Better Plants
U.S. DEPARTMENT OF ENERGY

Industrial Water Systems
Virtual INPLT Training & Assessment

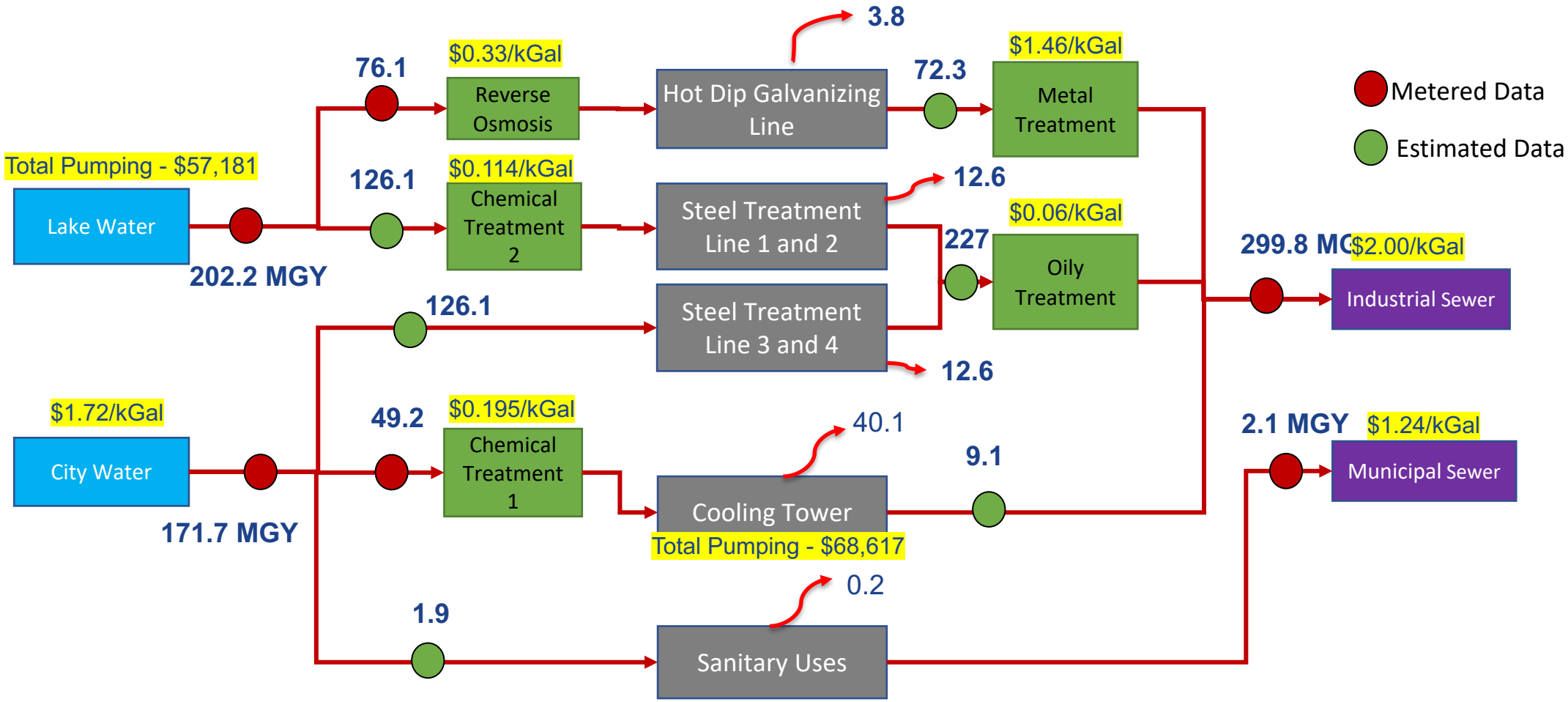
Session 4
Tuesday – July 6th, 2021
10 am – 12:30 pm

U.S. DEPARTMENT OF ENERGY

Review – Session 1 - 2

- Water Risks
- Industrial Water Assessment
  - Step 1 - Water Baselining
  - Step 2 - True Cost of Water
  - Step 3 - Identifying water savings opportunities
- Water Baselining
  - Plant Water Flow diagram
  - Data Collection (system level and facility level)
- True Cost of Water
  - Data Collection (water intake, discharge, treatment and embodied energy)

Example Facility – With Data (From Session 3)



Agenda – Session Four

Today's Content:

- Introduction to PWP Tool
- Benchmarking – Overview
- PWP – Working Session
- Kahoot Quiz Game
- Q&A

Plant Water Profiler Tool - Overview

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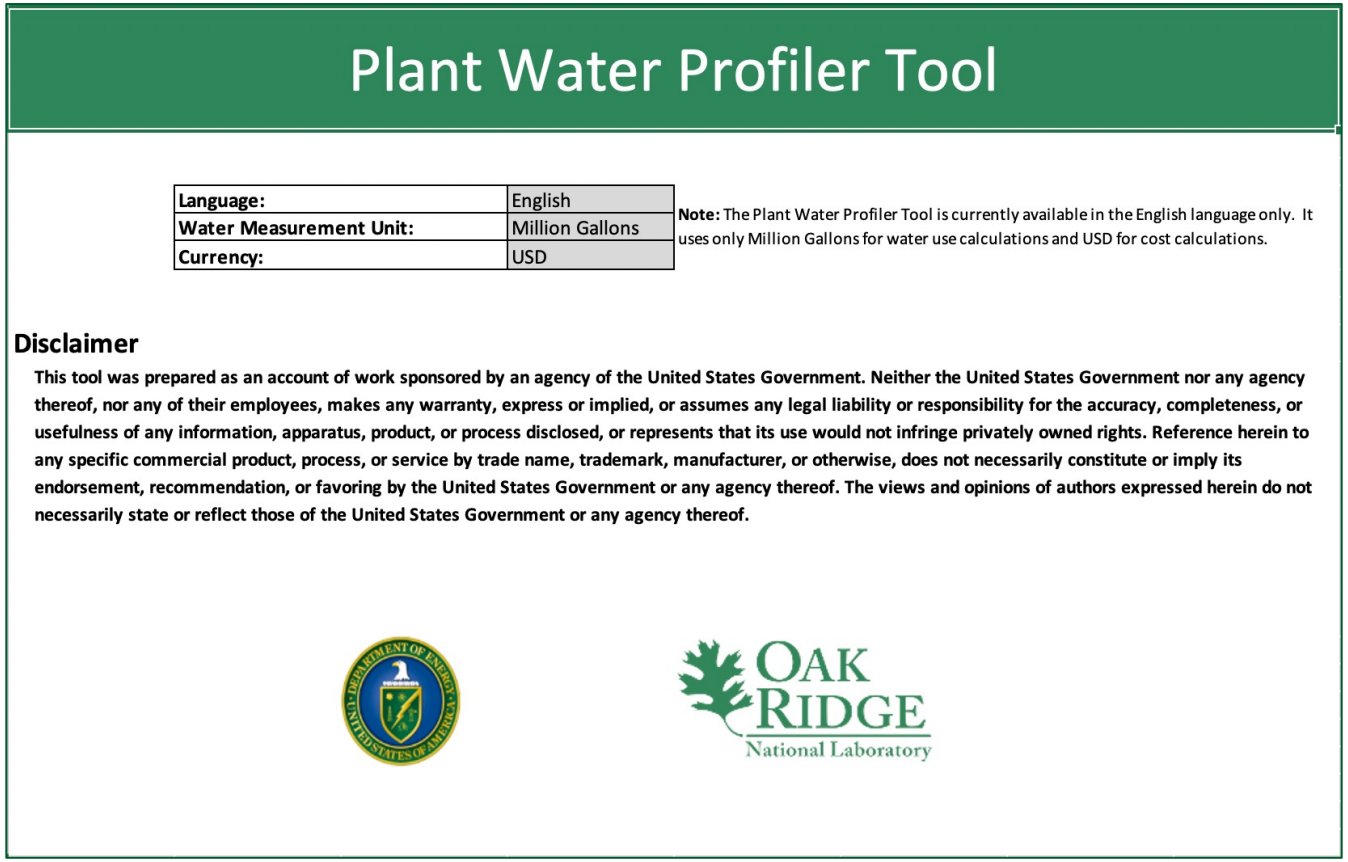
Plant Water Profiler (PWP) Tool

The Plant Water Profiler (PWP) tool is a comprehensive excel-based tool designed for use by manufacturing plants to help perform a facility level water assessment

https://www.energy.gov/eere/amo/plant-water-profiler-tool-excel-beta-version-pwpex-v01



Plant Water Profiler Tool

Language:	English
Water Measurement Unit:	Million Gallons
Currency:	USD

Note: The Plant Water Profiler Tool is currently available in the English language only. It uses only Million Gallons for water use calculations and USD for cost calculations.

