3	7.3	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.6	57	-5.4	6.3	6.3	0.0863	0.00	114	1	100	5
20480	1/17/18	1:40	7.4	7.4	7.3	84	3.6	0	---	0	0	---	7.4	7.3	7.3	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.6	57	-5.4	6.3	6.3	0.0863	0.00	113	1	99.1	5
20481	1/17/18	1:45	7.2	7.3	7.2	85	3.6	0	---	0	0	---	7.2	7.1	7.1	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.6	57	-5.4	6.3	6.3	0.0863	0.00	115	1	100	5
20482	1/17/18	1:50	7.1	7.2	7.1	85	3.5	0	---	0	0	---	7.1	7	7	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.5	57	-5.5	6.2	6.2	0.0863	0.00	116	1	100	5
20483	1/17/18	1:55	7	7.1	7	85	3.4	0	---	0	0	---	7	6.9	6.9	---	30.39	0.00	0.00	0	0	0	0	0	0	0.2	0	6.4	57	-5.6	6.1	6.1	0.0864	0.00	116	1	100	5
20484	1/17/18	2:00	7	7.1	6.9	85	3.4	0	---	0	0	---	7	6.9	6.9	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.4	57	-5.6	6.1	6.1	0.0864	0.00	115	1	100	5
20485	1/17/18	2:05	6.9	7	6.9	85	3.3	0	---	0	0	---	6.9	6.8	6.8	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.3	57	-5.7	6	6	0.0864	0.00	110	1	96.5	5
20486	1/17/18	2:10	6.8	6.9	6.8	85	3.2	0	---	0	0	---	6.8	6.7	6.7	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.3	57	-5.7	6	6	0.0864	0.00	114	1	100	5
20487	1/17/18	2:15	6.8	6.8	6.8	85	3.2	0	---	0	0	---	6.8	6.7	6.7	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.2	57	-5.8	5.9	5.9	0.0864	0.00	116	1	100	5
20488	1/17/18	2:20	6.6	6.8	6.6	85	3	0	---	0	0	---	6.6	6.5	6.5	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.2	57	-5.8	5.9	5.9	0.0864	0.00	116	1	100	5
20489	1/17/18	2:25	6.6	6.7	6.5	85	3	0	---	0	0	---	6.6	6.5	6.5	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	6.1	57	-5.9	5.8	5.8	0.0864	0.00	116	1	100	5
20490	1/17/18	2:30	6.4	6.5	6.4	86	3.1	0	---	0	0	---	6.4	6.3	6.3	---	30.39	0.00	0.00	0	0	0	0	0	0	0.2	0	6	57	-6	5.7	5.7	0.0865	0.00	100	1	100	5
20491	1/17/18	2:35	6.3	6.4	6.3	86	3	0	---	0	0	---	6.3	6.2	6.2	---	30.38	0.00	0.00	0	0	0	0	0	0	0.2	0	5.9	57	-6.1	5.6	5.6	0.0865	0.00	113	1	99.1	5
20492	1/17/18	2:40	6.2	6.3	6.2	86	2.9	0	---	0	0	---	6.2	6.1	6.1	---	30.39	0.00	0.00	0	0	0	0	0	0	0.2	0	5.8	57	-6.2	5.5	5.5	0.0865	0.00	116	1	100	5
20493	1/17/18	2:45	6.1	6.2	6.1	87	3.1	0	---	0	0	---	6.1	6	6	---	30.39	0.00	0.00	0	0	0	0	0	0	0.21	0	5.5	57	-6.5	5.2	5.2	0.0865	0.00	116	1	100	5
20494	1/17/18	2:50	6	6.1	6	86	2.7	0	---	0	0	---	6	5.9	5.9	---	30.39	0.00	0.00	0	0	0	0	0	0	0.21	0	5.4	57	-6.6	5.1	5.1	0.0866	0.00	116	1	100	5
20495	1/17/18	2:55	5.8	6	5.8	86	2.5	0	---	0	0	---	5.8	5.7	5.7	---	30.38	0.00	0.00	0	0	0	0	0	0	0.21	0	5.3	57	-6.7	5	5	0.0866	0.00	111	1	97.4	5
20496	1/17/18	3:00	5.8	5.9	5.8	87	2.8	0	---	0	0	---	5.8	5.7	5.7	---	30.38	0.00	0.00	0	0	0	0	0	0	0.21	0	5.3	57	-6.7	5	5	0.0866	0.00	116	1	100	5
20497	1/17/18	3:05	5.8	5.8	5.7	87	2.8	0	---	0	0	---	5.8	5.7	5.7	---	30.38	0.00	0.00	0	0	0	0	0	0	0.21	0	5.2	57	-6.7	4.9	4.9	0.0866	0.00	114	1	100	5
20498	1/17/18	3:10	5.7	5.8	5.7	87	2.7	0	---	0	0	---	5.7	5.6	5.6	---	30.38	0.00	0.00	0	0	0	0	0	0	0.21	0	5.1	57	-6.8	4.8	4.8	0.0866	0.00	114	1	100	5
20499	1/17/18	3:15	5.7	5.7	5.6	87	2.7	0	---	0	0	---	5.7	5.6	5.6	---	30.38	0.00	0.00	0	0	0	0	0	0	0.21	0	4.9	57	-7	4.6	4.6	0.0866	0.00	116	1	100	5
20500	1/17/18	3:20	5.5	5.7	5.5	87	2.5	0	---	0	0	---	5.5	5.4	5.4	---	30.38	0.00	0.00	0	0	0	0	0	0	0.21	0	4.7	57	-7.2	4.4	4.4	0.0867	0.00	116	1	100	5
20501	1/17/18	0:53	10			73	3	4.6	N			-	1.8				30.71	0.00																				
20502	1/17/18	1:53	9			77	3	4.6	NNE			-	0.6				30.69	0.00																				
20503	1/17/18	2:53	7			80	1.9	5.8	N			-	-3.3				30.7	0.00																				
20504	1/17/18	3:53	9			77	3	3.5	NNW			-	2.4				30.72	0.00																				
20505	1/17/18	4:53	8.1			83	3.9	Calm	Calm			-	-				30.72	0.00																				
20506	1/17/18	5:53	10			80	5	5.8	N			-	0.4				30.73	0.00																				
20507	1/17/18	6:53	10			80	5	5.8	N			-	0.4				30.74	0.00																				
20508	1/17/18	7:53	12			77	6.1	5.8	N			-	2.7				30.75	0.00																				
20509	1/17/18	8:53	14			71	6.1	9.2	NNE			-	2				30.78	0.00																				
20510	1/17/18	9:10	10	10	5.4	83	5.9	2	SSW	0.17	7	SSE	6.8	9.9	6.7	---	30.44	0.00	0.00	49	0.35	81	0	0	0	0.19	0	13.3	72	6	13	13	0.0852	0.00	562	1	100	5

Supervisory Control and Data Acquisition
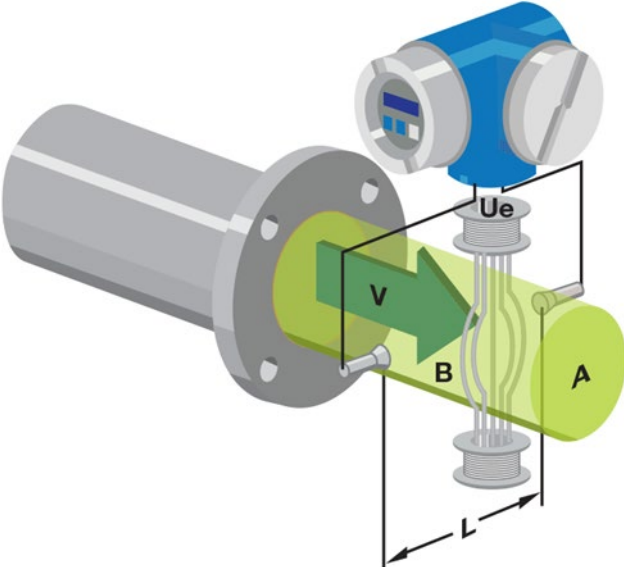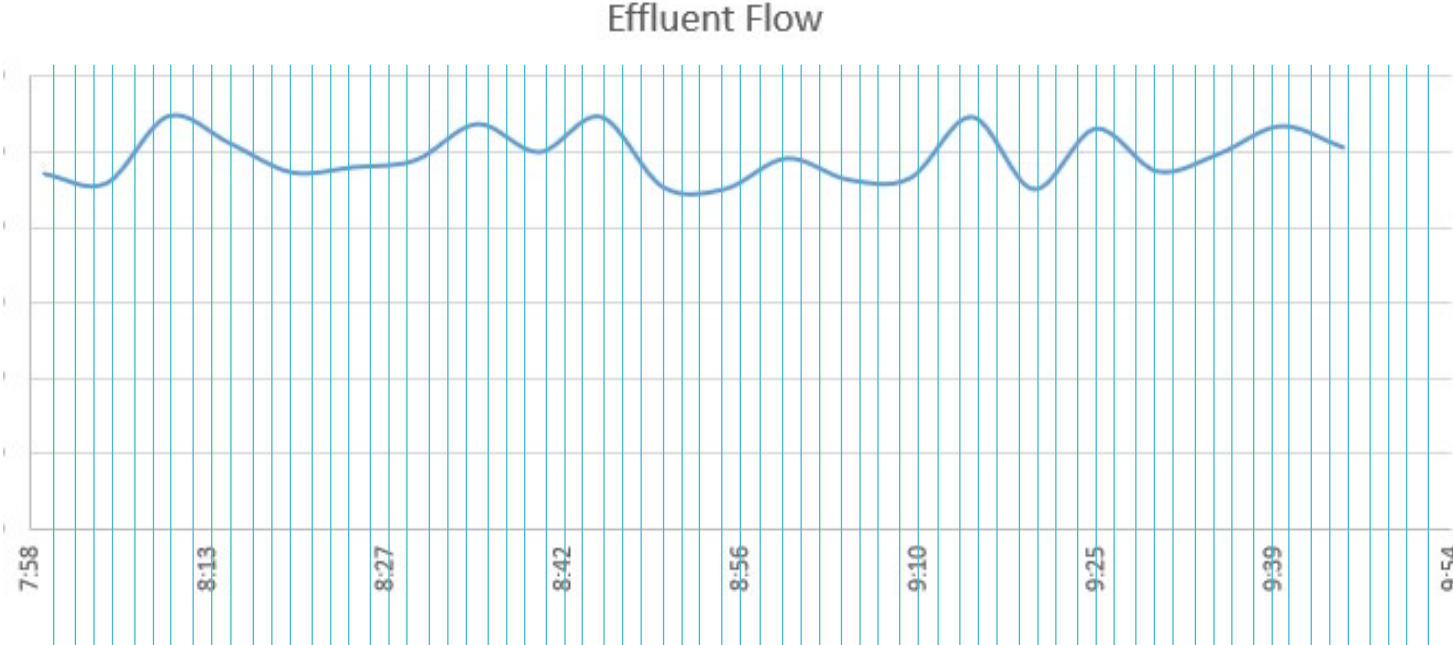
Data from Digital Inputs

PUMP

RUNNING

NOT
RUNNING
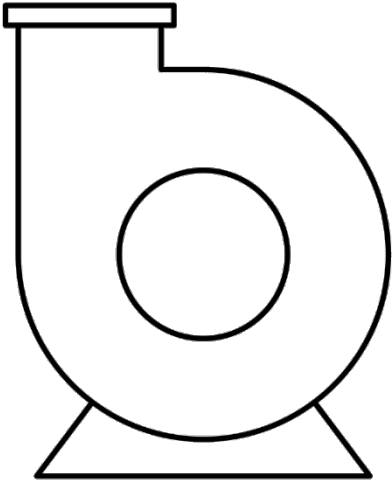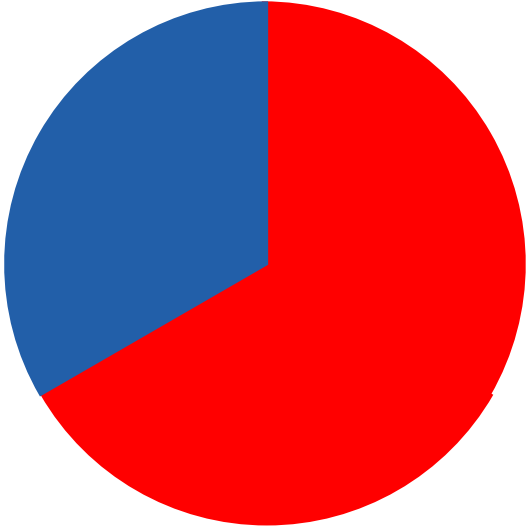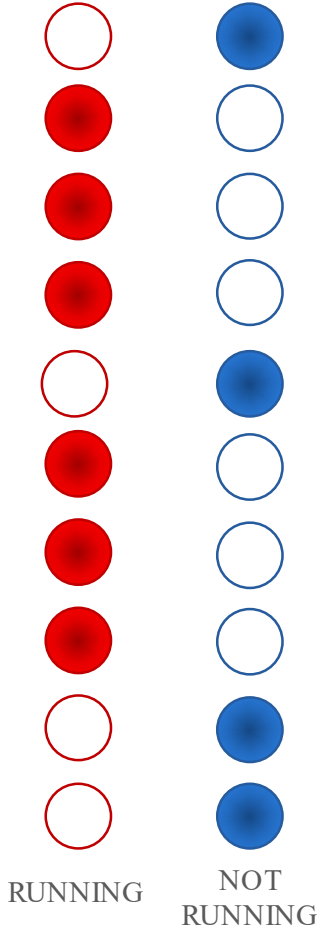
Data from Digital Inputs

	PUMP 1	PUMP 2	PUMP 3
6/26/2019 8:00	1	0	0
6/26/2019 8:05	1	0	0
6/26/2019 8:10	1	0	0
6/26/2019 8:15	1	0	0
6/26/2019 8:20	0	1	0
6/26/2019 8:25	0	1	0
6/26/2019 8:30	0	1	0
6/26/2019 8:35	0	1	0
6/26/2019 8:40	0	0	1
6/26/2019 8:45	0	0	1
6/26/2019 8:50	0	0	1
6/26/2019 8:55	0	0	1
6/26/2019 9:00	1	0	0
6/26/2019 9:05	1	0	0
6/26/2019 9:10	1	0	0
6/26/2019 9:15	1	0	0
6/26/2019 9:20	0	1	0
6/26/2019 9:25	0	1	0
6/26/2019 9:30	0	1	0
6/26/2019 9:35	0	1	0
6/26/2019 9:40	0	0	1
6/26/2019 9:45	0	0	1