Disclaimer

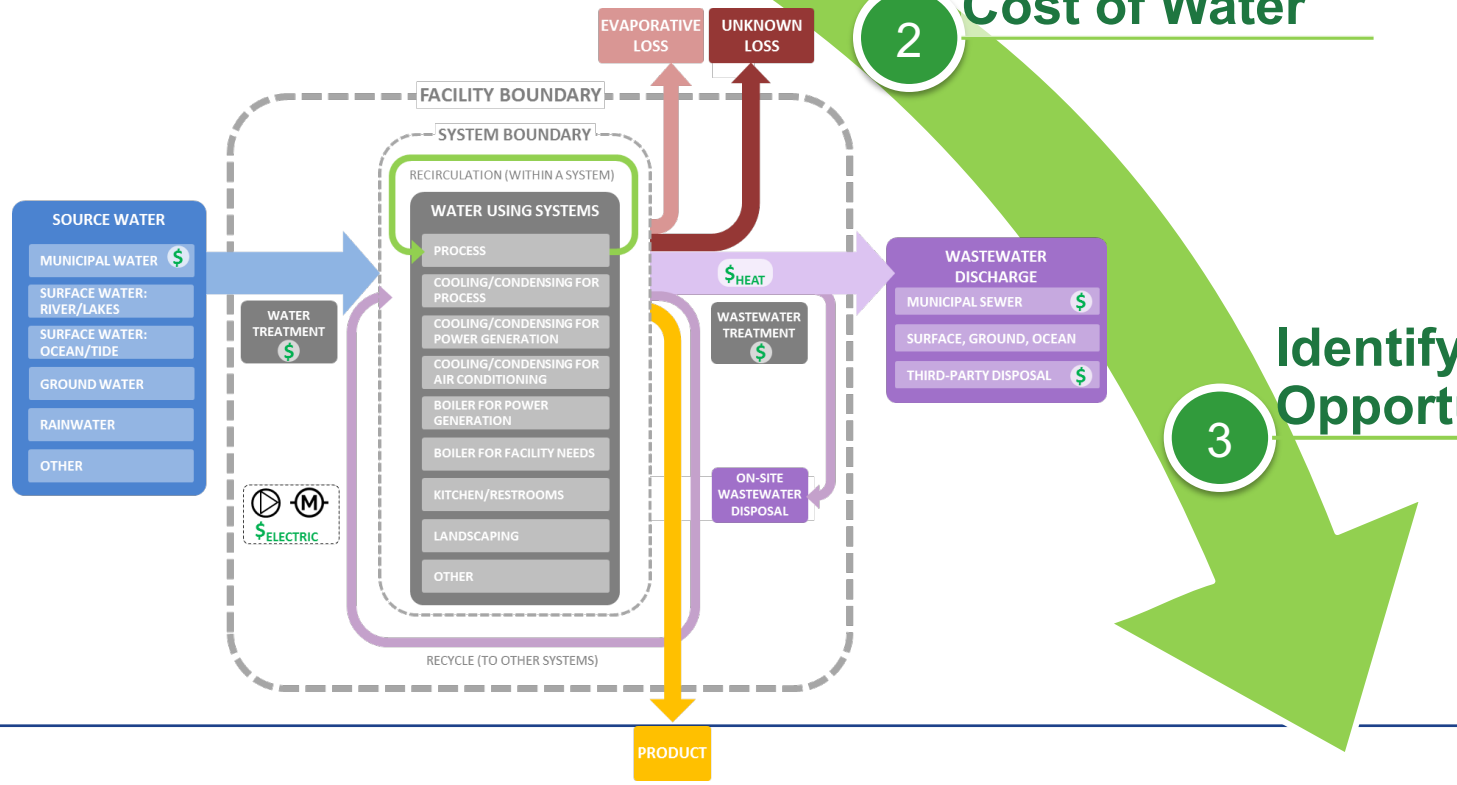
This tool was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PWP Tool Concept

1 Baseline Water Use and Water Balance

2 Determine True Cost of Water

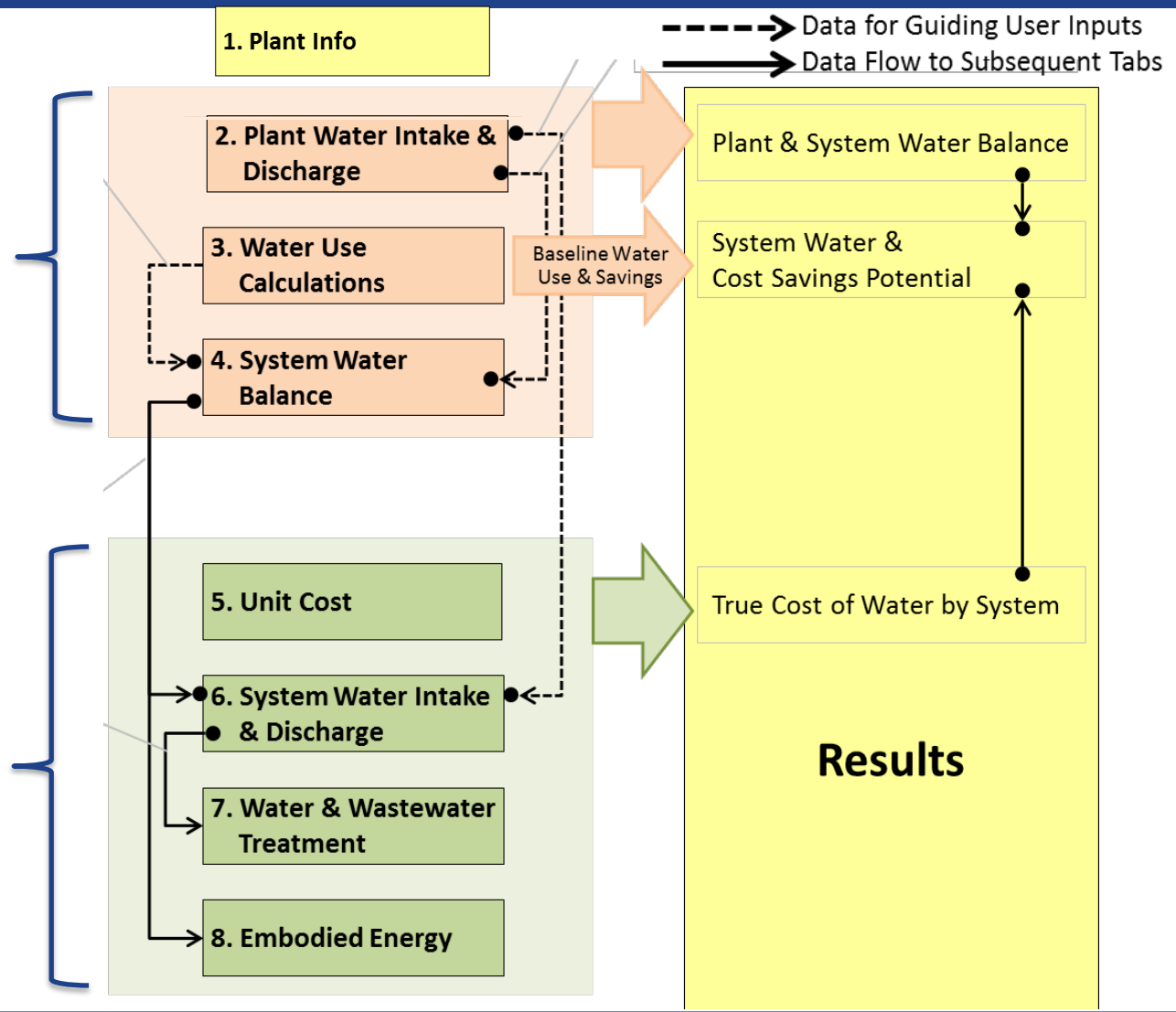
3 Identify Water Efficiency Opportunities



PWP Tool – Map

Baseline Water Use

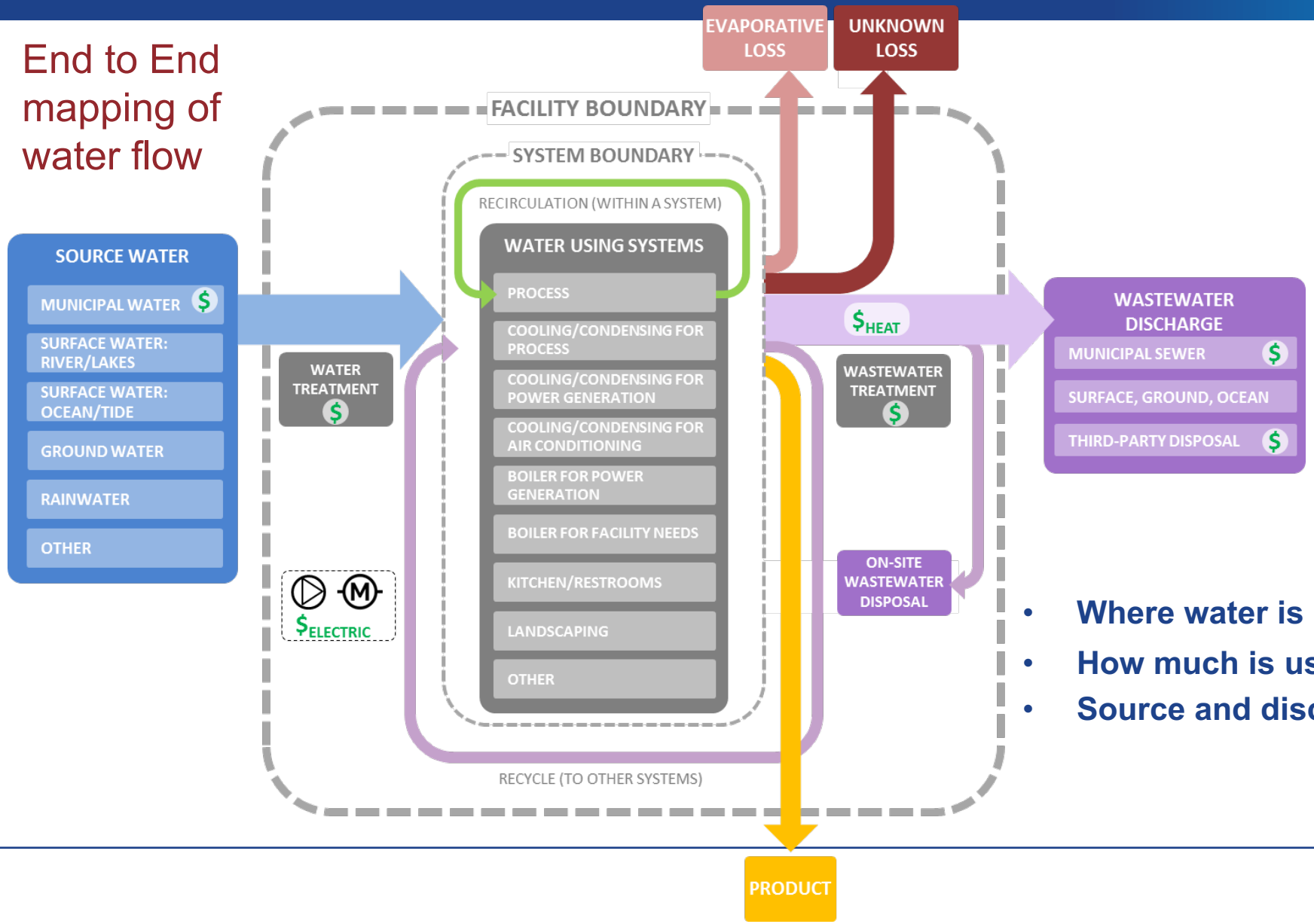
True Cost of Water



*Tab 9 and 10 associated with finding water savings opportunities

Step 1. Baselining water use

End to End mapping of water flow

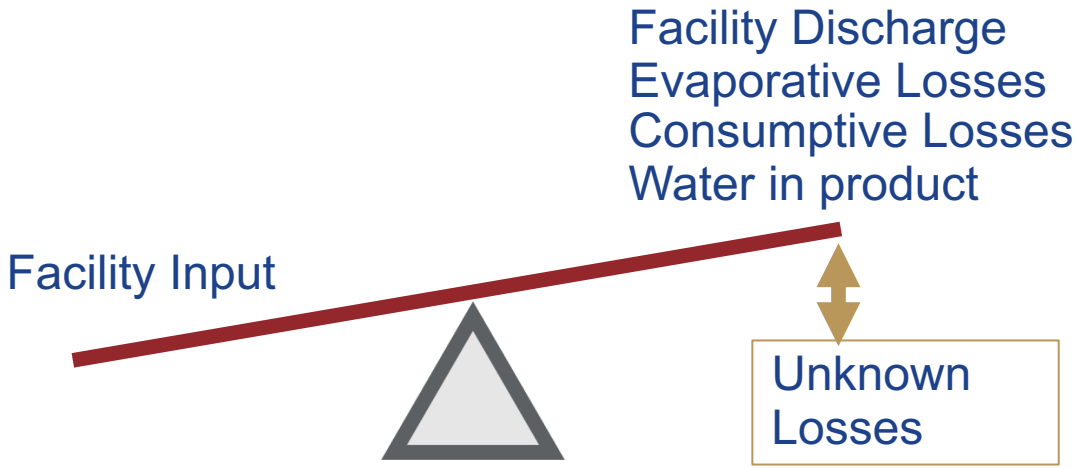


- Where water is used
- How much is used
- Source and discharge

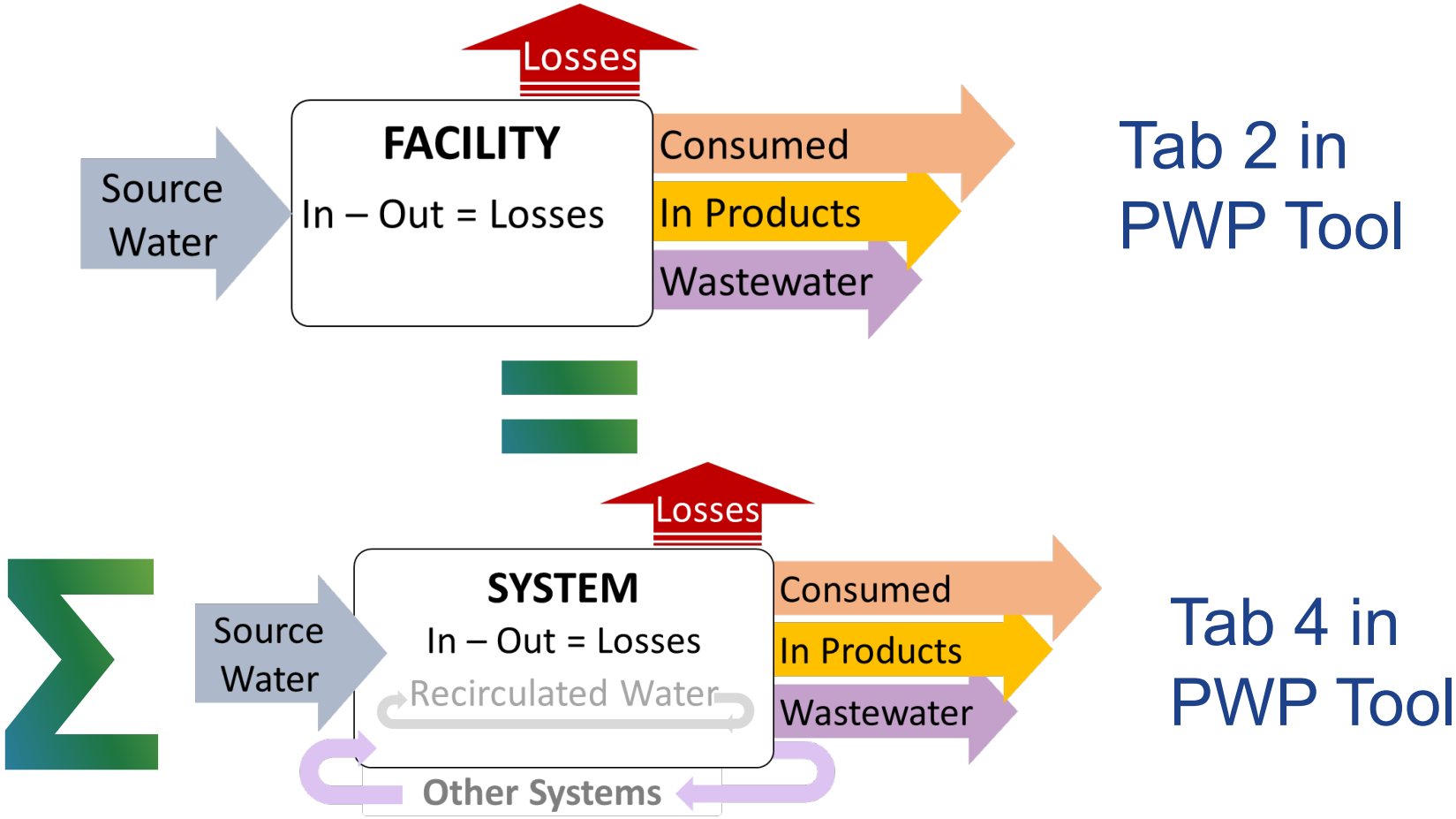
Step 1. Baselining water use (water balance)

- Total of all water used by individual **Systems** should equal **Plant Water Intake**

- **Plant Water Intake** should equal **Plant Water outflows**



Step 1 - Baseline Water Use and Water Balance



Tab 2 in PWP Tool

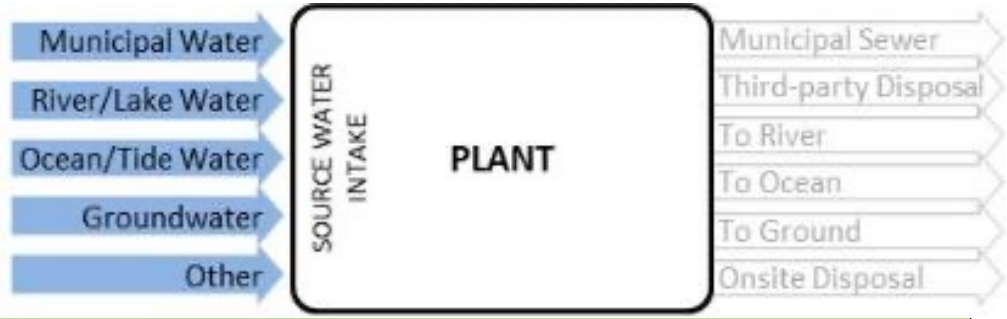
Tab 4 in PWP Tool

Tab 3 provides calculators to estimate system water consumption

Tab 2 – Plant Water Intake Table

Part 2.1 - Plant's Source Water Intake

Please select the data interval (i.e., monthly or annual) and provide an estimate of water intake in your plant from applicable water sources. You may also select a water source that is not listed in the table, such as rainwater, desalinated water, or other. Select the quality of water from the drop-down list.