Pump Sequencing
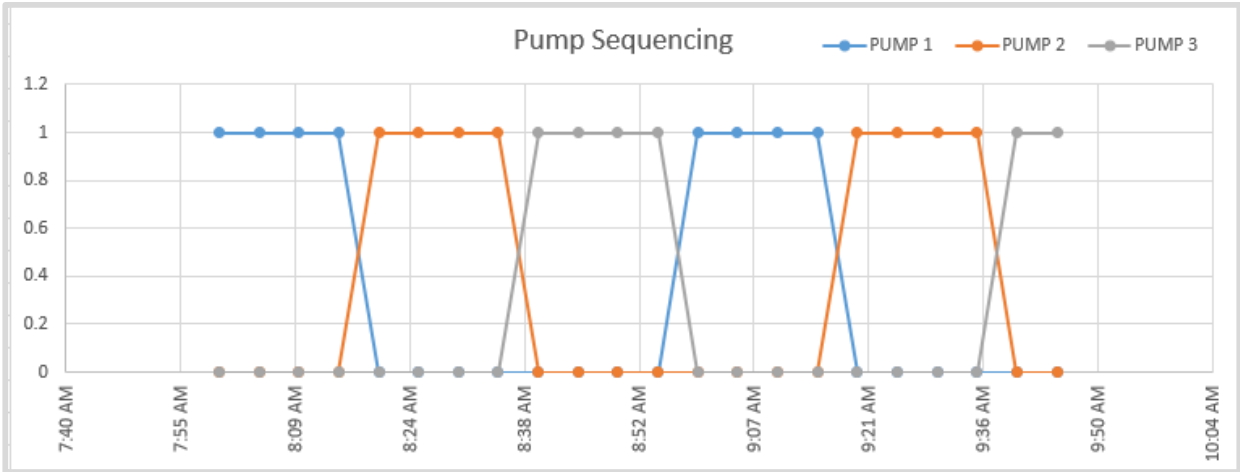
Data from Analog Inputs

FLOW METER

Effluent Flow

7:58   8:13   8:27   8:42   8:56   9:10   9:25   9:39   9:54

Data from Analog Inputs

	Effluent Flow
6/26/2019 8:00	497.04016
6/26/2019 8:05	495.7854421
6/26/2019 8:10	504.7508741
6/26/2019 8:15	501.1373634
6/26/2019 8:20	497.2516848
6/26/2019 8:25	497.9490425
6/26/2019 8:30	498.8701234
6/26/2019 8:35	503.7107209
6/26/2019 8:40	499.9615703
6/26/2019 8:45	504.6618195
6/26/2019 8:50	495.3146583
6/26/2019 8:55	495.013296
6/26/2019 9:00	499.1261152
6/26/2019 9:05	496.2736214
6/26/2019 9:10	496.4791696
6/26/2019 9:15	504.6519853
6/26/2019 9:20	495.0069653
6/26/2019 9:25	503.0830058
6/26/2019 9:30	497.3821176
6/26/2019 9:35	499.7582099
6/26/2019 9:40	503.4295097
6/26/2019 9:45	500.5839032

Effluent Flow
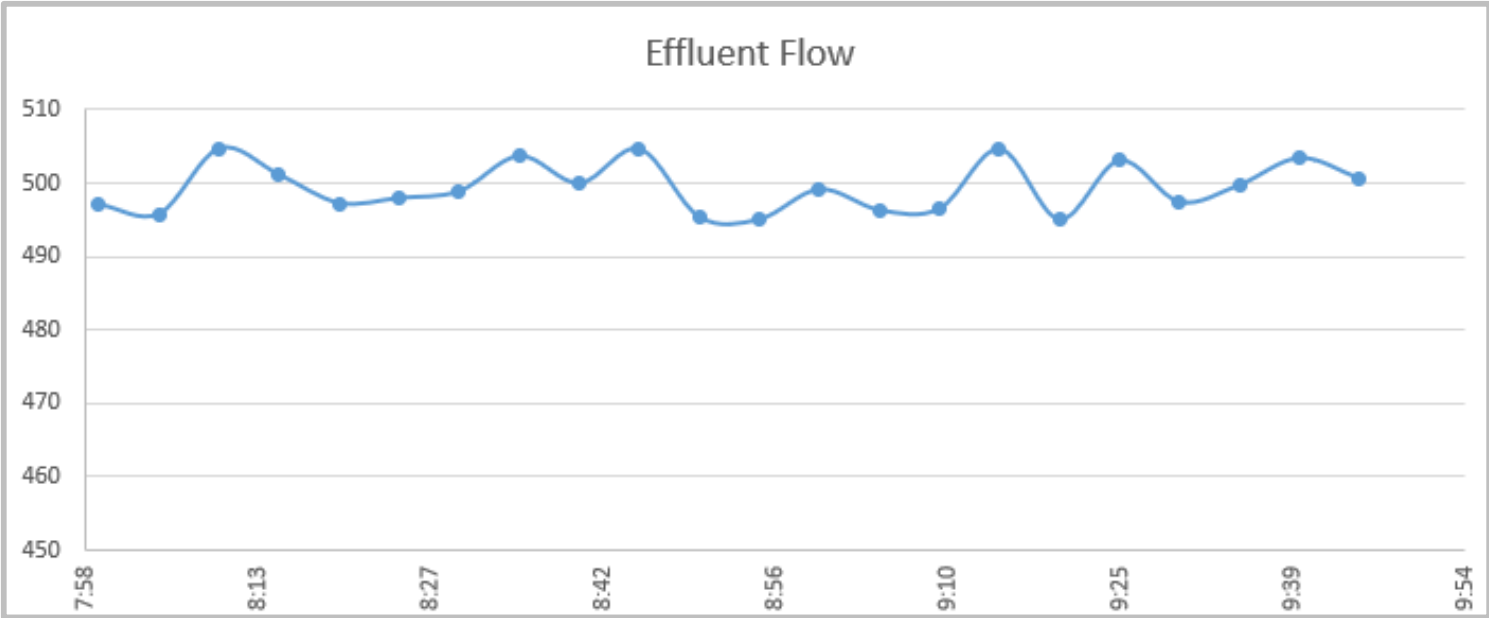
How is Process Data Used?

– Monitoring

– Automatic Control

– Automatic Report Generation

– Historical Reference

– Planning
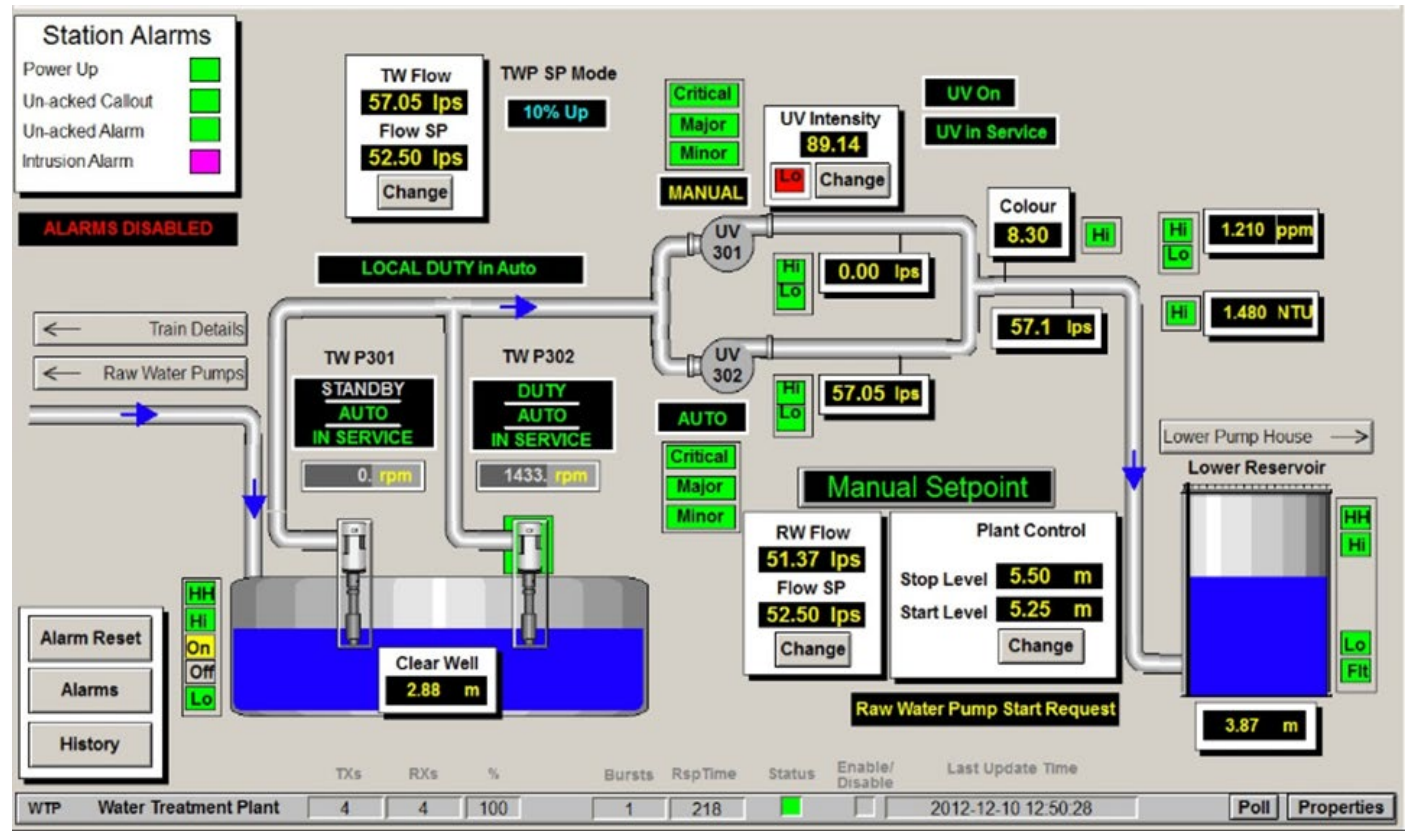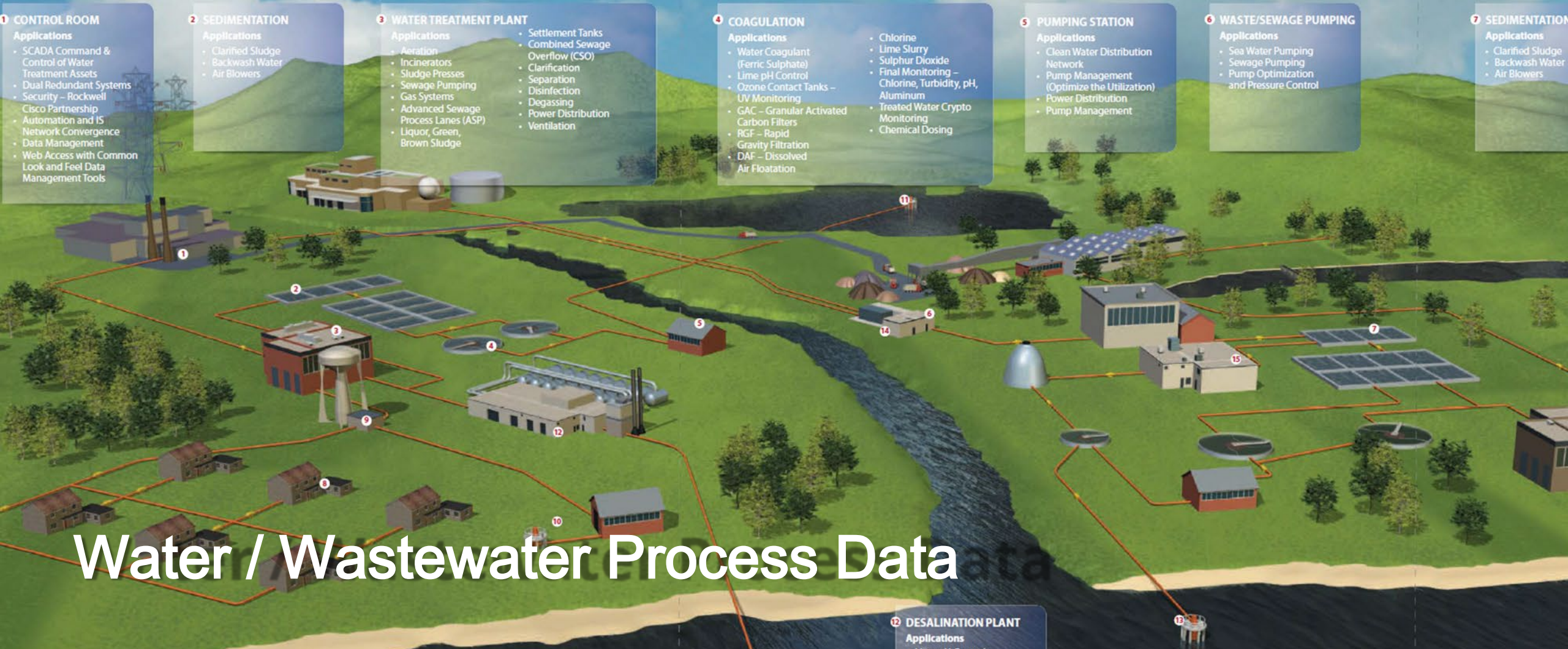
Water / Wastewater Process Data

1. CONTROL ROOM
Applications
- SCADA Command & Control of Water Treatment Assets
- Dual Redundant Systems
- Security – Rockwell Cisco Partnership
- Automation and IS Network Convergence
- Data Management
- Web Access with Common Look and Feel Data Management Tools

2. SEDIMENTATION
Applications
- Clarified Sludge
- Backwash Water
- Air Blowers

3. WATER TREATMENT PLANT
Applications
- Aeration
- Incinerators
- Sludge Presses
- Sewage Pumping
- Gas Systems
- Advanced Sewage Process Lanes (ASP)
- Liquor, Green, Brown Sludge
- Settlement Tanks
- Combined Sewage Overflow (CSO)
- Clarification
- Separation
- Disinfection
- Degassing
- Power Distribution
- Ventilation

4. COAGULATION
Applications
- Water Coagulant (Ferric Sulphate)
- Lime pH Control
- Ozone Contact Tanks – UV Monitoring
- GAC – Granular Activated Carbon Filters
- RGF – Rapid Gravity Filtration
- DAF – Dissolved Air Floatation
- Chlorine
- Lime Slurry
- Sulphur Dioxide
- Final Monitoring – Chlorine, Turbidity, pH, Aluminum
- Treated Water Crypto Monitoring
- Chemical Dosing

5. PUMPING STATION
Applications
- Clean Water Distribution Network
- Pump Management (Optimize the Utilization)
- Power Distribution
- Pump Management

6. WASTE/SEWAGE PUMPING
Applications
- Sea Water Pumping
- Sewage Pumping
- Pump Optimization and Pressure Control

7. SEDIMENTATION
Applications
- Clarified Sludge
- Backwash Water
- Air Blowers

8. IRRIGATION & WATER TRANSFER
Applications
- Remote Pumping Station
- Communication Front End
- Storage Reservoir
- Leakage Detection
- Front End and Centralized Control Room
- RTU and Telemetry Communication Network
- Security Network and Access (ISA 99)
- Installation Simulation and Predictive Simulation
- Water Consumption Monitoring
- SCADA Application
- Water Distribution

9. WATER STORAGE
Applications
- Reservoir
- Storage Reservoir

10. WATER SUPPLY & BOREHOLES
Applications
- River Water Supply and Boreholes

11. WATER INTAKE
Applications
- River Water Supply and Boreholes
- Power Distribution
- Intake Pumping Station (Mesh and Screens)

12. DESALINATION PLANT
Applications
- Lime pH Control
- Ozone Contact Tanks – UV Monitoring
- GAC – Granular Activated Carbon Filters
- RGF – Rapid Gravity Filtration
- DAF – Dissolved Air Floatation
- Chlorine
- Lime Slurry
- Sulphur Dioxide
- Final Monitoring – Chlorine, Turbidity, pH, Aluminum
- Treated Water Crypto Monitoring
- Chemical Dosing