Year	2018
Data Interval	Monthly

Month	Plant's Source Water Intake (Million Gallon)							
	Municipal Water Potable	Municipal Water Nonpotable	Municipal Water	River or Lake Nonpotable	Ocean or Tide	Groundwater	Other	Total
January	0.95			0.15				1.1
February	0.95			0.15				1.1
March	0.95			0.15				1.1
April	0.95			0.15				1.1
May	0.95			0.15				1.1
June	0.95			0.15				1.1
July	0.95			0.15				1.1
August	0.95			0.15				1.1
September	0.95			0.15				1.1
October	0.95			0.15				1.1
November	0.95			0.15				1.1
December	0.95			0.15				1.1
Annual								-
ANNUAL TOTAL	**11.4**	**-**	**-**	**1.8**	**-**	**-**	**-**	**13.2**

Note: *If the plant boundary encompasses the entire facility, ANNUAL TOTAL should match with Facility-Wide Annual Source Water Intake you have entered in Part 1.3, also shown here in the purple cell.* 13.2

Tab 3 – Example System Level Calculator

Yellow	Please input data ONLY in the yellow cells.
Orange	Please select from the drop-down menu in the orange cells.
Tan	Please DO NOT enter any data or delete values in the tan cells. They contain formulae.
Purple	Please DO NOT enter any data in the purple cells. They show values calculated elsewhere for guiding user input and cross-checking results.
Gray	Please DO NOT enter any data in the gray cells. They are not applicable to your plant.

Part 3.2 - Cooling Tower Water Use

This table calculates cooling tower water use in the plant. Please select the applicable cooling/condensing system and enter required data in the highlighted cells.
For "Load (Fraction of Chiller Tonnage)," the typical range is 0.5-0.8. For "Evaporation Rate per 10°F Temp. Drop," 0.85% is a typical value, and the typical range is 0.65% for moist climate to 1.0-1.2% for dry climate. For "Temp. Drop Across Cooling Tower," typical range is 10-15°F. For conductivity, first select "Conductivity Unit" from the drop-down list on the right and then enter data below.

Conductivity Unit:	µS/cm

Cooling Tower	Hours of Operation per Year	Cooling Tower Tonnage	Load Factor (Fraction of Tonnage)	Evaporation Rate per 10°F Temp. Drop (%)	Temp. Drop Across Cooling Tower (°F)	Makeup Water Conductivity µS/cm	Blowdown Conductivity µS/cm	Million Gallon per Year (% of Gross Water Use)				
								Gross Water Use	Incoming Makeup Water	Outgoing Blowdown	Outgoing Evaporation	Recirculated Water
Cooling Tower for: Process 1	2,912	250	0.8	0.85%	10	600	1,800	105 (100%)	1.34 (1.28%)	0.446 (0.425%)	0.891 (0.85%)	103 (98.7%)
Cooling Tower for: Air Conditioning	2,000	75	0.78	0.85%	10	600	1,800	21.1 (100%)	0.269 (1.28%)	0.0895 (0.425%)	0.179 (0.85%)	20.8 (98.7%)

Tab 4 – System Level Water Balance

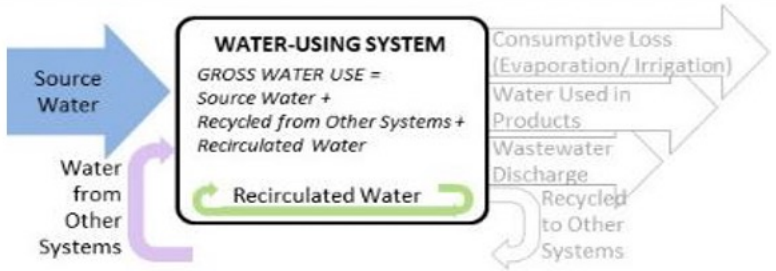
Part 4.1 - System Gross Water Use

For EACH water-using system, please provide an estimate of water use originating from different paths. ***Note:*** *You may use values in the purple cells, which were calculated in previous tabs, as a guide for your estimates in yellow cells, as shown below:*

** Use calculated Incoming Water (Source Water + Water From Other Systems) for user estimate for Source Water and Water From Other Systems.*

** Use calculated Recirculated Water for user estimate for Recirculated Water.*

** Use calculated Gross Water Use to cross-check TOTAL of User Estimate of Water Use.*



Water-Using System	Water Flows Calculated on Tab 3 (Million Gallon per Year)			Water Use (Measured or Estimated) (Million Gallon per Year)			
	Incoming Water (Source Water + Recycled From Other Systems)	Recirculated Water	Gross Water Use	Incoming Water		Recirculated Water	**Total (Gross Water Use)**
				Source Water	Recycled Water From Other Systems		
Process: Process 1	6.84	0.96	**7.8**	6.8		0.96	**7.76**
-	-	-	-				-
-	-	-	-				-
Cooling Tower for: Process 1	1.337	103.495	**104.832**	1.3		100.0	**101.3**
Cooling Tower for: Air Conditioning	0.269	20.791	**21.06**	0.3		20.79	**21.09**
-	-	-	-				-
Boiler for: Facility Needs	3.841	1.28	**5.121**	3.85		1.28	**5.13**
-	-	-	-				-
Kitchen and Restrooms	1.399	-	**1.399**	1.4			**1.4**
Landscaping and Irrigation	1.849	-	**1.849**		1.85		**1.85**
-							-
TOTAL	**15.533**	**126.527**	**142.06**	**13.65**	**1.85**	**123.03**	**138.53**

Note: *System-level TOTAL for Source Water should closely match with plant-level ANNUAL TOTAL calculated in Part 2.1, also shown here in the purple cell.* 13.2

Step 2. Determine True Cost of Water

Tab 5 - Define Unit Cost of all components – Typical Values are Provided

Tab 6 & 7 - Match unit cost with water flow volumes identified through water baselining

Tab 8 - Define the embodied energy components – Pumps, Fans and Heating

Tab 7 – Cost of Water and Wastewater Treatment

Part 7.1 - Onsite Water Treatment

Please select water treatment processes from the drop-down list for your plant. Enter a percent estimate of water that is treated for applicable incoming water categories. For example, if "Process A" receives water from "River," all of which undergoes "Water Treatment Process 1" and "Water Treatment Process 2," enter 100% in both cells of that row.

Water-Using System	Water from:	Quantity (Million Gallon per Year)	% of Water Use Undergoing Water Treatment	
			Water Treatment Process	
			Reverse Osmosis	Lime Softening
Process: Product Cooling	Municipal Water: Potable	6.8	100%	
	River or Lake: Nonpotable	-		
	Water from Other Systems	-		
	Recirc. within System	-	100%	
Cooling Tower for: Process 1	Municipal Water: Potable	-		
	River or Lake: Nonpotable	1.3		100%
	Water from Other Systems	-		
	Recirc. within System	100.0		

Step 3. Identify water opportunities – Tab 9 & 10

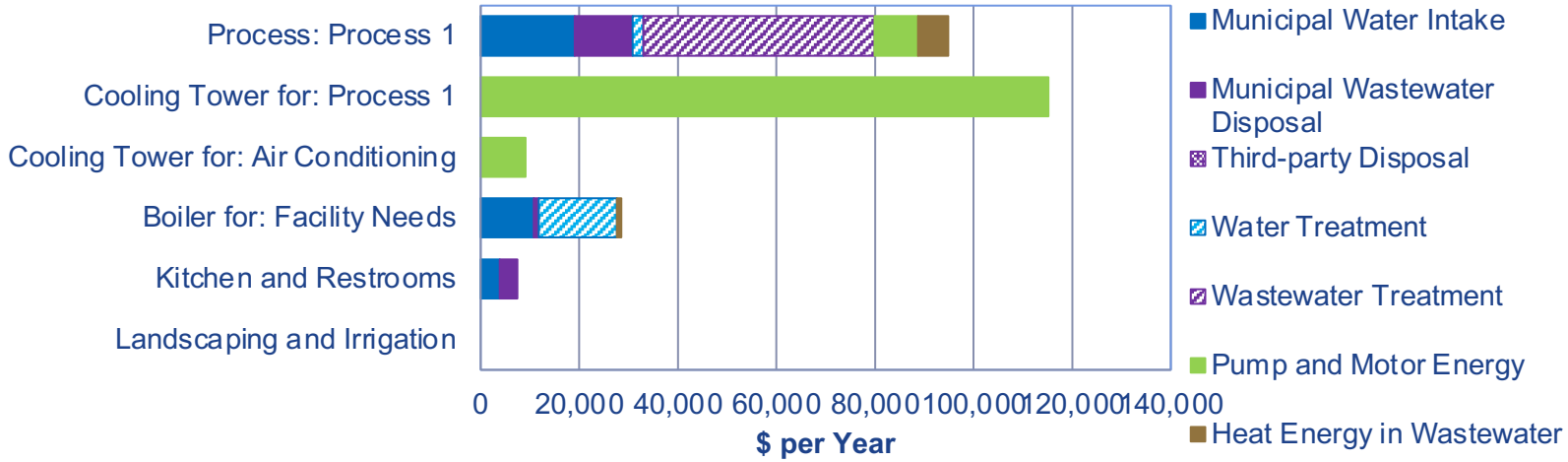
Checklist of plant and system level measures

User answers questions to evaluate water efficiency status on system-level and to identify potential opportunities.