13. PRESSURE BOOSTING
Applications
- Raw Water Pump Station
- Out Going Pump House
- Ventilation

14. ENERGY FROM WASTE
Applications
- Incinerators
- Sludge Presses
- Gas Systems
- Combined Heat and Power (CHP)

15. TREATMENT PLANT INLET
Applications
- Tunnels
- Filtration
- Sewage Pumping
- Sluice Gates
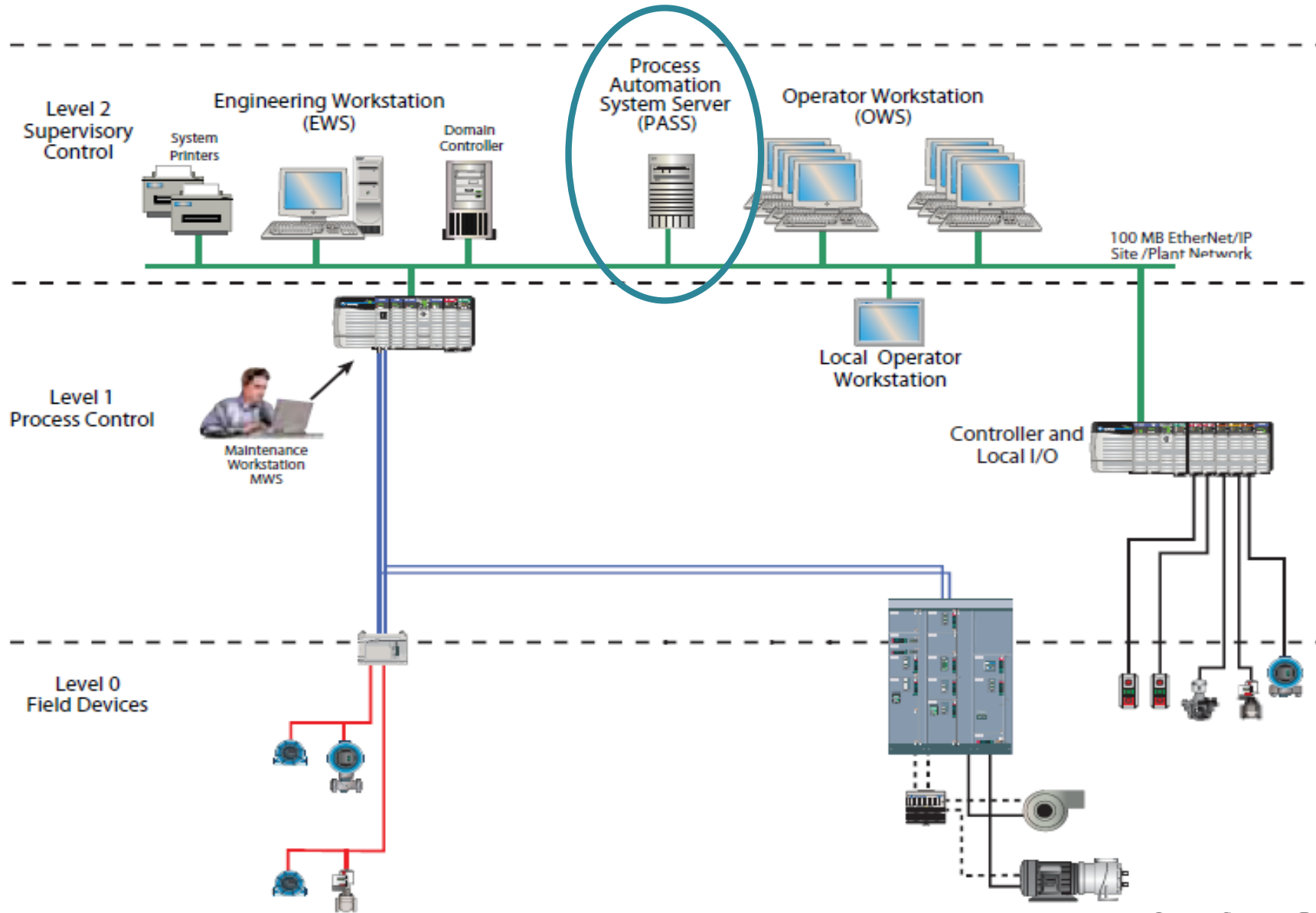- Diversion Chamber
- Separation
- Power Distribution

Image Source: Rockwell Automation

Sources of Data

Process
– Equipment
– Instruments

Enterprise
– Business aspects

"Other"
– Human
– Environment

Enterprise Data

– **Inventory**
  – Chemicals stored on or off site

– **Purchasing**
  – Chemicals, filters, other consumables

– **Scheduling**
  – Personnel
  – Assets

– **Billing**
  – Fixed-based metering
  – Accounting software

Other Sources of Data

Personnel
– Setpoints
– Forms

Weather

Temporary Population Increases
– Holidays
– Football season

"Other"
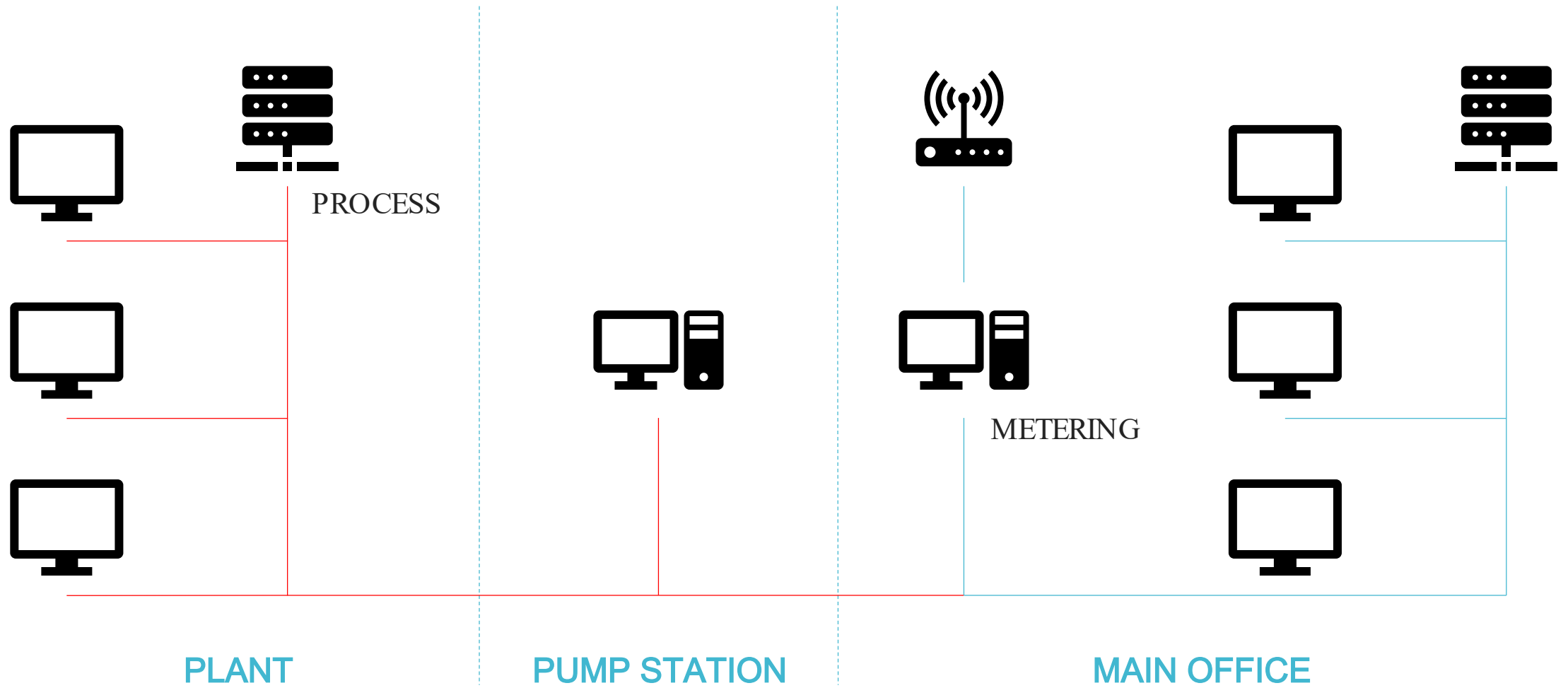
Inventory

SMART
OPERATIONS

Process

Scheduling

"Other"