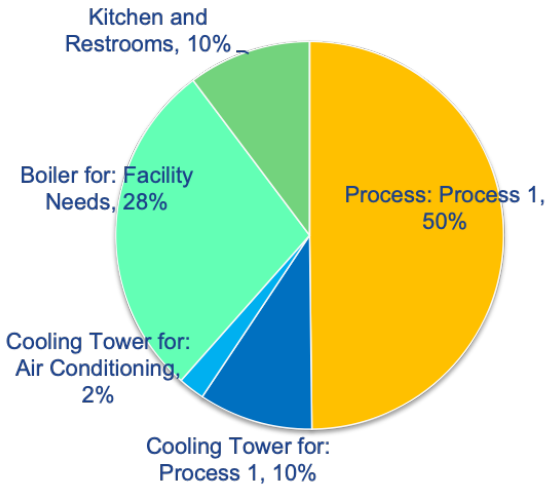
System Water Efficiency Status	Response
Process	
Cooling/condensing for process	
Has once-through cooling water been eliminated with the use of chillers, cooling towers, or air-cooled equipment?	No
Has blow-down/bleed-off control on cooling towers been optimized?	No
Is treated wastewater (or other sources of water for cooling tower make-up) reused where possible?	No
Are cycles of concentration for cooling towers maximized through efficient water treatment?	No
Cooling/condensing for air conditioning	
Boiler for Facility	
Kitchen and Restrooms	
Landscaping	

PWP results

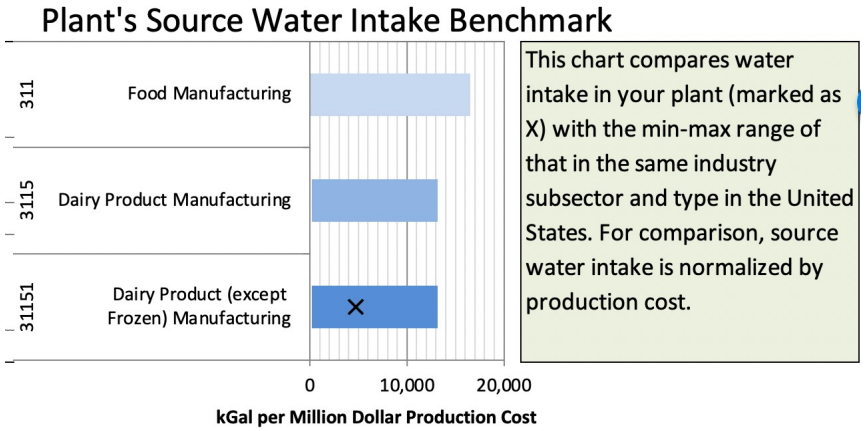
True Cost of Water



Water Intake by System



Comparison with Industry Average



Water Imbalance by System

Water-Using System	Incoming Water	Outgoing Water	Water Imbalance		
	Million Gallon per Year		Million Gallon Per Year	% of Incoming Water	% of Total Loss
Process: Process 1	6.8	6.405	0.395	5.8%	87.2%
Cooling Tower for: Process 1	1.3	1.3	-	-	-
Cooling Tower for: Air Conditioning	0.3	0.27	0.03	10.0%	6.6%
....					
PLANT TOTAL	**15.5**	**15.047**	**0.453**	**16.5%**	**100.0%**

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Acknowledgement

Industry Partners

- Saint-Gobain North America #, ⊗
- Ford Motors *
- KYB *
- ArcelorMittal ⊗
- Owens Corning ⊗
- ALCOA
- Arconic
- General Motors

* Provided beta testing feedback
# Provided case study
⊗ Hosted Water INPLT Pilot Training

Sponsor

Advanced Manufacturing Office
US Department of Energy

Development, Advising and Outreach

Mini Malhotra, Sachin Nimbalkar, Kristina Armstrong, Thomas Wenning, Sujit Das, Daryl Cox, and Wei Guo
Oak Ridge National Laboratory

Joe Cresko, Eli Levine, Bruce Lung, Andre Defontaine, and Sandy Glatt
US Department of Energy

William Morrow and Prakash Rao,
Lawrence Berkeley National Laboratory

Alberta Carpenter and James McCall
National Renewable Energy Laboratory

Diane Graziano, Sarang Supekar, and Nwike Iloeje
Argonne National Laboratory

Benchmarking in PWP Tool

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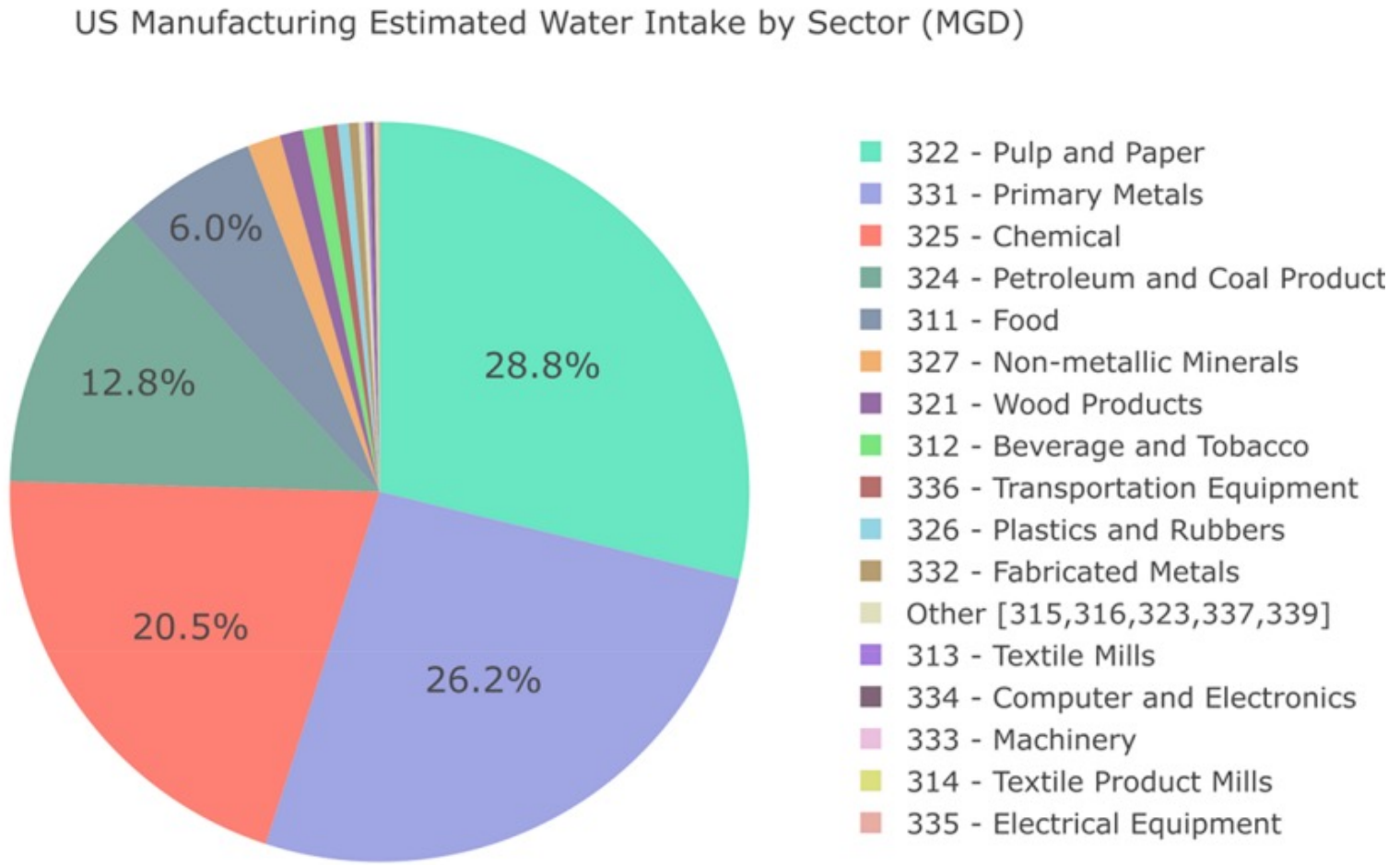
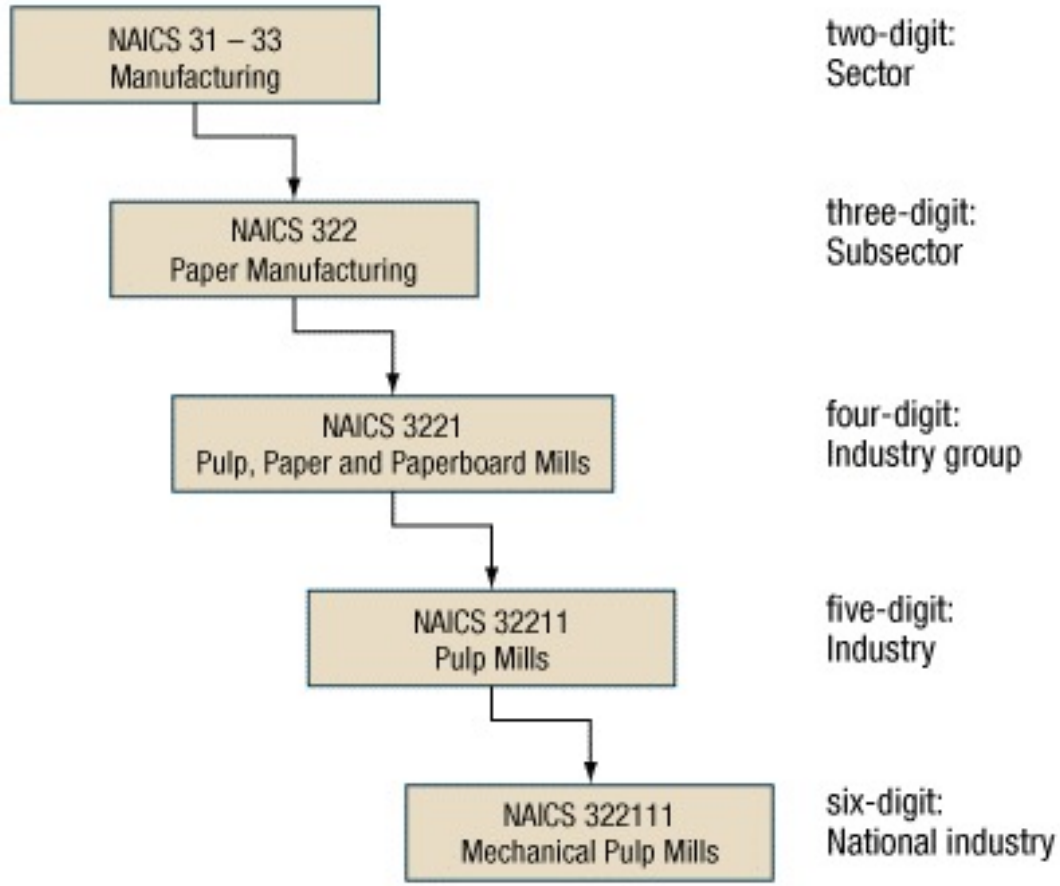
Review from session 1-
Nationally, water intake is reported by aggregated sectors (NAICS)