Inventory

PREDICTIVE
OPERATIONS

Process

Scheduling
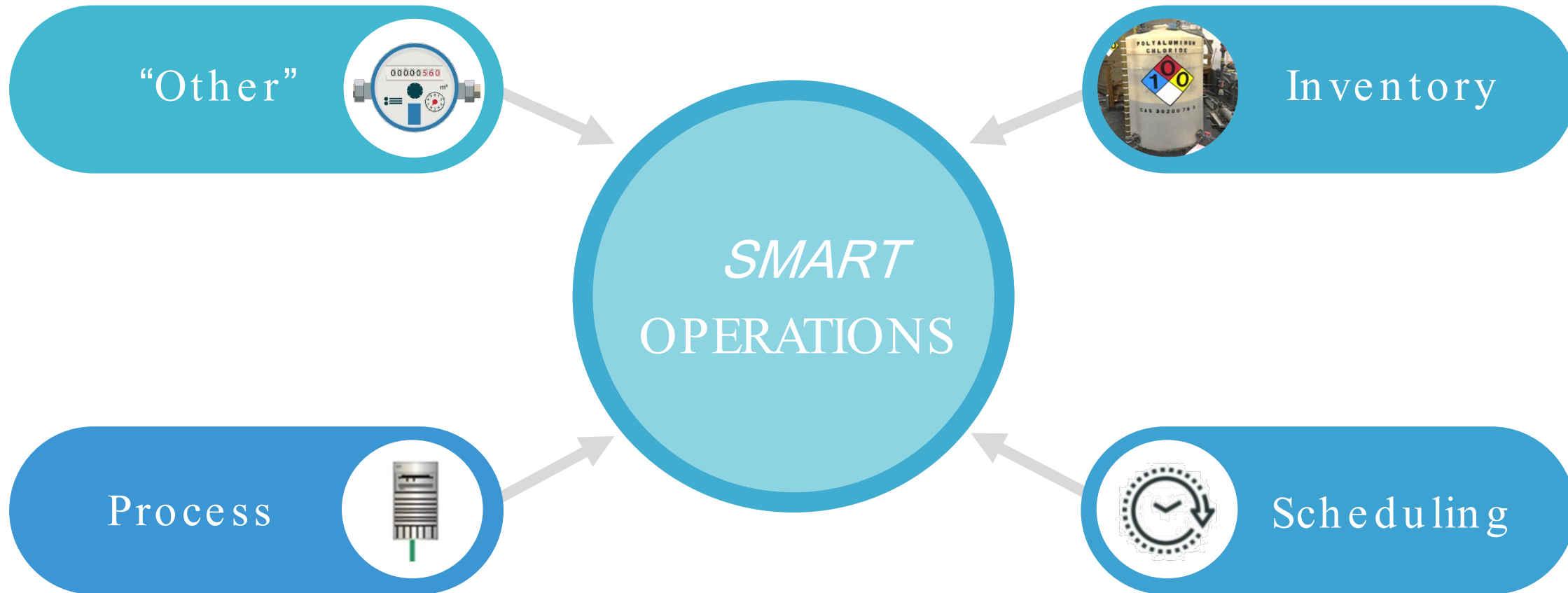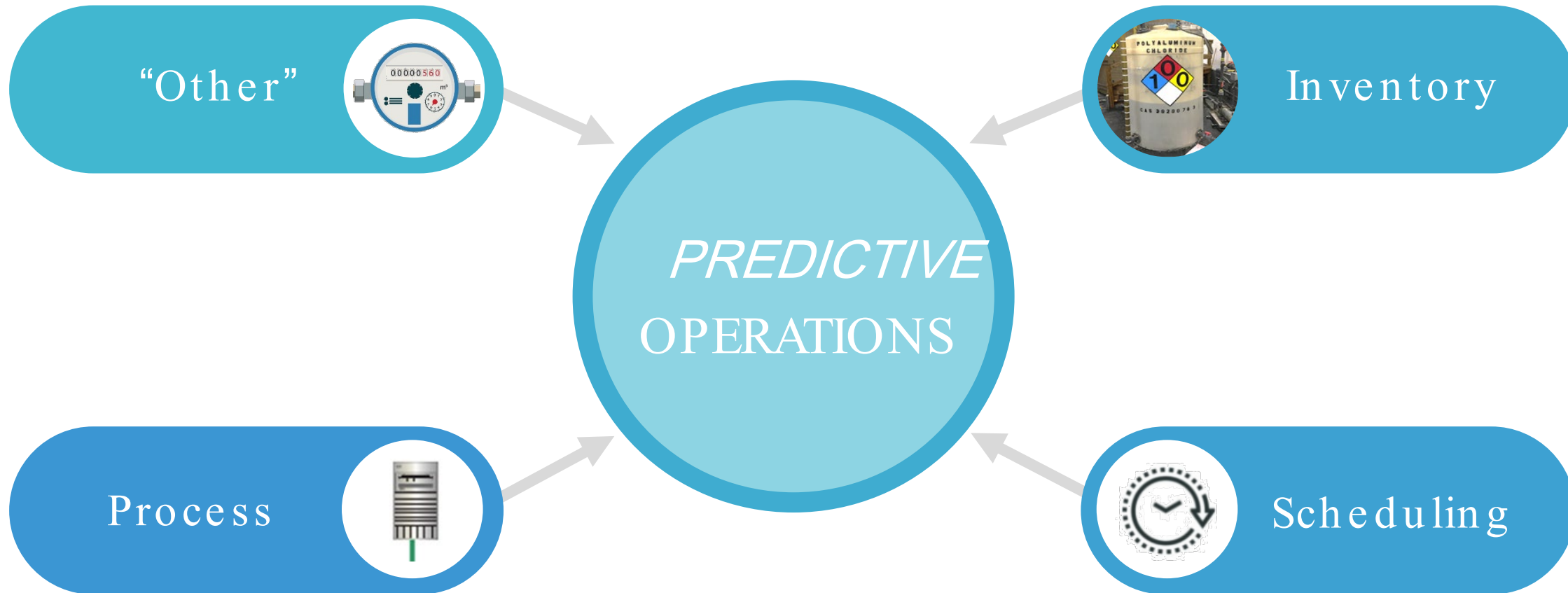
Issue: Machine for Each Data Station

HEADWORKS

TREATMENT

EFFLUENT

METERING

PLANT

PUMP STATION

MAIN OFFICE
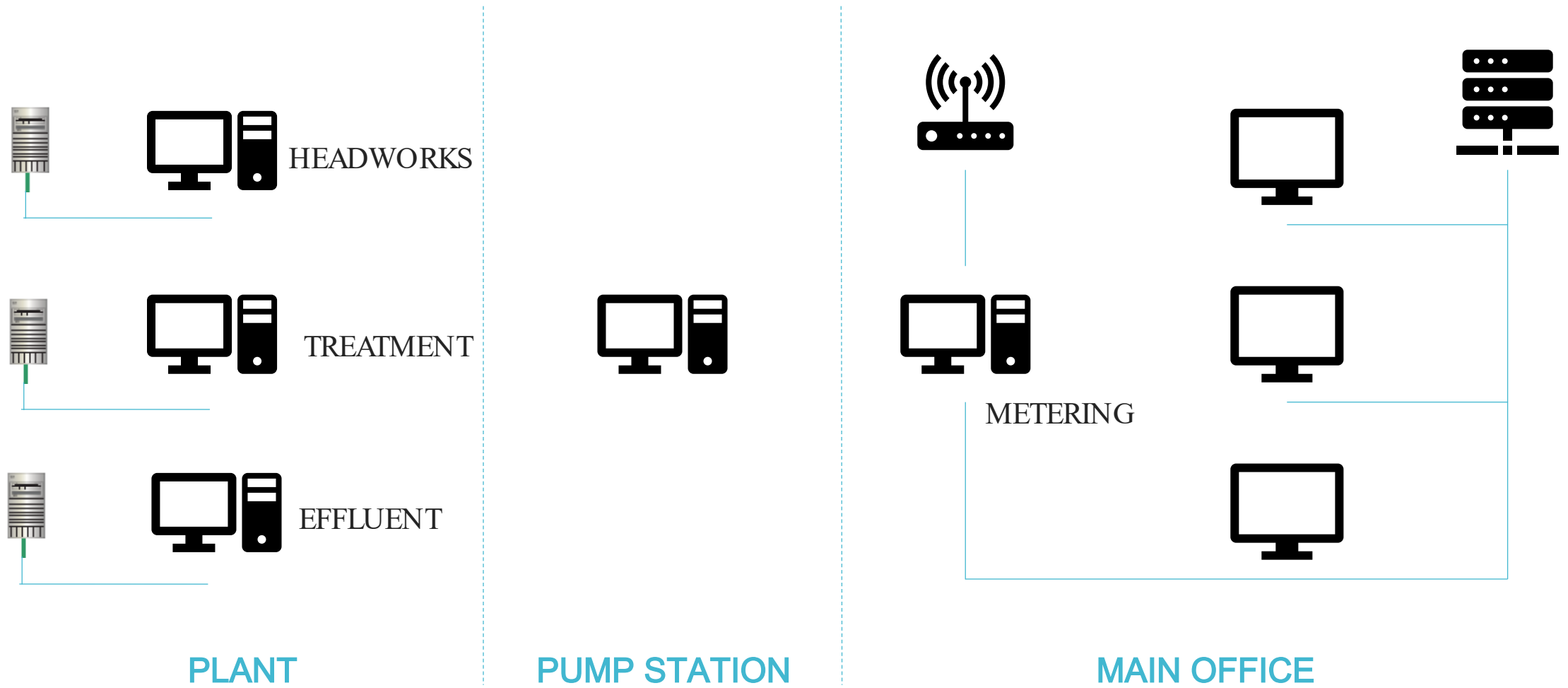
Solution: Single Data Network