Source: P Rao et.al. "Evaluation of US Manufacturing Subsectors at Risk of Physical Water Shortages

Water use by NAICS

The North American Industry Classification System (NAICS) is the standard used by federal statistical agencies to classify businesses in US, Canada, and Mexico

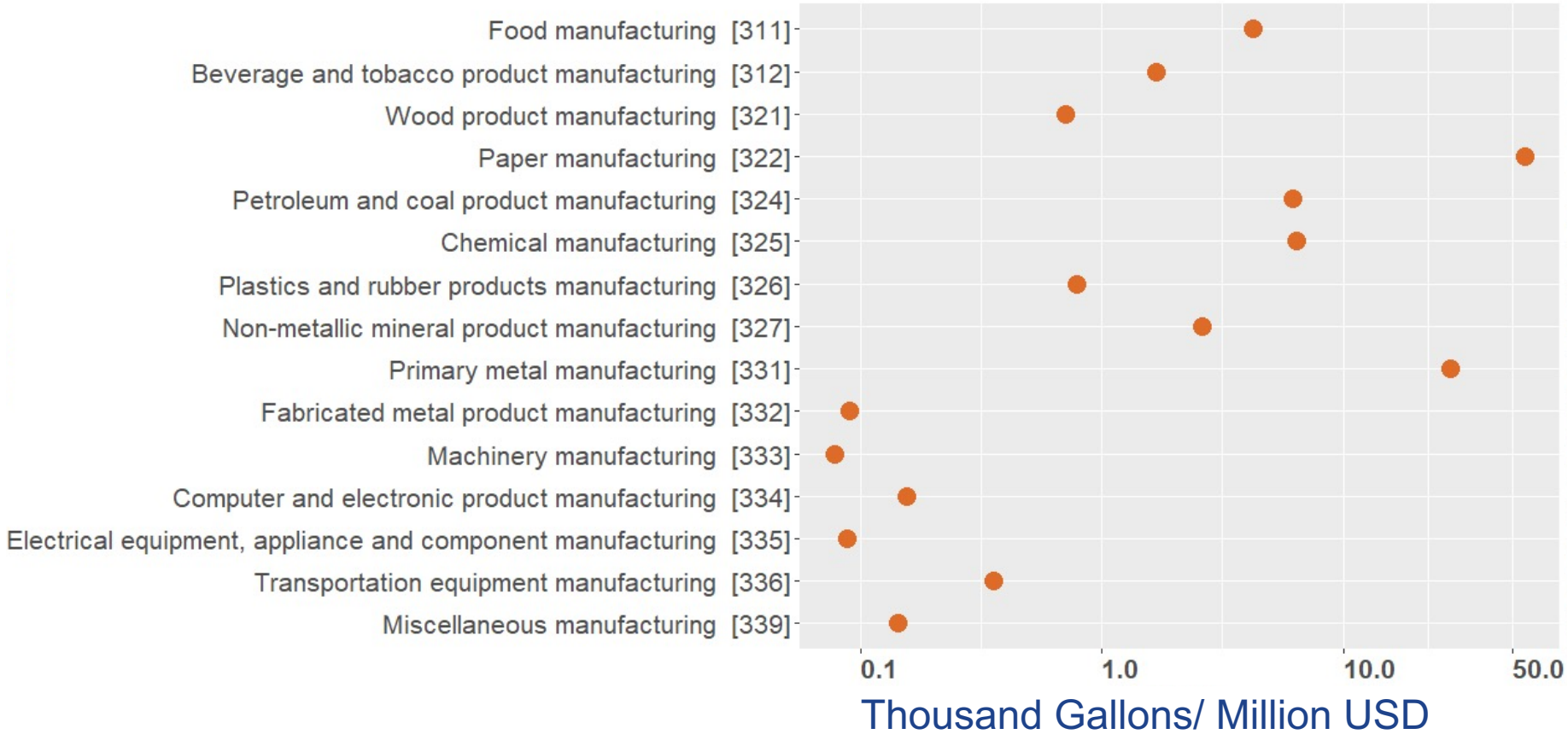


We have participants from:

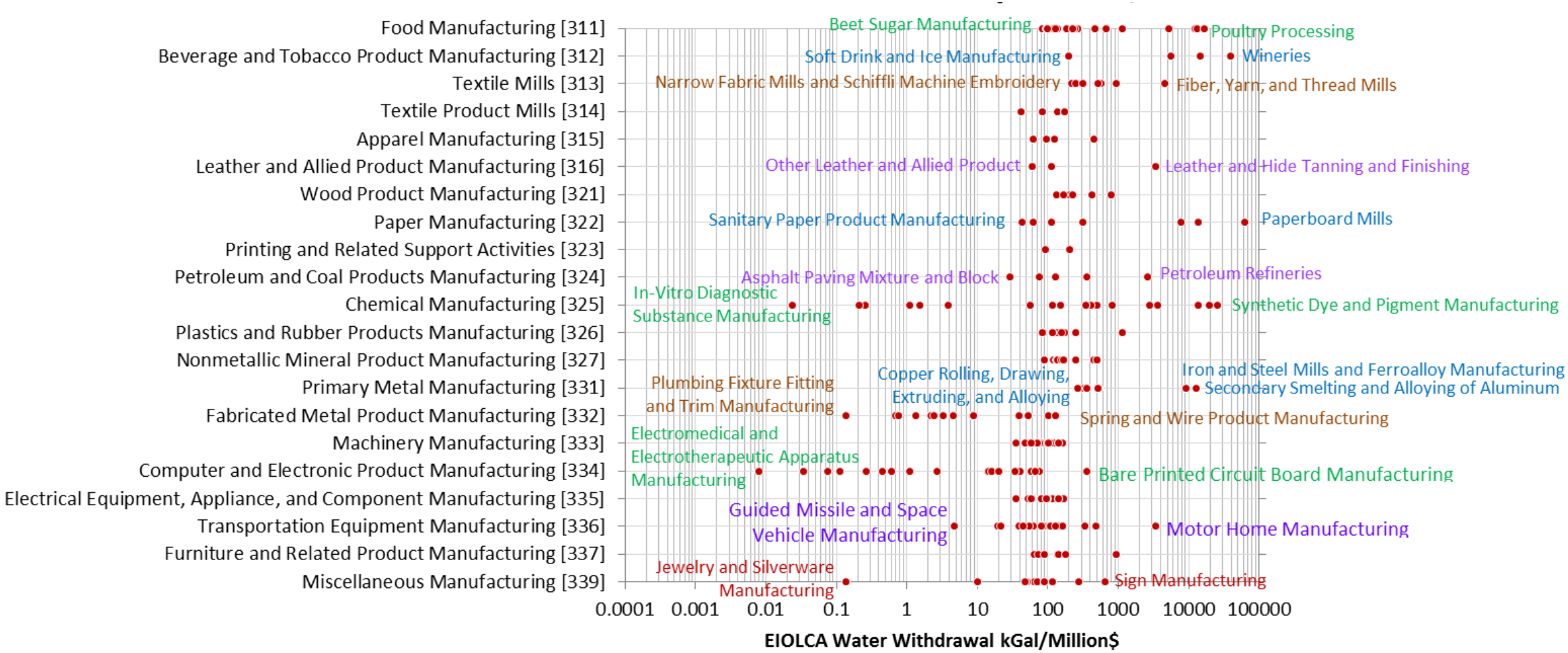
NAICS	Sector
311	Food Manufacturing
322	Pulp, paper
325	Chemicals
326	Plastics
327	Clays
331	Iron & Steel
333	Machinery
335	Appliances and equipment
336	Motor vehicle & aerospace
337	Furniture

Canadian water use data

Canada has been collecting data through surveys and reports water use by 3-digit NAICS code. This can help facilities benchmark their water consumption



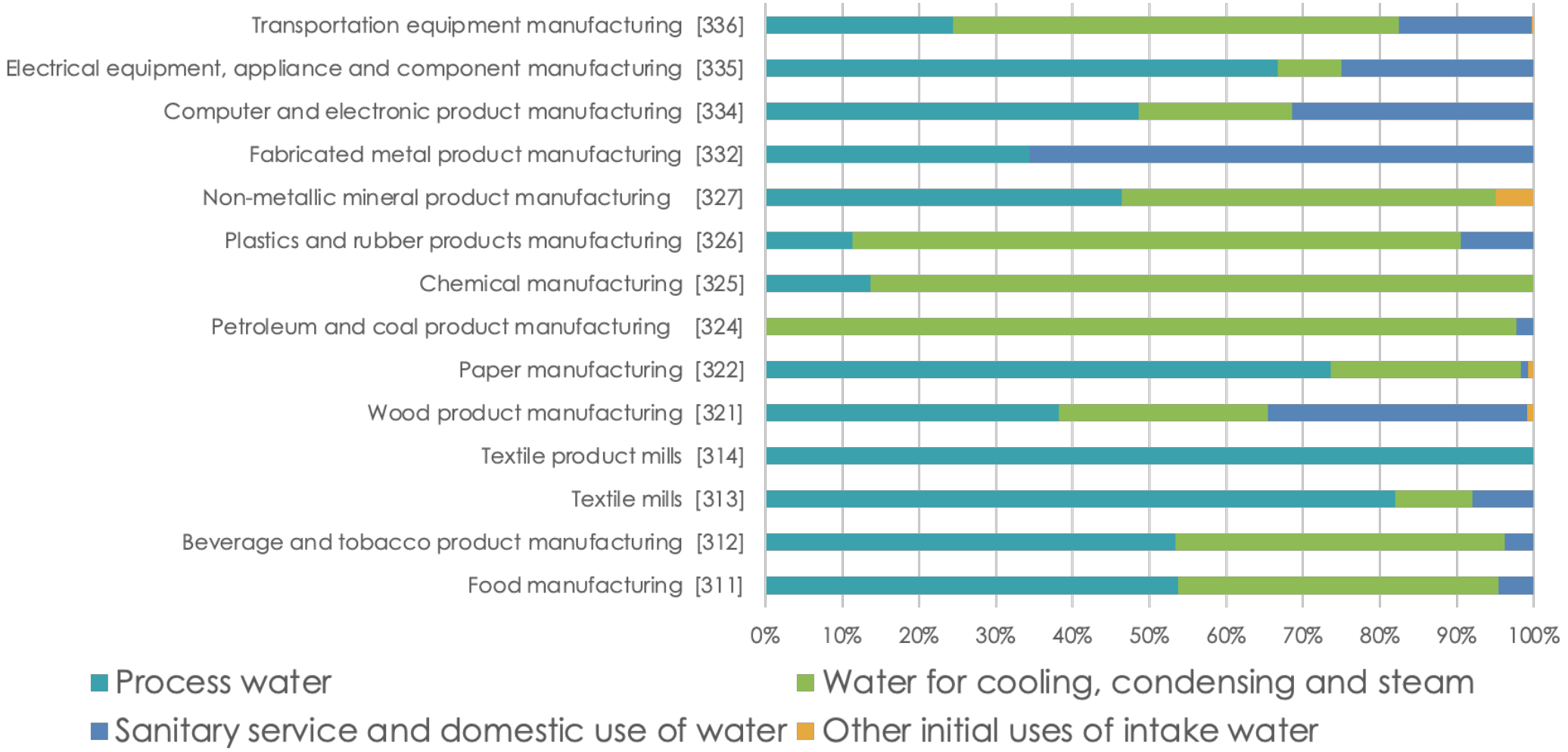
Researchers have used regression models to estimate water intake at 6-digit NAICS code for the U.S. economy. (Values used in PWP tool)



Estimates based on:

Blackhurst, B. Y. M., Hendrickson, C., & Vidal, J. S. I. (2010). Direct and indirect water withdrawals for U.S. industrial sectors. *Environmental Science & Technology*, **44**(6), 2126– 2130.

Statistics Canada also provides a general overview of process level uses by sector



Key points to remember about benchmarking

Remember there is high variability and uncertainty in the estimates because of lack of data. Use estimates and average with caution.

We are aware that facilities in water-stressed regions may be already implementing water saving strategies. Their water intake may be much lower than the averages. (e.g.: facilities in Western U.S. or Mexico).

Your facility may decide to use a different metric than gallons/$. (e.g.: gallons/tons, gallons/employee*day, gallons/hours of operation).

For our participants in Brazil:

Facilities outside of North America may check NAICS codes in www.naics.com.

You may find your local water intake estimates through your local water agency (*"Agua na Industria – Uso e coeficientes tecnicos" Agencia Nacional de Aguas*).

PWP – Working Session

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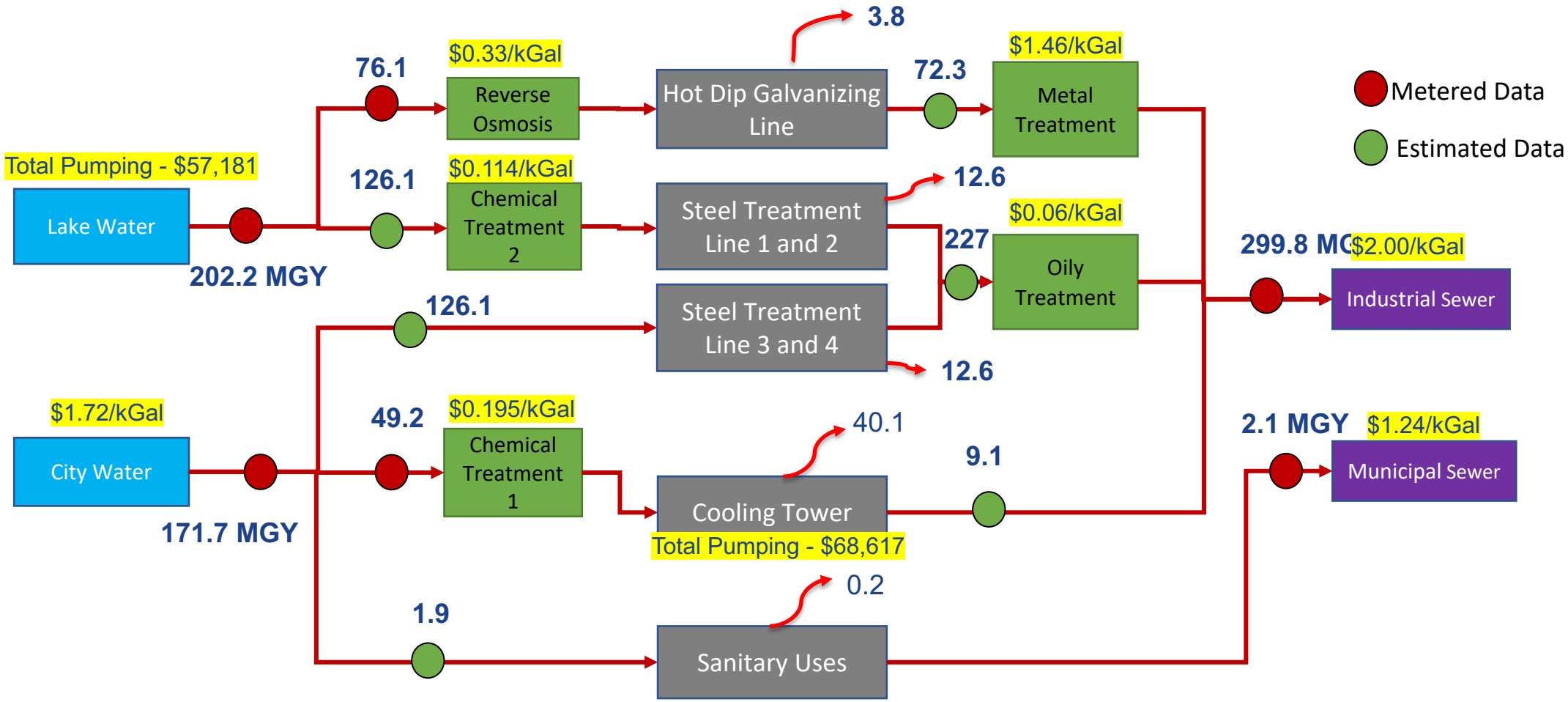
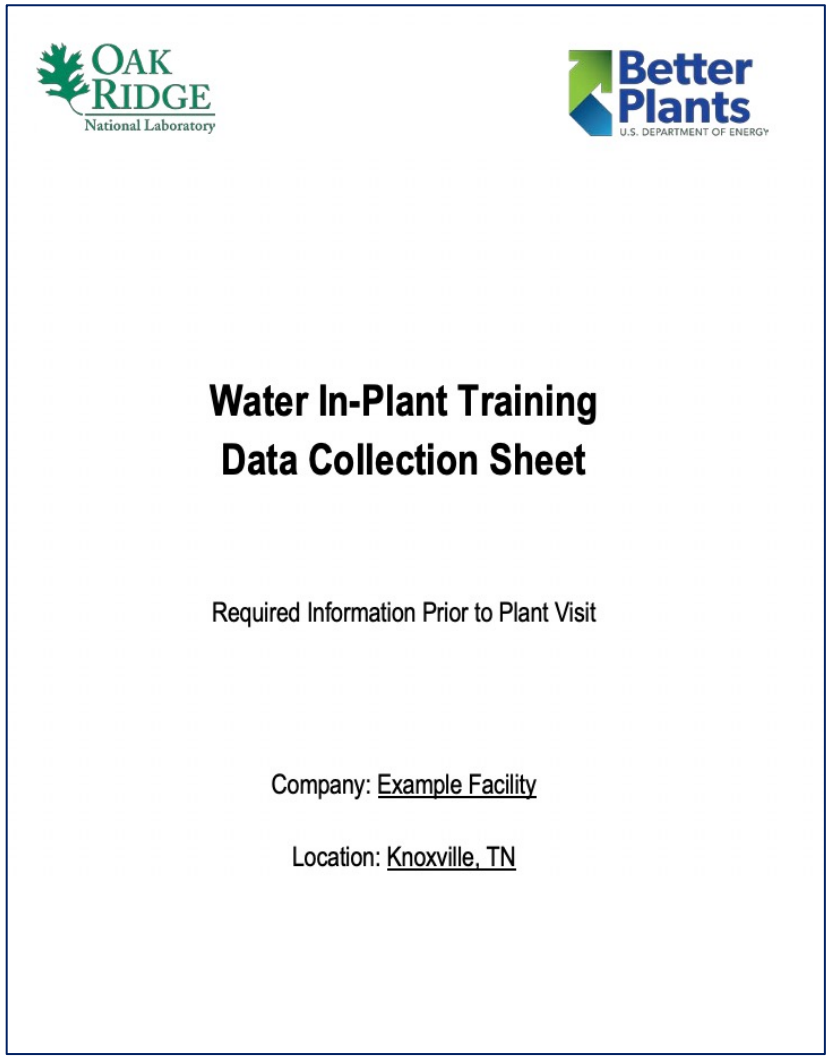
Example Facility – With Data