PROCESS

METERING

PLANT

PUMP STATION

MAIN OFFICE

CASE STUDY

- Midstream Oil Facilities along 200-mile pipeline

- Truck Unloading Process
  - Check-in
  - Unload
  - Print Receipt

- Integrated Systems
  - Site Process – Truck unloading station
  - Scheduling – Expected deliveries
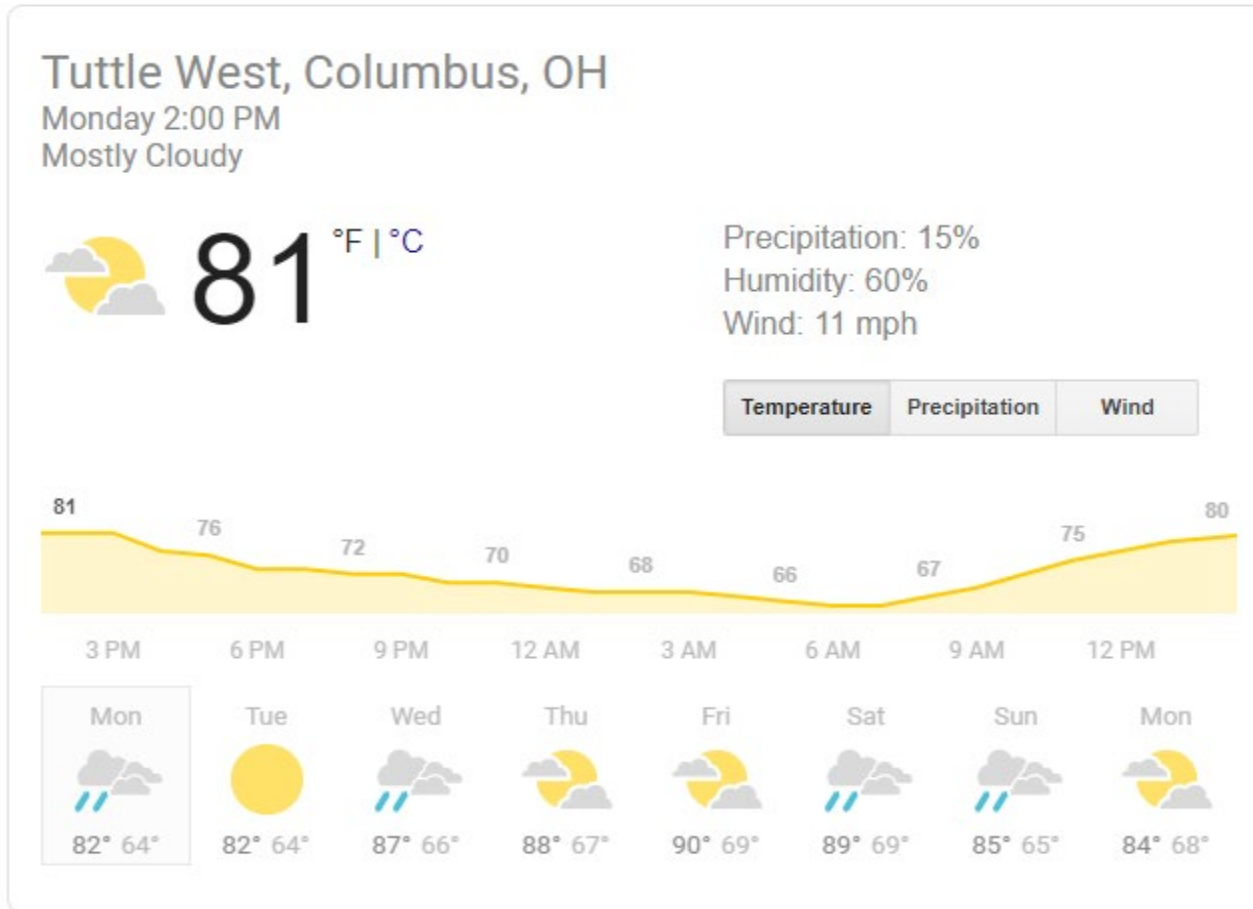 - Inventory – Volume of oil stored at each facility at any given time

Application to Wastewater

Trucked -in Waste

– Coordinate and schedule deliveries from different providers

– Fast, accurate automated billing

– Improved plant logistics

  – Tank capacities

  – Control of wastewater characteristics
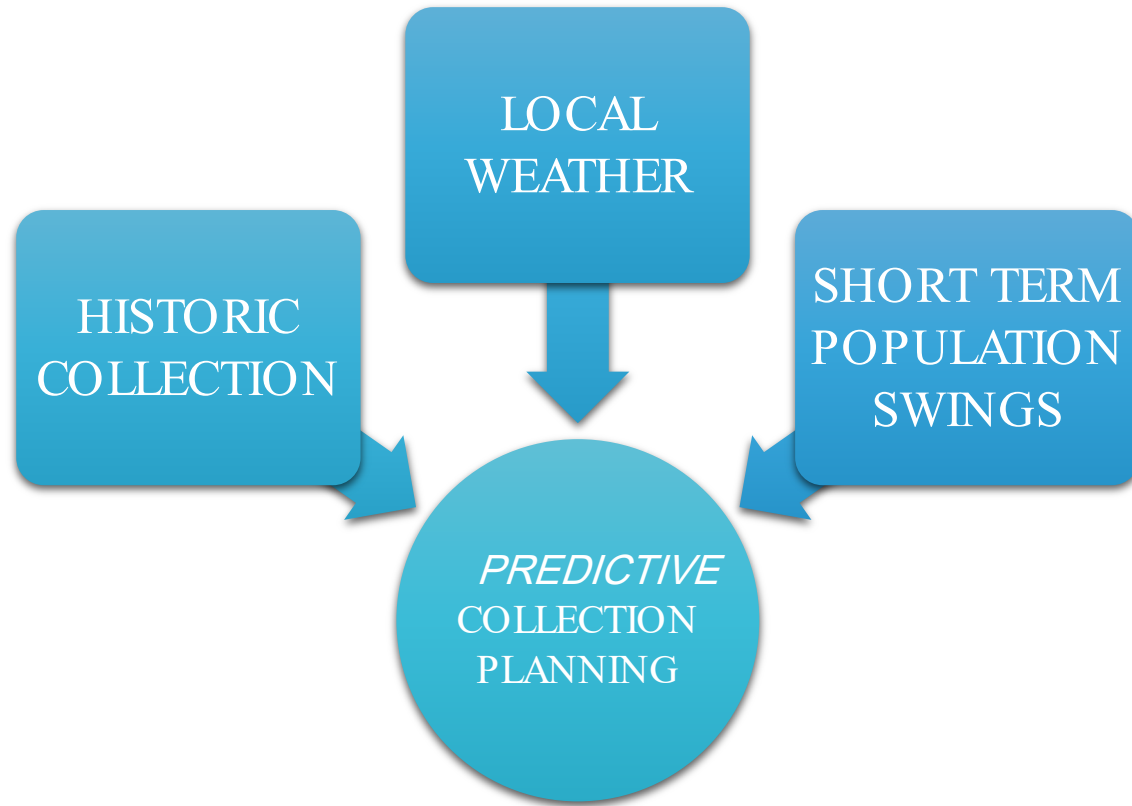
Application to Wastewater

Tuttle West, Columbus, OH
Monday 2:00 PM
Mostly Cloudy

81 °F | °C

Precipitation: 15%
Humidity: 60%
Wind: 11 mph

| Temperature | Precipitation | Wind |

81 76 72 70 68 66 67 75 80

3 PM 6 PM 9 PM 12 AM 3 AM 6 AM 9 AM 12 PM

| Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon |
| 82° 64° | 82° 64° | 87° 66° | 88° 67° | 90° 69° | 89° 69° | 85° 65° | 84° 68° |

More on weather.com   Feedback

Local weather available via APIs

APIs are snippets of code that provide access to real-time data on the web.

Application to Wastewater

HISTORIC COLLECTION

LOCAL WEATHER

SHORT TERM POPULATION SWINGS

PREDICTIVE COLLECTION PLANNING

Application to Wastewater

Produced

Water Process

– Production MGD

Consumed

Enterprise

– Fixed Based Metered Water MGD

Dirty

Wastewater Process

– Effluent MGD

Application to Wastewater

Produced Water → Consumed Water → Dirty Water
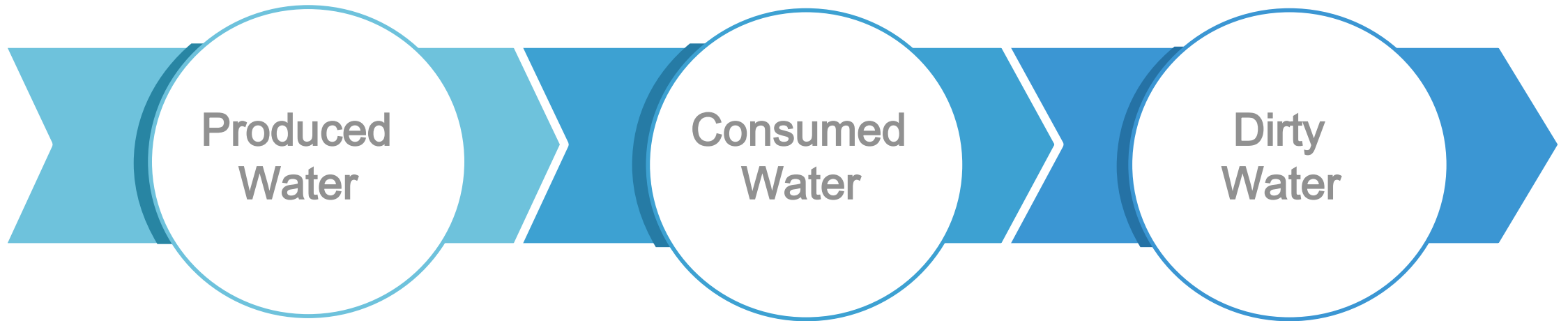
Total Water Lifecycle

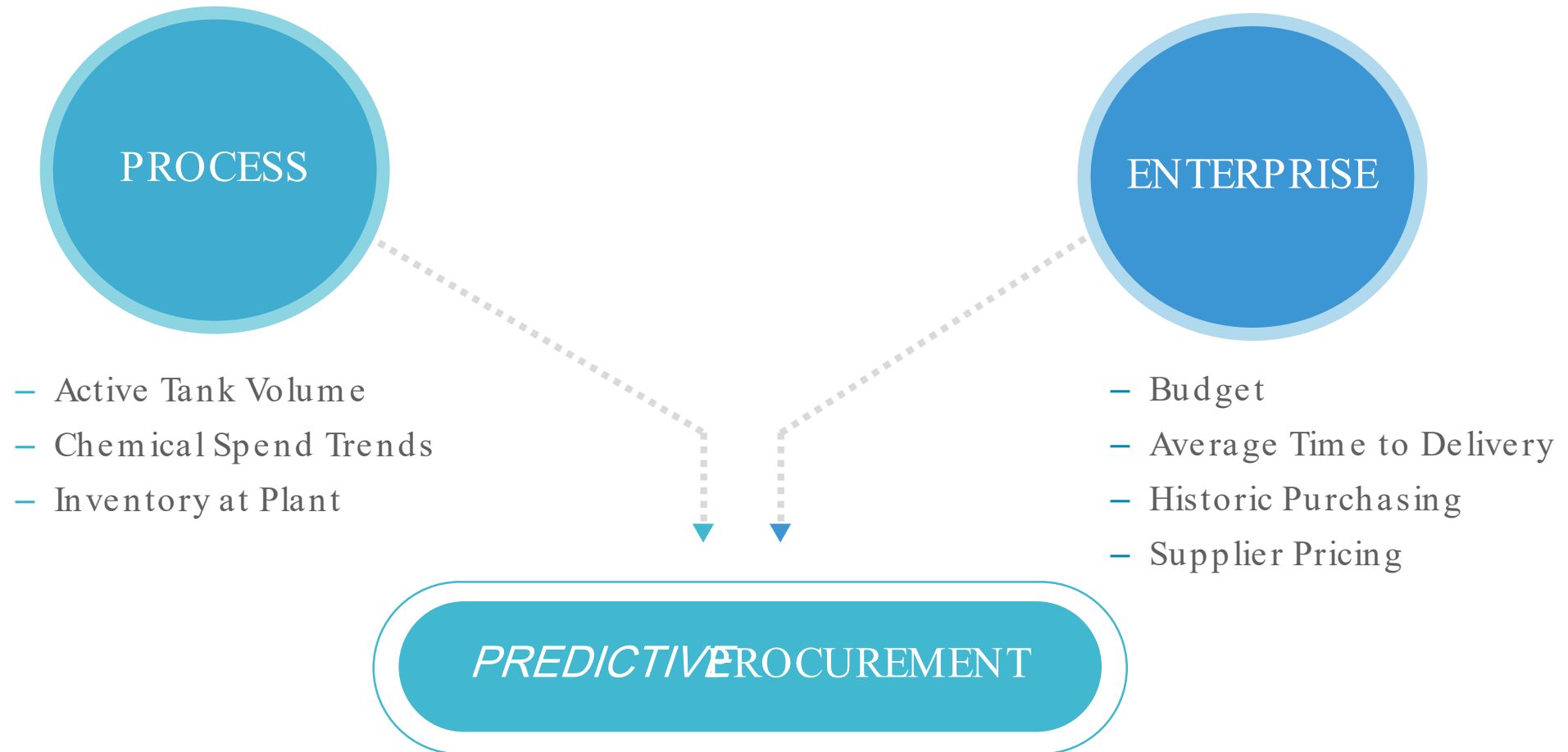# Application to Wastewater

Procurement

Chemical purchasing based on manual inventory or schedule

- Time spent performing inventory

- Purchasing department logistics

- Material handling costs

Application to Wastewater

PROCESS

– Active Tank Volume
– Chemical Spend Trends
– Inventory at Plant

ENTERPRISE

– Budget
– Average Time to Delivery
– Historic Purchasing
– Supplier Pricing

PREDICTIVE PROCUREMENT

DISCUSSION

Vicki McCorkle, PE
Senior Automation Engineer
T&M Associates
vmccorkle@tandmassociates.com | 614.408.9218