Data Collection Sheet

Helps collect all the necessary data to complete the Plant Water Profiler Tool



OAK RIDGE National Laboratory

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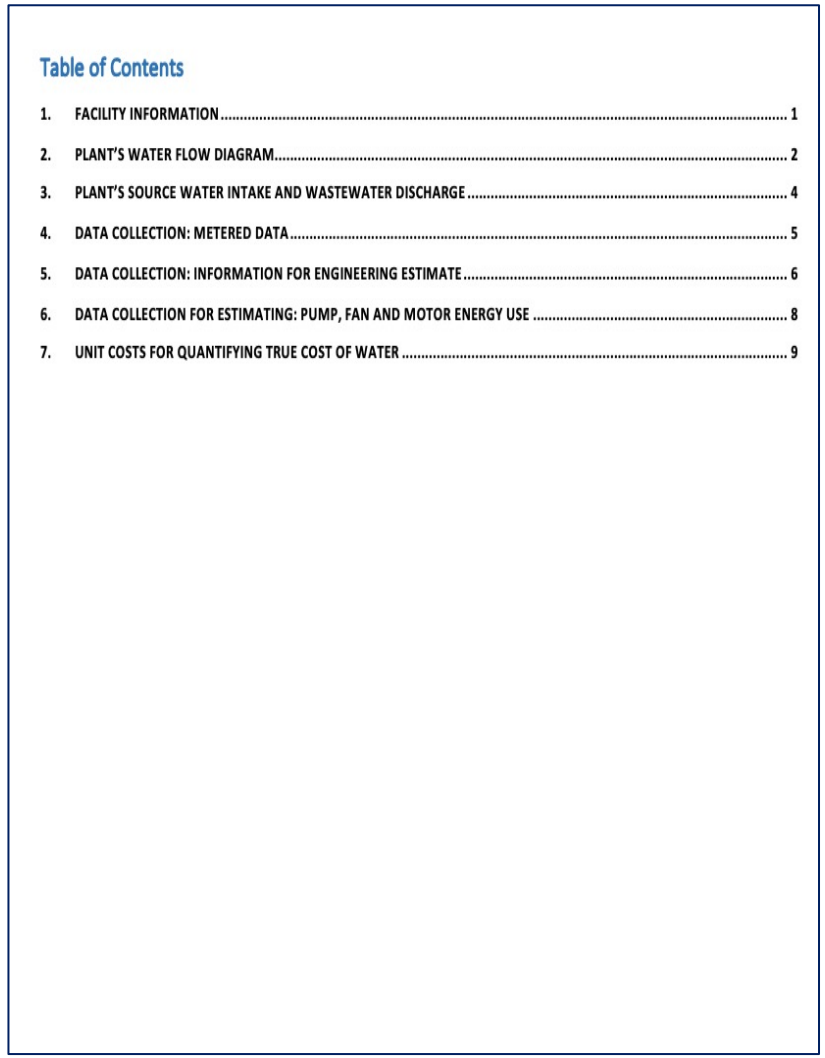
Water In-Plant Training
Data Collection Sheet

Required Information Prior to Plant Visit

Company: Example Facility

Location: Knoxville, TN



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Open Discussion

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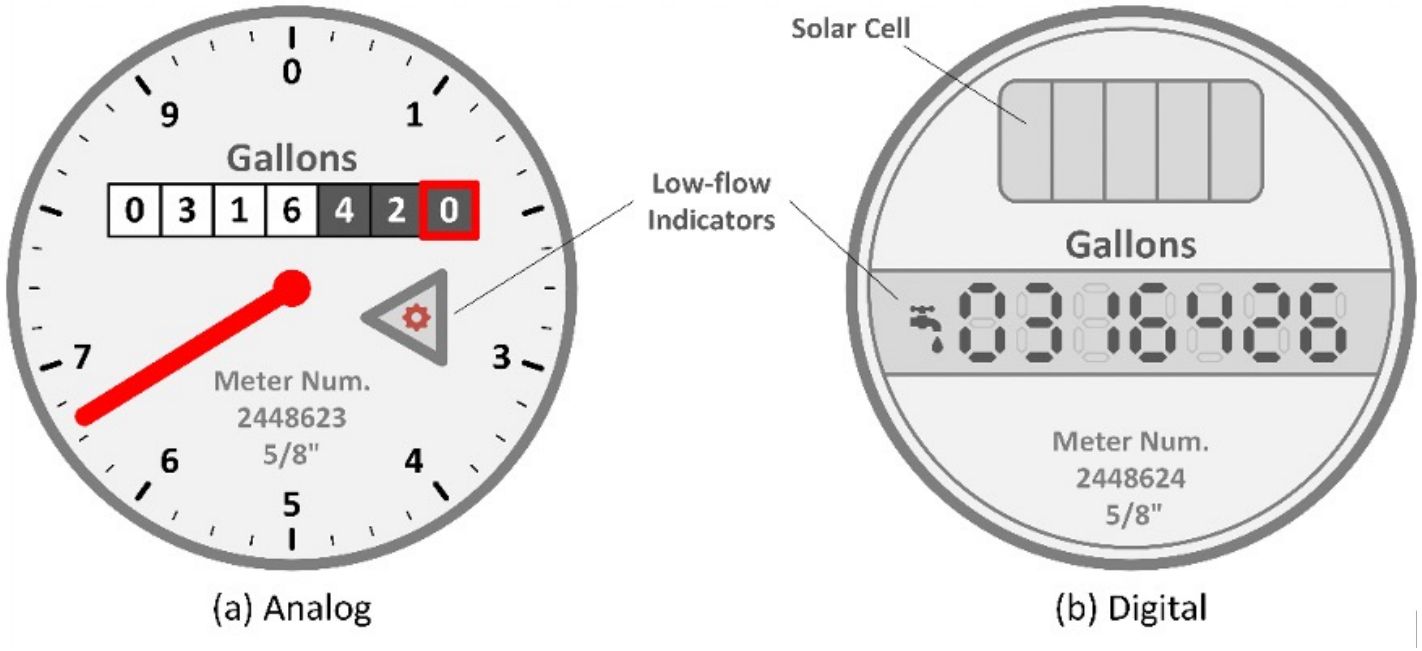
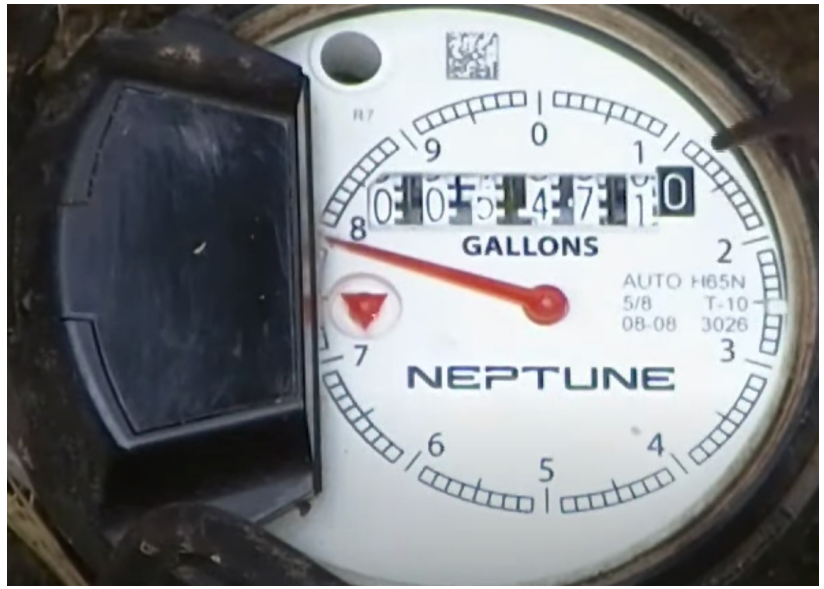
Reading Meters



Analog meters are read by reading the rolling tick dial which records to the tens place.

The value in the red box fixed and the last whole digit is read by reading the sweeping hand



Both reading 316,426 gallons

Thank You all for attending today's webinar.

See you all on next Tuesday – July 13th, 2021 – 10 am ET

If you have specific questions, please stay online and we will try and answer them.

Alternately, you can email questions to me at thirumarank@ornl.gov

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